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ASTRONAUTICS AND AERONAUTICS, 1979-1984

A CHRONOLOGY

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

ASTRONAUTICS AND AERONAUTICS, 1979-1984

A Chronology

by Bette R. Janson and Eleanor H. Ritchie

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NASA maintains an internal history program for two principal reasons. (1) Sponsorship of research in NASA-related history is one way in which NASA responds to the provision of the National Aeronautics and Space Act of 1958 that requires NASA to "provide for the widest practicable and appropriate dissemination of information concerning its activities and the results thereof." (2) Thoughtful study of NASA history can help agency managers accomplish the missions assigned to the agency. Understanding NASA's past aids in understanding its present situation and illuminates possible future directions. Selection of items for inclusion in the chronology is the responsibility of the History Office employee assigned to assemble them; omission or manner of treatment has no relationship to agency policy.

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Preface

Astronautics and Aeronautics for 1979-1984 completes the series of annual chronologies of events in aeronautics, aviation, and space science and exploration prepared by the History Division of the National Aeronautics and Space Administration since 1961. The concluding volume of the series, *Astronautics and Aeronautics* for 1985, was published in 1988.

The present volume was written by Bette R. Janson and Eleanor H. Ritchie under the editorial supervision of the director of the NASA History Division. Items for inclusion in this volume were collected by Eleanor H. Ritchie and Lee D. Saegesser of the NASA History Division.

As with any work of this nature, its extensive scope has made the use of primary sources prohibitive. Thus, entries are based largely on normally reliable secondary sources. All entries are followed by their sources to provide researchers guides for further investigations.

July 1989

Sylvia D. Fries
Director, NASA History Division
Washington, D.C.

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ASTRONAUTICS AND AERONAUTICS, 1979

January

January 1: The International Telecommunications Satellite Organization (INTELSAT) announced that this week it would complete taking over all of its own managerial and operational activities, performed by the U.S. Communications Satellite Corporation (ComSatCorp) since INTELSAT's founding in 1964. ComSatCorp had been handing back responsibilities gradually since 1973 and would continue to provide technical and laboratory services under contract. Jobs done by ComSatCorp had included procuring spacecraft and launch services, operating and maintaining facilities, carrying out technical studies, and performing research and development. This would be the first time in INTELSAT history that it would incorporate all of its own executive functions, both administrative and technical. (INTELSAT Release 79-1-1)

January 2: Wire services reported that an explosion that damaged a Space Shuttle engine during test firing at Bay St. Louis, Miss., on December 27 might delay the first Shuttle launch, now scheduled for the end of September. Further tests would await determining the cause of the accident—apparently failure of a valve in a high-pressure pump feeding oxygen to a combustion chamber. The engine had completed 255 seconds of a 52-second test firing when the pump exploded, damaging the engine, and NASA would also need 3 to 4 weeks to repair damage to the test stand. Last September, when NASA announced delay of the first launch, originally scheduled for March, Associate Administrator John F. Yardley warned of further delays "if unforeseen problems arise or the tests are not entirely successful." (*NY Times,* Jan 2/79 [UPI], A-13; *W Post,* Jan 4/79 [AP], A-2)

January 3: George C. Marshall Space Flight Center (MSFC) announced that the five "payload specialists" selected last July to operate experiments on the first Spacelab mission in 1981 would begin training January 9 at seven cities in the United States and two in Canada. Selection and training of non-NASA scientists to fly in space was a "famous first" for NASA; the scientists chosen by their colleagues having experiments aboard the Spacelab would be the first noncareer astronauts and would include the first Western Europeans and the first non-U.S. citizens to fly on a U.S. space mission. Three payload specialists were Europeans: Ulf Merbold of West Germany, representing Max-Planck Institute of Stuttgart; Claude Nicollier of Switzerland, representing Europe's Space Technology Center (ESTEC); and Wubbo Ockels of the Netherlands, representing Groenigen University. U.S. selectees were Michael L. Lampton of the University of California at Berkeley and Byron K.

Lichtenberg of the Massachusetts Institute of Technology (MIT). Since October 1978, the five had been in Europe learning to operate experiments designed by European scientists. Two of the selectees would actually fly on Spacelab 1, and the other three would operate the experiment equipment on earth.

Spacelab 1 would carry 40 instruments, about equally divided between NASA and European Space Agency (ESA) experiments in terms of weight, volume, and power requirements; fields of investigation would include solar physics, space plasma physics, stratosphere and upper-atmosphere physics, biology, medicine, astronomy, earth observation, materials processing, and technology areas, such as thermodynamics and lubrication. After leaving MSFC, the trainees would visit Redondo Beach (Calif.), the Johnson Space Center (JSC), Philadelphia, Boston, and Montreal (Quebec) and Toronto (Ontario) in Canada; return to JSC in Houston; visit Palo Alto, Calif; and be back at MSFC in Huntsville on March 22. (MSFC Releases 79-1, 79-4)

• MSFC reported that a delegation from the People's Republic of China (PRC) visiting the United States since November would arrive at MSFC January 5 to investigate peaceful uses of space technology. Following up a visit to the PRC last July by Presidential Science Advisor Dr. Frank Press, the Chinese delegation, accompanied by NASA representatives, had visited several NASA centers and U.S. aerospace industry establishments. Among items of interest to the visitors at MSFC would be the Space Shuttle orbiter Enterprise, currently undergoing tests.

The PRC representatives were to be in the United States until mid-January and had concluded an informal agreement on developing a civilian communications system for the PRC and on buying equipment to receive Earth resources data from Landsat remote-sensing satellites. NASA Administrator Dr. Robert A. Frosch headed the U.S. delegation, and Dr. Jen Xin-min, director of the PRC's Academy of Space Technology, headed the PRC delegation. (MSFC Release 79-2)

January 7: The *New York Times* reported that a huge international scientific project supported by 147 nations would begin this week. The $500 million Global Weather Experiment (GWE), part of the Global Atmospheric Research Program (GARP), would be a joint effort of the World Meteorological Organization and the International Council of Scientific Unions, financed by the meteorological group. It would expand the existing World Weather Watch, now generating more than 40,000 daily observations, by using 10 satellites, 50 research vessels, 110 aircraft, 300 high-altitude constant-level balloons, and 300 instrumented ocean buoys, in addition to other measuring devices.

The widely dispersed instruments and large numbers of scientists would study seasonal weather cycles in Earth's atmosphere and would gauge the practical limits of present technology for weather forecasting, to compile what would be the most complete record of global weather data ever attempted.

Twice daily, about 50 oceanographic research ships from 22 nations would release balloon-borne packages for atmosphere measurements; U.S. researchers would release 150 balloons in the Atlantic and Pacific oceans to monitor winds and temperatures at an altitude of 47,000 feet. Satellites would record wind forces and directions by photographing changes in cloud shapes and positions; they and other spacecraft would record atmospheric temperature and humidity as well as ocean rainfall and sea surface temperatures.

The head of the U.S. team, Rex Fleming of the National Oceanic and Atmospheric Administration (NOAA), said that the belt of tropical oceans around Earth's equator was an enormous heat sink absorbing solar energy and creating much of the world's weather and that observations there were meager. "This will be the first time that an annual record of weather data will have been taken over the whole world," Fleming said. "The world can't afford to do this every year, but we hope from all this to design a weather-observance system that the world can afford." U.S. organizations besides NOAA taking part in the GWE would include the Departments of Commerce (DOC), Defense (DOD), Energy (DOE), Interior, State, and Transportation (DOT); the National Center for Atmospheric Research; NASA; the National Science Foundation (NSF); Defense Nuclear Agency; the Air Force, Army, Navy, and Coast Guard; and many academic institutions. (*NY Times*, Jan 7/79, 1)

January 10: NASA reported that its first high-energy astronomy observatory, *Heao 1,* had exhausted its attitude-control gas supply, ending a 17-month mapping of celestial X-ray sources. Launched August 12, 1977, and designed for a 6-month lifetime, *Heao 1* had returned data of such quality that NASA had extended its mission. Its systems and experiments had functioned well throughout, though the primary mission ended in February 1978. Results included raising the number of X-ray sources from the 350 previously known to nearly 1,500; locating a new black-hole possibility near the constellation Scorpius, bringing the total to four; and discovering a universal hot plasma constituting a major part of the mass of the universe, as well as a dust and gas cloud with a mass probably sufficient to "close" the universe (prevent its perpetual expansion). The results had already engendered more than 160 technical papers and scientific presentations, and analysis of the *Heao 1* data would require years of work by high-energy astrophysicists; the findings might change fundamental concepts of the universe, the NASA report said. *Heao 1* would probably reenter Earth's atmosphere in late March. (NASA Release 79-4; MSFC Release 79-3).

January 16: NASA declared the launch of *Comstar C* on June 29, 1978, to be successful. Put into a transfer orbit by an Atlas Centaur at the Eastern Test Range (ETR), the spacecraft on July 1 successfully fired its apogee motor to go into the desired synchronous orbit. The assessment was signed January 12 by Joseph B. Mahon, director of the expendable launch-vehicle program in the Office of Space Transportation Systems, and by John F. Yardley, associate administrator for space transportation systems. (NASA MOR M-491-201-78-03 [postlaunch] Jan 16/79).

January 20: At a press conference on NASA's budget for fiscal year 1980 (FY80), Dr. Robert A. Frosch, NASA administrator, said the 1980 budget year would not "go down in history as my favorite." The request NASA submitted to Congress was just over $4.7 billion, an increase of about $160 million over the FY79 budget, counting in the latter a $185 million supplemental NASA had asked for. The FY80 request would amount to slightly less than the rate of inflation, Dr. Frosch said; not counting the $185 million supplemental in the FY79 budget, the 1980 request would be "about equal to inflation." Whereas funding sought for space science and applications was up about 20% and the total amount included support for all ongoing programs, it contained no money for "new flight project starts of any major kind" in space sciences or applications. The budget did contain "some increases in aeronautics, where it is more difficult to identify a major new start in any case."

"Current best estimate" for the first Space Shuttle flight was November 9, postponed from September 28, and NASA's schedule had been adjusted accordingly.

Money requested for space science had increased $100 million, about 20% over FY79; this covered major projects and research and development now under way, such as Space Telescope, Galileo (the Jupiter-orbiter probe), the high-energy astronomical observatory, Spacelab, the solar polar mission, infrared astronomy satellite, and solar maximum mission. Applications funding included money for joint multiagency research in crop monitoring and commodity projection by NASA, together with the Departments of Agriculture, Commerce, and Interior and the Agency for International Development (AID). Funds for aeronautics would increase 14% to cover current research and technology and to continue the aircraft energy efficiency program, with research on reduction of noise and pollution.

In manpower, NASA would lose 674 permanent Civil Service positions over FY79 and FY80, part of this the agency's share of a government-wide 2% cut in personnel. Frosch summarized the budget as one that "in key program areas continues momentum. . .while it's tight, we think we can make a good transition to the Shuttle era and we can keep going on the science, the applications, and the aeronautics. . ." (Text; *W Star,* Jan 22/79, A-10)

January 22: The *Washington Post* reported that Pluto, known for some 40 years as the outermost planet of the Earth's solar system, would no longer be furthest from the Sun as of this date, when it would edge inside the orbit of Neptune and remain there until March 1999. Discovered in 1930 by Clyde Tombaugh at the Lowell Observatory, Pluto had an elliptical orbit that would bring it inside that of Neptune every 248 years (that is, the crossing last happened in 1731, and before that in 1483) and keep it there for about 20 years.

Scientists at the U.S. Naval Observatory said that elliptical orbits of the two planets were so inclined that Pluto and Neptune could never come closer than about 240 million miles to one another. Last year, photographs of Pluto revealed a large satellite visible from only one side of the planet; it was named Charon, for the ferryman on the river Styx in Pluto's realm of Hades. (*Washington Post*, Jan 22/79, A-9)

January 25: NASA announced that it had named the first four Space Shuttle orbiters that would operate in space to honor U.S. explorer ships. The first orbiter (102) scheduled for launch later in 1979 was named for the *Columbia*, which located the Columbia River in 1792; Captain Robert Gray named the river for his sloop. Challenger (orbiter 099) was named for the ship that gathered data December 1872-May 1876, filling 50 volumes on Earth's oceans. Discovery (orbiter 103) was the ship looking in 1610-1611 for a northwest passage from the Atlantic Ocean to the Pacific Ocean by exploring Hudson's Bay. Atlantis (orbiter 104) was the first U.S.-operated vessel designed for ocean research, a two-masted ketch that logged half a million miles between 1930 and 1966. Enterprise, the first orbiter built, was named for a vessel exploring the Arctic from 1851 to 1854, as well as for the flagship in television's Star Trek; as the test orbiter, it was not intended for use in space. (NASA Release 79-10; *Washington Post*, Jan 26/79, C-2; *WSJ*, Jan 26/79, 1).

• NASA reported that engineers at MSFC and controllers at JSC, who had been trying to maintain the orbiting Skylab space station in an attitude of least atmospheric drag to keep it in space until the Shuttle could try to reboost or deorbit, had turned their efforts toward preserving some control over the spacecraft's final reentry, since NASA had decided in December to abandon rescue attempts. The controllers had put the Skylab into a solar-inertial attitude, pointing its solar panels at the Sun at all times to ensure full electric power, offering the possibility of some influence over the craft during reentry. Engineers had not agreed on the feasibility of such control but did agree that steps should be taken to preserve the option while studies continued. (NASA Release 79-12; MSFC Release 79-12)

• Dr. Frank Press, director of the Office of Science and Technology Policy, told the Senate subcommittee on science, technology, and space that President Carter's May directive reaffirmed the policy of five previous administrations: separation of military and "open" civilian space programs; data sharing, hardware sharing, and technology transfer between civilian and military programs; and domestic civilian remote sensing regulated by the government.

The United States had spent $100 billion over the past 20 years on federal space activities: about $67 billion for civilian programs ($25 billion for Apollo alone) and $33 billion in military programs. Today, the expenditure was about half and half. The FY79 budget request had been $7.1 billion, and the FY80 request would be $7.9 billion (up by 12%). These sums did not include private investment in space, more than $2 billion in communications satellites alone. (Text, Jan 25/79)

January 30: NASA launched for the U.S. Air Force a satellite called SCATHA (spacecraft charging at high altitudes) from Cape Canaveral Air Force Station at 4:42 p.m. EST on Delta into a transfer orbit pending its boost into operational orbit February 2. Later orbit elements were 43,297-kilometer apogee, 27,512-kilometer perigee, 1,416.6-minute period, 6.5° inclination. SCATHA carried twelve experiments, three provided by NASA, to collect data on high-energy solar-wind particles causing false signals from satellites by building up electrical charges on their surfaces. Military and commercial satellites in geostationary orbit over the Earth at 35,900 kilometers (22,300 miles) had been the major sufferers; the charges could effectively disable vital communications by causing equipment failure, false recording of unachieved events, or initiation of unplanned events.

SCATHA would meet the greatest challenge of its planned 1-year lifetime during a solar eclipse period beginning in March, when electrical charging would reach its height; Goddard Space Flight Center (GSFC) had included an electric-field detector, a pair of 50-meter antennas to be extended in opposite directions in March to form a single instrument longer than a football field. Extension of the antennas might effect the spacecraft's dynamics. The USAF's Space and Missile System Organization (SAMSO) would reimburse NASA about $9 million for the launch. (NASA Release 79-3; NASA MOR M-492-303-79-01 [prelaunch] Jan 17/79, [postlaunch] Oct 25/789; *O Sen Star,* Jan 31/79, 1; *Today,* Jan 20/79, 8A; Jan 22/79, 6A; Jan 30/79, 10A; *W Star,* Jan 23/79, A-6)

During January: The ESA announced that it planned to launch one of its Intelsat V communications satellites on Europe's Ariane booster. The first four of this series of seven would be launched from mid-1979 to late 1980 on U.S. Atlas Centaurs; ESA's board opted for a 1981 Ariane launch of its sixth Intelsat V and for Shuttle launches for the other two. (ESA Release Jan 1979, 1)

February

February 1: Flight controllers at JSC reported that they would halt their 24-hour Skylab watch February 2, following NASA's decision to abandon attempts to boost or deorbit the space station. The January 25 maneuver that positioned Skylab's solar panels for constant sun tracking had removed it from the minimum-drag position and would result in speeding up its orbital decay. The repositioning was intended to increase power available to controllers to alter the path of Skylab's descent, now expected between June and August. (JSC Release 79-03)

February 5: NASA announced that it had signed a contract with Rockwell International Corporation's space systems group to build two Space Shuttle orbiters (OV-103 and OV-104), convert a ground-test orbiter (OV-99), and modify the first orbiter (OV-102); this would give NASA four orbiters for Shuttle operations. JSC would administer the $1.9-billion contract at Rockwell's California facilities and at the Kennedy Space Center (KSC) in Florida. (NASA Release 79-15; JSC Release 79-07)

February 6: The Foreign Broadcast Information Service (FBIS) reported Japan's successful launch of an experimental communications satellite *Ecs,* also called *Ayame,* from Tanegashima Space Center on an N-1 rocket at 5:46 p.m. local time. Early orbit elements were 34,411-kilometer apogee, 193-kilometer perigee, 604-minute period, and 24.1° inclination. Designed for communications tests at very high frequencies, *Ayame* would later be maneuvered into stationary orbit, the National Space Development Agency said. (FBIS, Tokyo Kyodo in English, Feb 6/79)

February 9: NASA reported that, in keeping with President Carter's directive on space policy, it would undertake a study with NOAA to determine how far private industry could participate directly in U.S. civilian remote-sensing programs. Under the direction of Arnold Frutkin, NASA associate administrator for external relations, and Wilbur H. Eskite, Jr., NOAA special assistant for studies and analysis, the agencies would ask for private-sector views on capital investment, system ownership, system concepts, development of commercial products, market assessments, incentives needed to participate, and the roles of government and private industry in remote sensing. (NASA Release 79-16)

February 17: The *Washington Post* reported that NASA's failure to tell a contractor about classified information on the USSR's early-warning radar network had cost the federal government $75 million, the cost of rebuilding the

Tracking and Data Relay Satellite System (TDRSS) to maintain communications with crews on the Shuttle in its first 10 years of operations. NASA had had to renegotiate a $786 million contract awarded 3 years ago to Western Union, which designed the TDRSS without knowing about the problem of interference from USSR installations located between the Baltic and the Black Seas and using frequencies high enough to overpower transmissions between the TDRSS and the Shuttle orbiter. An unidentified source told the newspaper that U.S. intelligence had given such a "superclassified" designation to data on Soviet radar frequencies and power outputs that NASA could not give the information to Western Union and its subcontractor TRW Systems, Inc. Renegotiation and rework had delayed the satellite system by at least a year, NASA told Congress, but would not impair Shuttle operations already delayed by engine development problems. (*W Post,* Feb 17/79, A-9)

February 18: Wallops Flight Center (WFC) launched SAGE (stratospheric aerosol and gas experiment) at 11:18 a.m. EST on a Scout into an orbit with 655.1-kilometer apogee, 554.6 kilometer perigee, 96.9-minute period, and 54.9° inclination. The 32-pound spacecraft would obtain data on aerosols and ozone in the stratosphere, to be used in studying climate and environmental changes that might adversely affect life at the surface. Data from SAGE would be checked with surface measurements from teams in the United States, Japan, and Europe. SAGE would obtain readings from tropical to high latitudes; similar data for the polar regions would come from an aerosol measurement experiment on *Nimbus 7.* (WFC Release 79-4)

February 20: NASA reported that four organizations in the United States and Canada had formed a joint sounding-rocket program to study this month's total solar eclipse and its effect on Earth's atmosphere and ionosphere. The February 26 event, visible in totality only in the northwestern United States and central Canada, would be the last one in this century observable from the North American continent. Working from two launch sites in western Ontario north of Minneapolis, Minn., NASA, the Army's Atmospheric Sciences Laboratory, the Air Force Geophysics Laboratory, and Canada's National Research Council (NRC) would gather data or predicting atmospheric responses to such disturbances.

NASA, through WFC, would be the U.S. lead agency for seven rocket launches during the operation. The NRC in Canada would provide construction, ground and flight safety, launch coordination, and other support. The Army lab would sponsor an experiment measuring electron densities, and the U.S. Air Force lab would operate a mobile observatory to measure infrared radiation from the upper atmosphere. (NASA Release 79-18)

February 25: The Soviet Union launched *Soyuz 32* from the Baykonur site at 2:54 p.m. local time, carrying a two-man crew to occupy the orbiting *Salyut 6* space station for the first time since November 1978, when the *Soyuz 29* astronauts returned after a record 139 days in space. *Soyuz 32* was manned by Lt. Col. Vladimir Lyakhov, 37, acting as commander on his first flight, and civilian flight engineer Valery Ryumin, 39, who was aboard *Soyuz 25* when it failed to dock with *Salyut 6* in October 1977 and had to return to Earth 2 days later.

Gen. Vladimir Shatalov, head of the USSR's space training program, said *Salyut 6* had been "an effective platform for work in space," having been occupied for 8 of the 16 months since its launch in September 1977. It had seen five successful manned dockings (three by international crews including cosmonauts from Czechoslovakia, East Germany, and Poland as part of the Intercosmos program), as well as dockings by a number of unmanned supply vessels delivering food and fuel. (*NY Times*, Feb 26/79, A-14; *W Post*, Feb 26/79)

During February: The National Aeronautic Association (NAA) reported that the Federation Aeronautique International (FAI) had admitted the People's Republic of China as an active member effective January 1. (NAA *News*, Jan-Feb 79)

• MSFC reported completion of a number of Shuttle tests precedent to qualifying the engine and combined elements of the configuration for flight later in 1979. Thiokol Corporation, prime contractor to MSFC for Shuttle motor development, completed static firing tests of the solid-fuel rocket motor February 17 at its Wasatch Division in Utah. During the two-minute firing, the motor thrust reached about 3 million pounds, and the system gimbaling the nozzle for guidance underwent the most severe duty cycle expected to occur during flight. This motor, more than 35 meters long and 3.5 meters in diameter, was the largest of its type ever developed for space flight and the first built for use on a manned craft.

Qualification tests later this spring would check out production, assembly, and firing cycle to support a full flight schedule. Each launch would use two of the motors, separated at burnout and parachuted into the ocean for recovery and reuse. On February 23, MSFC also concluded ground vibration tests of the complete Shuttle configuration, assembled for the first time to provide data on liftoff and flight conditions. (MSFC Releases 79-18, 79-19, 79-21)

March

March 1: NASA reported that arrangements for press coverage of the overland trek of Space Shuttle orbiter Columbia from Rockwell's plant at Palmdale, Calif., to Dryden Flight Research Center (DFRC) and the flight from there to KSC, would begin March 7 for DFRC and March 5-9 at KSC. The trip by truck would precede the mating of Columbia to its Boeing 747 carrier, the brief flight test March 9 of ferry preparations and tile status, and the departure soon after for KSC. The Shuttle would be off-loaded and moved into the orbiter processing facility March 10-11. (NASA Release NE79-2)

• NASA announced preparations for *Voyager I's* encounter with the planet Jupiter about March 5. The Jet Propulsion Laboratory (JPL) would provide television coverage of the event; employees at Langley Research Center (LaRC) would have a special 7 a.m. colloquium in the center's cafeteria, complete with breakfast service and television monitors throughout the area. After 18 months of space travel, the encounter would take place at 7:42 a.m. EST at a distance of 278,000 kilometers (172,750 miles) from the planet's cloud tops. Real-time images and live programming through *Comsat 1* would continue for about two hours. (NASA Release 79-26; LaRC anno, undated)

March 2: At "encounter minus 4 days," JPL issued a Voyager bulletin showing a nine-photo mosaic of Jupiter's surface constructed from time-lapse photographs taken 7.8 million kilometers (4.7 million miles) from the planet. The bulletin also gave data on expected Sun and Earth occultations by Jupiter offering opportunities for "unique radio science and ultraviolet measurements" and on the close approaches to the five large Jovian satellites that would also occur March 5. (Mission status report 37)

March 5-6: Voyager 1 successfully met its objectives at the encounter with Jupiter, NASA reported, "streaking" past the planet, "threading its way among the five astounding satellites, and discovering that Jupiter, like Saturn and Uranus, is a ringed planet." The spacecraft had performed as predicted upon close approach, disappearing behind Jupiter for two hours, penetrating its flux tube, and passing close to both Ganymede and Callisto. It had been subject to hazards from Jupiter's enormous magnetosphere and high radiation; reception of emergency information and issuance of corrective orders would require more than an hours travel time to Earth and back. However, results were "beyond its creators' wildest dreams," especially the imagery of volcanic eruptions and other details on Jupiter's moons. NASA Administrator Robert Frosch and Deputy Administrator Alan Lovelace said "superlatives fail us."

The Voyager project manager, JPL's Robert Parks, called it "spectacularly successful." (NASA MOR S-802-77-01/02; mission status reports 38, 39)

March 6: NASA announced that it had assigned MSFC responsibility for developing a solar electric propulsion stage to be used first in a planned flyby of Halley's comet upon its return in 1985, and after that for a rendezvous with comet Tempel II. MSFC had been studying for several years the concept of a system using solar energy to provide electrical power for ion engines. Other uses for such a system would be high-energy planetary and Earth-orbiting missions. (NASA Release 79-31; MSFC Release 79-24)

March 7: NASA announced that Dr. Noel W. Hinners, associate administrator for space science, had accepted appointment as director of the National Air and Space Museum, effective in April. He had joined NASA in 1972 as chief scientist and deputy director of Apollo lunar exploration in the Headquarters Office of Manned Space Flight and had held his present job since June 1974. (NASA Release 79-32)

March 8-12: Columbia, the first reusable Space Shuttle orbiter, started on its way to space Thursday, March 8, with a nine-hour tow by truck from the Rockwell International hanger at Palmdale, Calif., where it was assembled, to the DFRC at Edwards Air Force Base, 38 miles away, where it would be mounted on a Boeing 747 for a brief test of the orbiter plane assembly before flying to KSC. In Lancaster, Calif., the orbiter's 78-foot wings hung over the sides of the two-lane road into town, barely clearing utility poles, and some street lights had to be moved to clear the way. Spectators lined the route to see the five-story-high 122-foot-long orbiter pass by on its 90-wheel trailer, dwarfing its train of security vehicles, trucks, and a fire engine. Onlookers commented on the heavy security arrangements, but NASA officials said that they had to protect the craft from bystanders who might touch the fragile thermal-protection tiles on the spacecraft surface. Obviously missing were a number of black tiles on Columbia's belly and white tiles on its sides, to be added in Florida along with the engines and computers.

The scheduled takeoff for Florida might be delayed because of bad weather, NASA spokesmen warned, to lessen chances of an accident during the cross-country flight; adverse conditions had developed along the route.

The 15-minute test flight Friday of the orbiter-747 combination resulted in extensive damage to the protective-tile surface of the orbiter, said former astronaut Deke Slayton, NASA's manager for orbiter flight tests. As the 747 took off down the runway at Edwards, parts of the dummy tiles, some as long as 2.5 feet began to fall off the spaceship. When the flight ended, Columbia had lost not only some of the plastic-foam dummy tiles attached by tape to the areas around the windows, fuselage sides, wings, and midtail, but also some of the 26,000 actual protective tiles bonded to the spaceship at the plant. "When the dummies began to fall off, the tape which was attached to them started to swirl around and damage some of the real tiles," said Slayton, who flew one of two chase planes to keep an eye on the orbiter-747 test flight.

NASA had decided to send Columbia to KSC without about 8,000 tiles that could be installed there; dummies had been used to cover areas where in-flight problems might arise, but after seeing the test results, engineers decided that not all the dummies were needed. Slayton said that the orbiter-747 assembly was now scheduled to depart for Florida on Monday, March 12. The 3,000-mile ferry flight had originally been set for Friday, March 9, but a problem arose in mounting the orbiter on the 747, caused by misalignment of the orbiter to the three struts atop the 747, and the test flight was delayed until Friday afternoon, after which the tile problem occurred.

Although NASA engineers said March 10 that the combination could still fly cross-country March 12, a later report said that 34 dummy tiles were lost and 39 damaged; 7 real tiles were destroyed or lost and 100 damaged. Replacement of missing tiles would delay the trip at least to Saturday, March 17; NASA planned to complete the fix without removing the orbiter from its carrier aircraft. (*NY Times,* Mar 9/79, A-20; *W Post,* Mar 9/79, A-3; Mar 12/79, A-7; *W Star,* Mar 10/79, A-5; Mar 11/79, A-6; Mar 12/79, A-4; *Today,*, Mar 9/79, 1A, 16A; Mar 10/79, 1A, 8A; *NASA Dly Actv Rept,* Mar 13/79)

March 15: ESA announced approval of a remote-sensing study to be carried out by member states, including Denmark, France, Italy, the Netherlands, Sweden, and the United Kingdom, with other member states expected to join later. Starting with defining optical and microwave instruments for monitoring land and ocean surfaces, to be used by European remote-sensing satellites planned for launch in the mid-eighties, ESA would stress developments now under way in the respective nations, such as a multimission platform being produced by Centre National d'Etudes Spatiales (CNES) for the SPOT satellite and a synthetic-aperture radar proposed by West Germany for Spacelab flights in 1983. (ESA anno Mar 15/79)

March 16: The DOD launched two spacecraft from Vandenberg Air Force Base on a Titan 3D, with no word on mission or orbital elements. A later report in *Aviation Week & Space Technology* said that the 10:30 a.m. local time launch put a Lockheed-built high-resolution film-return satellite in an orbit with 244-kilometer apogee, 177-kilometer perigee, and 96.4° inclination, to supplement a KH-11 high-resolution recon vehicle that had been operating in space since June 1978, furnishing data by digital transmission rather than film returned to Earth in reentry capsules. The digital system allowed much longer life for this type of spacecraft, whose usefulness did not depend on depletion of its film pod. "As is often the case with film-return spacecraft," said *Aviation Week & Space Technology,* the March 16 launch had included a piggyback payload, probably a ferret mission, put in orbit with 625-kilometer apogee, 623-kilometer perigee, and 95.7° inclination. (WTR cover Mar 16/79; *AvWk,* Apr 9/79, 18)

March 19-23: JSC was host to the 10th annual lunar and planetary science conference or more than 700 scientists from the United States, western Europe, Africa, Australia, and the Soviet Union. The conference had evolved to include reports not only on lunar studies but also on planetary studies and astrophysics. The five-day schedule included a presentation on Pioneer-Venus and on *Voyager I*'s Jupiter encounter, plus a three-dimensional film on Mars produced during the extended Viking mission. (JSC Releases 79-10, 79-11)

March 20: MSFC reported that the NASA barge Poseidon carrying a Space Shuttle external tank and other components had begun an 11-day trip to KSC by way of the Tennessee River and the Gulf of Mexico. KSC would use the items to check out assembly and movement of the components in the vehicle assembly building and to train personnel in stacking the Shuttle on its mobile launch platform. MSFC said the waterways to the Gulf, swollen by recent rains, had receded enough to permit a normal trip to KSC. (MSFC Release 79-27)

March 23: MSFC announced that payload specialists selected for Spacelab 2 would begin training in April with an orientation tour to visit most of the principal investigators whose experiments would ride on the 1982 mission. Each of the selectees had been a co-investigator on one of the Spacelab 2 experiments. The three men and one woman selected would visit six sites in the United States and three in the United Kingdom for a first look at many of the experiments and to allow them to decide with MSFC management how much training they would need before the flight. To be visited were Chicago, Iowa City, Palo Alto, Pasadena, Washington, D.C., and Cambridge, Mass., in the United States; and Abingdon, Dorking, and Birmingham in England. Those selected were Dr. Loren W. Acton, research scientist at Lockheed's Palo Alto laboratory; Dr. John-David F. Bartoe and Dr. Dianne K. Prinz, research physicists at the U.S. Naval Research Laboratory, Washington, D.C.; and Dr. George W. Simon, chief of the solar research branch at the Air Force Geophysics Laboratory, assigned to the Sacramento Peak observatory in New Mexico. Two of the specialists would actually fly on Spacelab 2 to operate the scientific experiments; the others would operate ground-based equipment and assist the two in orbit. Spacelab 2's payload would consist mainly of experiments in astronomy, high-energy astrophysics, and solar physics, plus plasma physics, botany, medicine, and space technology. (MSFC Release 79-30)

March 24: Columbia, first Shuttle orbiter destined for launch into space, landed with its Boeing 747 carrier at 11:03 local time on a 15,000-foot runway built for this and future landings at KSC. Among the 3,000 persons awaiting the arrival were astronauts John W. Young and Robert L. Crippen, scheduled as crew on the maiden flight set for November 9. NASA officials said "a series of minor snafus" might delay the first launch until 1980. (*W Star,* Mar 25/79, A-3; *W Post,* Mar 25/79, A-6; *NY Times,* Mar 26/79)

March 30: NASA announced that Dr. Robert A. Frosch, NASA administrator, and Roy Gibson, director general of ESA, on March 29 signed a memorandum of understanding in Washington, D.C., on a joint international solar-polar mission to be launched in 1983. NASA and ESA would each provide a spacecraft, and ESA would supply software and personnel to support ESA's flight operations in the United States. NASA would be responsible for mission control, launch operations, and tracking and data acquisition, and for several experiments. JPL would manage the NASA scientific effort and development of a NASA spacecraft; JSC would manage the Shuttle launch portion of the mission; ESTEC would manage the European effort.

The objectives of the mission would be to study the structure and emissions of the Sun as a function of latitude from the solar equator to the solar poles and to study the interplanetary medium Earth-to-Jupiter and the Jovian magnetosphere. Launched from a Shuttle, the two craft, each propelled by an upper-stage booster, would take a path in the ecliptic plane (that containing all the planets in Earth's system) toward Jupiter, using its gravity to propel them out of the ecliptic toward the Sun on trajectories to pass one over the north and one over the south solar poles, retrace the ecliptic track, pass over the opposite poles, and fly back toward Jupiter. Mission lifetime would be about five years. (NASA Release 79-37; ESA anno Mar 30/79)

During March: FBIS carried regular reports on the progress of the *Soyuz 32* cosmonauts aboard the *Salyut 6* orbiting space station. Upon arrival February 26, the crew had begun reactivating the thermal regulators, water regeneration system, and ventilation. On March 1, they had begun checkout of individual consoles and scientific instruments, tested the manual attitude control system, and corrected the flight path of *Salyut 6* using *Soyuz 32* propulsion.

The following day the crew did baseline medical checkups using Polynom apparatus; the flight engineer was tested in the morning, and the commander was tested in the afternoon. In an interview March 4, the crew's doctor reported that Lyakhov had needed 1.5 days to adapt to weightlessness but was now feeling well. The crew had asked to begin their exercise program on trainer machines and cycles several days ahead of schedule. Lyakhov's regime emphasized his "vestibular system"; Ryumin's, the cardiovascular. On March 5, Tass, the Soviet news agency, said that the doctors were keeping close watch on Commander Lyakhov, "a thick-set man...on his first flight in outer space." The commentator said "unhasty adaptation" was important during the first few days on the space station, which imposed three peak loads at one time: adaptation to weightlessness, complicated docking and transfer procedures, and emotional strain. More time had been allowed on this flight than usual for the crew to check all the station systems, both those governing flight and those controlling living conditions (the "boost week," a term used by cosmonaut Vladimir Kovalenok, one of the communications team keeping in touch with the *Soyuz 32* crew).

A March 6 broadcast interview with a "scientific employee at the Flight Center" on repair and servicing of the Salyut said that the intensive activity "did not mean that anything is broken or needs mending." On *Salyut 6,* unlike its predecessors, individual items of equipment for the first time could be exchanged when their resources were exhausted. The station had been in orbit for 18 months and carried almost 1,000 different instruments, the reporter said. Important systems, such as life support, had been designed to be practically failure proof by using interchangeable units within easy reach, facilitating periodic exchange of equipment. Introduction of the Progress automated cargo ships meant that new instruments, equipment, and tools were available upon crew request. *Progress 2* had brought the *Soyuz 29* crew a globe indicator for the control panel to show the station's location in relation to Earth; it had also brought new computer units for the Delta automated navigation system.

The first job in reactivating the *Salyut 6* station had been to check out the docking unit on the transfer module, with its opening into outer space; the *Soyuz 26* crew had done this last year. Lyakhov and Ryumin would have to test each on-board system and plug in reserve circuits or replace units. The reporter pointed out that, notwithstanding the long use of the station, "not one reserve circuit in any system has so far been switched on." The current crew would replace ventilators in the thermal system, light bulbs, cables in the television and communications systems, components of the exercise equipment, and filters and regenerators in the life-support systems.

On March 12, *Progress 5* was launched with a load of fuel for the *Salyut 6* propulsion unit and materials for its on-board systems. A commentator said that portable cables and other mobile elements of radiocommunication "wear out heavily" on long flights; the crew had replaced headsets, cables, and switches. They had also set up and operated an on-board videotape recorder and a video monitoring device. An interview March 13 with cosmonaut Vladimir Aksenov said that the Salyut represented a new stage of technology, not only because it could be supplied but also because it could be overhauled in space with components and assemblies flown there by freight and crew transport vessels. Aksenov noted that the crew had used an ordinary soldering iron, said to be an enormous departure for repairs in a closed weightless space. Also, he said, basic scientific apparatus had heretofore been assembled in a ground workshop and checked out in a ground station; for the first time, the installation and test of new apparatus would take place on an operating space station in orbit. This was made possible by a wide selection of tools designed especially for use in space: pliers, screwdrivers, clamps, and special instruments to handle special nuts and bolts.

Upon the arrival March 14 of the *Progress 5,* bringing fuel, equipment, experiment materials, and mail, the crew's doctor said in an interview that previous flights had indicated that weightlessness had some tricky aspects and that the consequences of exposure to it could be very serious. The current crew were apparently beginning to feel at home in the new surroundings, however. After unloading the ferry, the crew had the job of dismantling the Kristall electric furnace used for more than 40 experiments in space processing of materials and installing new apparatus better designed to operate in weightlessness; they had also plugged in a new chemical battery to reinvigorate the power system. By March 21, the unloading of the supply ship was completed, and the crew was ahead of schedule using the new equipment, especially a color television camera to show the interior of the station with equipment replacements including new sensors installed in the work area to detect minimal air pollution in the station's atmosphere. On March 24, the crew communicated by television with the flight control center "in the direction from earth to the spaceship. . . for the first time in the history of space flight." The control center could now transmit drawings, plans, and working documents from the ground to the Salyut; "in principle," said the report, "any central TV transmission can be sent to the spaceship." By month's end, Tass said that the crew had adapted to weightlessness and were proceeding with scheduled tasks. (FBIS, Tass in English, Mar 1-28/79)

April

April 2: NASA reported that 35 candidates for Space Shuttle astronaut had completed classroom instruction and moved into engineering assignments at JSC. The courses had begun in July 1978, and the successful candidates would become astronauts in July 1980. NASA had brought in personnel from other NASA centers and from universities to conduct courses on subjects such as space physics, ascent and reentry aerodynamics, spaceflight physiology, and tracking techniques; veteran astronauts had lectured on the budget process, people, and requirements in the space program and on being a CAPCOM (capsule communicator). Videotapes of the classes would be available to all employees at JSC.

The first crews selected for Shuttle flights had begun lessons in the mission simulator, and the astronaut candidates would be observers. Lessons would include tests of every sort of emergency the crews might encounter during a mission, supervised by instructors who had spent six months learning how to harass the astronauts in their simulator exercises. The lesson plan, scheduled to take nine months "not counting. . . problems," would prepare the crews for nearly any emergency, NASA said. (NASA Release 79-34; JSC Release 79-20)

April 3: The NAA announced that Sam B. Williams, president of Williams Research Corporation of Walled Lake, Mich., would receive the Collier Trophy, the oldest U.S. aviation award. Williams had designed and developed the world's smallest high-efficiency fanjet engine, a low-cost lightweight means to realization of the cruise missile. The Williams engine measured 12 x 37 inches, weighed 145 pounds, and produced more than 600 pounds of thrust; it had qualified for both Air Force and Navy cruise missiles. The NAA had presented the trophy annually since 1911 for the greatest achievement in aeronautics or astronautics in the United States, demonstrated by actual use in the preceding year. (NAA Release Apr 3/79)

April 4: NASA reported that improved components and techniques could lower the "now prohibitive" cost of using turbine rather than piston engines in small general aviation aircraft. If turbines cost only half again instead of three times as much as piston engines, small plane users could reap the advantages of one-third the weight, proven reliability and safety, multifuel capability, and less maintenance, vibration, noise, or pollution.

A study by Lewis Research Center (LeRC) said that an advance turbine aircraft would be 25% cheaper to operate, would use 10% less fuel, and would cost 15% less to purchase than an equivalent aircraft powered by a typical reciprocating engine. Although only 8% of general aviation aircraft flying in the United States, were turbine powered, the study said that the market for

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an advanced turbine engine could reach 25,000 units per year by the late 1980s. The general aviation field included 98% of U.S. civilian aircraft. (NASA Release 79-29)

• INTELSAT reported that two new regional satellite systems proposed by member groups would be technically compatible with its present system and would not threaten its economic well-being. A proposed European Communications Satellite (ECS) system would provide telecommunications service to countries in Eastern and Western Europe and North Africa beginning in 1982, working with Europe's terrestrial network. A Palapa B system, a joint venture of Association of Southeast Asian Nations (ASEAN) countries including Indonesia, Malaysia, the Philippines, Singapore, and Thailand, would serve remote areas not having access to INTELSAT's system, also beginning in 1982. (INTELSAT Releases 79-07-I, 79-09-I)

April 5: MSFC reported that Shuttle orbiter Enterprise would go to KSC to give NASA workers experience in prelaunch handling. After a year of tests at MSFC, Enterprise would resume the tailcone on its main-engine area for piggyback flight, and the dummy pods removed during testing would be replaced. After the refit, NASA would tow the Enterprise to Redstone Army Air Field for loading on its 747 carrier, with departure set for April 12 or 13, depending on weather. (MSFC Release 79-36; NASA Release 79-42)

April 10: NASA announced that Dr. Robert A. Frosch, administrator, and Dr. Willy Moenandir Mangoendiprodjo, director of Indonesia's telecommunications agency, had signed a memorandum of understanding April 9 for launch of two Indonesian domestic communications satellites. NASA would furnish reimbursable launch and associated services for a second generation of Palapa spacecraft. The new satellites would replace existing communications satellites: *Palapa A-1,* launched July 8, 1976, and *Palapa A-2,* launched March 10, 1977. The Shuttle would launch the first Palapa B in June 1982; the second during the first half of 1983. (NASA Release 79-43)

April 13: NASA announced it would join Soviet scientists for the first time in a study of physiological changes due to simulated weightlessness. Tests in each country on 10 subjects aged between 35 and 40 would comprise two weeks of control observations, one week of bed rest, and two weeks of post-rest measurements, including stress tests and blood and urine samples. Half of each group would be horizontal during the total bed rest, the others would rest with heads lowered 6° for horizontal. U.S. tests had kept subjects horizontal only, and the identical studies would indicate the best procedure. The program would begin in mid-May at the Moscow Institute of Medico-Biological Problems and continue at Ames Research Center (ARC) in July. Both NASA and USSR scientists would take part in each experiment. (NASA Release 79-46; ARC Release 79-17)

• NASA reported that its small astronomy satellite *Sas 3* had reentered the atmosphere April 9 over the Pacific Ocean after nearly four years of scanning the skies for X-ray data, although its design lifetime had been only one year. Launched May 7, 1975, from the San Marco platform off the coast of Kenya, the 195-kilogram. *Sas 3* in a 500-kilometer orbit had discovered 2 new quasars and about half the 35 known X-ray bursters (stars emitting huge brief bursts of X-rays once every few hours). *Sas 3* indicated that these bursts resulted from thermonuclear reactions on the surfaces of neutron stars. (NASA Release 79-44)

April 15: The North American Air Defense Command (NORAD) issued a fact sheet on satellite decay predictions by its Space Defense Center, watching over more than 4,500 man-made satellites in orbit around the Earth. The Tracking and Impact Predictions (TIPs) gave time and position for large items such as payloads and rocket motors that might survive reentry and impact on Earth; for smaller objects likely to burn up without reaching the ground, the center would compute only a probable date of decay. Predictions would depend on many variables but were necessary under a 1971 pact between the United States and the Soviet Union that both nations would help identify objects that might reenter over the other's territory; TIPs would prevent mistaking a reentering object for an incoming warhead and triggering warning networks. (PAO, Peterson AFB, Apr 15/79)

April 16: NASA announced that an experimental balloon launched April 12 at 6:23 p.m. from the National Scientific Balloon Facility in Texas to test a new heavy-lift design had apparently failed at about 10:42 p.m. somewhere over northwestern Louisiana. The balloon measured about 41 million cubic feet and carried an instrumented payload weighing about 5,300 pounds. (Hq PAO anno Apr 16/79)

April 24: NASA reported that the Shuttle orbiter Enterprise, which arrived at KSC April 10-after a piggyback flight from MSFC, would be rolled out to Launch Complex 39 on May 1 as part of an exercise to clear the way for launch of its sister ship, Columbia, which had arrived at KSC March 24 for checkout and final installation of thermal tiles. This would be the first time a complete Space Shuttle configuration had been put together in the Vehicle Assembly Building (VAB) and moved to the launch pad; use of the Enterprise would confirm compatibility of assembly and launch facilities and ground support equipment with elements of the Shuttle and would rehearse KSC staff in Shuttle handling operations.

On April 17, a 15-story external tank was mated with two inert solid-fuel rocket boosters on a mobile launcher platform in high bay 3; more than 75,000 visitors to the center viewed the assembly moving down the 2-mile towway to the VAB, into which Enterprise was moved April 18. The delta-wing orbiter would be mated with the external tank in a 19-hour operation before its 3.5-mile ride to Pad A, former site of Apollo lunar launches modified for Shuttle operations, where it would remain until the first week of June. (NASA Release 79-50)

• DOT announced that Secretary Brock Adams had sent to Congress proposed legislation to provide $6.6 billion for improving U.S. airports and airway systems over 5 years, beginning October 1, 1980. The proposal emphasized aviation safety measures to meet expected 1980s growth in air transportation. Financed by a 10 year continuation of the airport/airway trust fund and related aviation user taxes, the bill would include airport development and planning; acquisition and upgrading of airway facilities and equipment; research to reduce congestion and delays at large U.S. airports; improvement of air traffic control, instrument landing systems and radars, and other navigation aids; reduction of aircraft noise; and funding for smaller airports to reduce the load on larger ones. (DOT Release 51-79)

During April: NASA reported new data on Venus from the Pioneer mission and the radar at the Arecibo observatory in Puerto Rico. Radar had given best information on the surface of Venus, not visible through optical telescopes because of heavy cloud cover. Radar images covering an area 80 million square kilometers showed craters on Venus as large as 320 kilometers in diameter; like lunar craters, which they resembled, they apparently resulted from meteorite impacts.

A circular area 1,120 kilometers in diameter called Alpha, first noticed because of high radar reflectivity, consisted of many parallel ridges identifiable for great distances. This area had no Earth counterpart except extensive dune systems in the Arabian peninsula; Alpha showed a central dark object, possibly a volcano. Another radar feature known as Beta, with long rays of rough material extending out as far as 48 kilometers, also had a central dark area like a volcano crater. The radar also detected parallel ridges about 2,100 miles high, extending more than 960 kilometers across the surface of Venus, forming a structure exceeding the Grand Canyon in scale.

A report on Pioneer Venus orbiter and multiprobe mission findings included discovery of the largest canyon in the solar system, bigger than Mar's Vallis Marineris, previously thought largest. Lightning activity detected by USSR Venera spacecraft was continuous from altitudes of 32 kilometers down to 2 kilometers, with discharges as frequent as 25 per second. Pioneer's orbiter apparently saw this lightning also; experimenters Dr. Boris Ragent of ARC and Dr. Jacques Blamont of the University of Paris now theorized that a glow measured by Pioneer instruments was continuous indistinguishable lightning on Venus, rather than an occurrence on the spacecraft. The orbiter also found an 1,100-kilometer-wide hole containing few or no clouds in the North Pole cloud cover, suggesting a downflow of atmosphere there. (NASA Release 79-47; ARC Release 79-12)

May

May 3: NASA announced that its satellite system ASDAR (aircraft-to-satellite data relay) had started operation as part of the GWE that began earlier this year [see January 7], collecting and relaying weather observations from aircraft in flight and leading to possible million-dollar savings annually in aviation fuel costs. The system, consisting of a power supply, clock, 80-watt transmitter, small computer, and antenna, would monitor and report eight times per hour the aircraft's location and altitude, together with weather data generated by equipment already aboard each ASDAR-equipped airliner.

The system would relay the information through a NOAA satellite to weather data centers and on to the users. Relay of quickly changing weather information to subsequent flights within two hours could save time and fuel by taking advantage of favorable winds or avoiding threatening storms. Also, the 17 widebody jets using ASDAR would regularly cross the southern hemisphere and the tropics, where data were not usually available. Participating countries included England, Australia, the Netherlands, the Scandinavian countries, Singapore, and the United States (NASA Release 79-51)

NASA also reported that ARC's research aircraft Galileo II had gone to Saudi Arabia to join an international study of the monsoon, a storm system bringing nearly all the Asian subcontinent's annual rainfall in June, July, and August, supplying torrents of moisture for the crops and overwhelming the area in floods. In 1978 the storms killed more than 900 people and left more than 3 million homeless. MONEX (the monsoon experiment) would trace the origin of the storms and attempt to provide weather forecasts that would be "extremely useful" in an area "practically devoid of basic weather data," according to Joachim Kuettner, director of the U.S. effort. (NASA Release 79-55)

May 4: NASA launched *FltSatCom-B,* second in a series of five fleet satellite communications system spacecraft, from Cape Canaveral on an Atlas Centaur at 2:56 p.m. into a transfer orbit, before firing its apogee kick motor May 6 to move it toward a 23,300-mile altitude synchronous-orbit station over 23°W, which it should reach in late July. This was the 50th launch by an Atlas Centaur. The TRW-built 4,100-pound *FltSatCom 2* was about 880 pounds heavier than any previously launched by this vehicle, requiring it to take a path offset 2.4° from the equator. Like its predecessor *FltSatCom 1* launched in 1978, now on station over 100°W, *FltSatCom 2* would link ships, submarines, and planes to various ground-based control centers and would provide service to White House communications centers. The Air Force reported that about 420 surface ships and 90 submarines contained equipment for communicating by satellite, and the number was growing. (NASA Release 79-49; NASA MOR M-491-202-79-02 [prelaunch] May 1/79, [postlaunch] Nov 5/79; *W Post,* May6/79, 17; *LA Times,* May 5/79)

May 8: NASA reported that LaRC staffers were using the SAGE satellite launched from WFC February 18 to measure and track into the stratosphere the ash and gases from an eruption of La Soufriere, a volcano on St. Vincent island in the Caribbean, between April 13 and 17. The eruption, detected first by SAGE while passing over the island April 23, deposited as much as an inch of dust on neighboring islands and provided an opportunity to study stratosphere distribution of aerosols from a single source. NASA alerted scientists around the world to use ground-based and balloon-borne instruments in checking between 6°N and 20°N latitudes for effects of the eruption. SAGE might answer questions about the effect of aerosols and ozone on climate and environmental quality. (NASA Release 79-56; LaRC Release 79-29; WFC Release 79-8)

• NASA reported that since February 14 the infrared instrument on Pioneer Venus orbiter had been returning "degraded data"; efforts to solve the problem had not succeeded. The instrument began to register a power input of 6 to 7 volts instead of the required 10 volts; it had done this three times before, but each time ground command was able to reset the instrument with almost no loss of information. The orbiter had returned excellent data for 72 orbits of Venus (one per day) including more than 800,000 temperature profile, albedo, humidity, and cloud height measurements, enough for a thorough survey of the planet. NASA's radiometer-science team reported that results already exceeded mission objectives despite the apparent loss of the instrument. Dr. Fred W. Taylor of JPL said the instrument might yet be revived. (NASA Release 79-59)

May 10: MSFC reported that 1.5-second ignition-test firings May 4 of a cluster of three Space Shuttle main engines at National Space Technology Laboratories (NSTL) had been successful, clearing the way for the second phase of verification tests. The three flight-type engines, previously acceptance tested individually at the facility, had undergone the cluster test in an assembly including the engines, a simulated orbiter midbody, and a flight-type aft fuselage to which the engines were fitted. Frank Stewart, MSFC test manager, said that sequencing was good and that he foresaw no problems with the first long-duration firing scheduled for May 15. The tests would evaluate system performance in a static-firing environment as a step in verifying the system for the first manned orbital Shuttle flight. Cluster firings would take place about once per month through July; the third phase of long-duration firings would begin in September and conclude in November, after the equipment had been modified. (MSFC Release 79-47)

May 14: MFSC reported that the first Space Shuttle engine tested for flight acceptance had "passed with flying colors" a 520-second endurance test May 12 that simulated launch conditions. Scheduled for use on Columbia, this engine would undergo electrical and mechanical checkout before formal acceptance. The tests began April 25 with 1.5-second ignition-test firing, followed by a 100-second calibration-test firing May 2. After formal acceptance, the engine would go by truck to KSC for installation. The other two of the cluster of three Rockwell-built engines to be used on Columbia were at Space Technology Laboratories for the same series of tests. (MSFC Release 79-45; NASA Release 79-68)

May 16: NASA reported that the multispectral scanner on *Landsat 3* had begun sending defective images at random; the pulse to trigger a line-start signal was not working. The scanner images, line-by-line transmissions of views from an oscillating mirror, would form a continuous line unless arranged one under the other by line-start and line-end scan pulses. GSFC engineers noticed that lines normally printed under the preceding line to fill in a picture were either missing a start signal or lacking about a fourth of the line. Last fall they had solved a similar problem by switching to a backup system, the one now malfunctioning.

Since its launch March 15, 1978, *Landsat 3* had transmitted more than 91,000 scenes each representing an area 185 square kilometers of Earth's surface, used to produce either photographs or computer tapes. The equipment needed to correct for the missing data would not be available until later in 1979, the agency said; however, most *Landsat 3* data were still accurate, and *Landsat 2* was still "going strong" after producing more than 325,000 scanner scenes since 1975. (NASA Release 79-67)

May 17: NASA announced that Dr. Robert A. Frosch, its administrator, would head a 13-member delegation of U.S. officials to the People's Republic of China May 19-June 3 to learn about PRC space activities and discuss areas of planned cooperation, including a PRC domestic communications satellite system and ground station for PRC reception of Landsat data. The U.S. group, including representatives of the White House Office of Science and Technology Policy, National Security Council, State Department, National Telecommunications and Information Administration, NOAA, and U.S. Geological Survey, would meet with PRC officials in Beijing and tour their space installations. Frosch would return to the United States, after the Beijing meetings. The group had been invited by Dr. Jen Xin-min, head of the PRC Academy of Space Technology and leader of a space delegation that visited NASA and space industry firms in 1978; President Carter and PRC vice premier Deng Xiaoping had signed an agreement on space cooperation January 31, 1979.

Meanwhile, the press reported that ComSatCorp president Joseph Charyk had told the corporation's annual meeting in Washington of talks with PRC representatives on providing ComSat technical assistance in building a network of satellites and ground stations estimated to cost "in the hundreds of millions of dollars," most of the necessary equipment to be purchased in the United States (NASA Release 79-70; *W Star,* May 16/79, F-1; *W Post,* May 16/79, D-7)

May 23: ESA reported that the first qualification test of its Ariane launcher first stage had been "satisfactory" May 17 with further tests scheduled for early autumn. The 139-second duration (nominal operating time) had tested the resistance of nozzle-throat linings, which had been modified, and propellant depletion. The second stage had completed tests that began last October; the third stage was currently undergoing tests. (ESA/CNES Release No. 17)

May 28: The U.S. Air Force launched a DOD surveillance spacecraft from Vandenberg Air Force Base at 11:30 a.m. PDT on a Titan 3B-Agena into an orbit with 323-kilometer apogee, 126-kilometer perigee, 89-minute period, and 96.4° inclination. DOD made no announcement, but press reports said that the launch was probably a low-resolution search-and-find mission; this type of system would remain in orbit about 2.5 months. (NASA wkly SSR, May 24-30; *D/SD,* May 31/79, 149; *AvWk,* June 11/79, 23)

May 29: The *Washington Star* reported on a NASA Pioneer Venus briefing at the annual meeting of the American Geophysical Union in Washington, D.C., which revealed that Venus (far from being the dull and featureless object it appeared, covered by heavy cloud layers) had spectacular terrain and a unique atmospheric circulation system. *Pioneer Venus 1* had been sending back radar and other information since it arrived at Venus in December 1978; *Pioneer Venus 2* had arrived shortly thereafter, separating into five probes to study the atmosphere, four of which reached the "smoldering 900° F surface."

Dr. Harold Masursky of the U.S. Geological Survey reported that radar scans of Venus had shown a mountain estimated at 37,000 feet, far higher than Earth's 29,028-foot Mt. Everest. Dr. Alvin Seiff of ARC said that Venus's atmospheric circulation was different from any known elsewhere: Earth's surface absorbed sunlight, and the resulting heat in combination with Earth's rotation made the atmosphere flow west to east. However, the atmosphere of Venus absorbed the sunlight 30 to 35 miles above the surface, and heat variations in the atmospheric layers apparently drove one another with their motion. (*W Star,* May 29/79, A-2)

May 30: INTELSAT announced a first step toward intersatellite communications links: an award of a $170,000 contract to Hughes Aircraft Company for design and fabrication of a traveling-wave tube, a vital component of an intersatellite link. Direct transmission via satellite was now possible only between points within one satellite's coverage area (about one-third of Earth's surface); messages for locations outside that area had to use land-based links or ground relay to a second satellite. The planned communications links could transmit directly from one satellite to another, saving one down and one up transmission, freeing that link for other use, and making the whole system more efficient and economical by making more stations available to direct access. (INTELSAT Release 79-10-I)

May 31: Photographs of Jupiter's moon Io taken by *Voyager 1* had revealed a strange "blue snow," identified as volcanic gases released by continuous eruptions in the equatorial region, the *New York Times* reported. Dr. Laurence A. Soderblom of the U.S. Geological Survey told the American Geophysical Union spring meeting in Washington, D.C., that wisps of the gas appeared in Io's south polar area along faults or fractures in the crust; this was the first finding of erupting volcanoes anywhere except on Earth, and the intense volcanic activity was "endlessly repaving [Io's] surface with volcanic material."

Dr. Edward C. Stone of the California Institute of Technology (CalTech), chief Voyager mission scientist, said that a change in the *Voyager 2* plan would include time-lapse photography of Io to pinpoint the nature of the volcanic activity. Dr. John C. Pearl of GSFC said *Voyager 1*'s infrared detectors showed that the main constituent of the gases was sulfur dioxide, also found in Earth's volcanic eruptions. Dr. Norman F. Ness, also of GSFC, said Jupiter's magnetic field extended far beyond Io's orbit, creating a "big power station in the sky." (*NY Times,* May 31/79, B-16)

During May: NASA reported that the X-ray telescope on *Heao 2* had photographed for the first time an X-ray "burster," a "bizarre" phenomenon occurring when compact celestial objects less than 50 kilometers (30 miles) in diameter increase suddenly and intensely in X-ray brightness. Such a burst, releasing more X-ray energy in 10 seconds than the Sun does in a week, was first discovered by a Netherlands/U.S. cooperative satellite carrying Harvard-Smithsonian detectors in 1976.

Scientists had not defined the nature of the bursts, which might result from explosions similar to a helium bomb on the surface of a neutron star or from violent instabilities in gas flow down a black hole. *Heao 2*'s picture, said Jonathan Grindlay of the Harvard-Smithsonian Center for Astrophysics, established the presence of a "steady" X-ray source in a "globular cluster" called Terzan 2, bringing the number of such clusters known to harbor X-ray sources to at least eight, six of these being bursters. The cores of globular clusters (oldest objects in the galaxy, consisting of round swarms of about 100,000 stars) were under study as possible precursors of black holes or of compact binary systems containing either neutron stars or black holes being formed to produce bursting X-ray sources. (NASA Release 79-65)

• NASA reported a number of personnel changes during May.

—Dr. John E. Naugle, longtime associate administrator currently serving as chief scientist, announced plans to retire June 29, 1979. After receiving a doctorate in physics in 1953 from the University of Minnesota, where he worked before joining the Convair scientific research laboratory, he began his NASA service at GSFC in 1959 as head of the nuclear emulsion section. Naugle served in 1961 as chief of physics in Physics and Astronomy Programs, Office of Space Science; as director of physics and astronomy programs in the Office of Space Science and Applications from 1962 to 1966; as associate administrator for space science and applications in 1967; and as deputy associate administrator of NASA in 1974, becoming associate administrator in 1975. In a reorganization of 1977, he assumed the duties of chief scientist. Dr. Robert A. Frosch, NASA administrator, said Naugle was "an effective proponent for space, an international negotiator of distinction, a leader and a guide to a generation of managers." (NASA anno May 9/79; NASA Release 79-63)

—Dr. Robert S. Cooper, director of GSFC since July 1, 1976, announced he would resign June 1 to become vice president for engineering at Satellite Business Systems. Cooper came to GSFC from DOD, where he was assistant director for defense research and engineering, beginning in 1972. He was a research engineer at the Massachusetts Institute of Technology (MIT) Lincoln Laboratory and, before that, a professor at MIT. He attended the University of Iowa and Ohio State University and received a doctorate in 1963 from MIT in electrical engineering. (NASA Release 79-60)

—JSC announced retirement May 18 of deputy director Sigurd A. Sjoberg after 37 years of service with NASA and its predecessor, the National Advisory Committee for Aeronautics (NACA). He joined NACA in 1942 as an electrical engineer and went to Houston when his group was relocated from Hampton, Va. He became director of flight operations in 1969 and deputy director of JSC in 1972. He would manage Houston operations for OAO Corporation (JSC Release 79-24; NASA Release 79-58)

—NASA announced appointment of Dr. Thomas A. Mutch as associate administrator for space science, effective July 1. Mutch, professor of geological sciences at Brown University, received a doctorate in geology from Princeton University in 1960 and had been a member of NASA's lunar science review board from 1969 to 1973, leader of the Viking project's lander imaging science team, and chairman of several NASA committees planning post-Viking exploration of Mars. A mountain climber, he had visited the Himalayas twice, most recently in 1978 with a group from Brown University. (NASA Release 79-72)

—NASAreported that astronaut Fred W. Haise, Jr., would resign at the end of June to become vice president for space programs at Grumman Aerospace. He began as a NASA research pilot at LeRC in 1959, followed by three years at DFRC, and was one of 19 astronauts selected in April 1966. As pilot of *Apollo 13*'s lunar module, he assisted in converting it into a "lifeboat" for the crew after an explosion in the service module about 55 hours after launch. He had been technical assistant to the manager of the Space Shuttle orbiter project and commanded one of the two crews piloting the Enterprise in approach-and-landing tests in 1977. (NASA Release 79-79)

—MSFC announced appointment of Dr. Mathias P. Siebel as manager of the Michoud Assembly Facility in New Orleans, La., succeeding Robert C. Littlefield, who died May 12. (MSFC Release 79-52)

—KSC announced retirement of Dr. Walter J. Kapryan, director of Shuttle operations, and appointment of George F. Page to fill that position, effective June 1. Kapryan began in 1947 at the Langley laboratory when it was NACA headquarters and went to Cape Canaveral as project engineer for Mercury Redstone 1. In 1963 he established the Gemini program office at KSC; he was deputy director of launch operations until September 1969. He had assisted with KSC's transition from Apollo to the Shuttle era. (KSC Release 100-79)

• FBIS reported on the status of the *Soyuz 32* crew in its continuing flight aboard *Salyut 6.* Since launch February 25, Vladimir Lyakhov and Valery Ryumin had done daily exercises and physical tests, noted by Soviet press services as "the cosmonauts are feeling well." Their May 3 activity was experimenting on the Kristall equipment, making "semiconductor monocrystals" of indium arsenide. On May 4 they operated a "submillimeter telescope" gathering data to predict cyclones in tropical zones of Earth. A commentator noted that this equipment was complicated, requiring exact calibration each time it was used, and could be aimed only by turning the entire station. On May 6 they used a "gamma telescope" to measure gamma radiation and charged particles in near-Earth space. On May 8 they replaced their television transmitter with a new one brought by *Progress 5.* On May 9-10 they used the Kristall to experiment with cadmium sulfide.

Tass reported May 13 the launch of *Progress 6*; a commentator said that the cargo ship contained "an unusual present" to the crew, a tulip scheduled to bloom in space. An ongoing task was to study the efforts of weightlessness and "other space flight factors" on plant growth; small hothouses aboard the Salyut could provide fresh food containing vitamins. The crew was growing green onions; they had reaped their first harvest and "ate it with the permission of biologists." They also had fennel, parsley, and garlic; Tass noted that "Despite successes of chemistry. . .scientists have not yet managed to create the same vitamins as in nature." The cosmonauts on *Soyuz 29* had repeatedly described the mushrooms they were picking as "really strange. . .their form was unusual with curly stems. . .". "Nevertheless," Tass said, "[the crew had been] greatly pleased. All living things evoke their enhanced interest. . .a psychological backup in their difficult work." The tulip in outer space, "merely an experiment to scientists," was for the cosmonauts "a symbol of spring" and an expression of solicitude for the crew that had been working for a long time in isolation. *Progress 6* docked May 15, and the crew was unloading cargo and reloading used equipment for the next fortnight. The major job was refueling, difficult and complex in space, but the crew had completed it by May 28. (FBIS, Moscow Tass in English, Dom Svc in Russian, Intl Svc in Russian, May 3-28/79)

June

June 1: NASA announced plans to shift Skylab into a lower-drag attitude that could extend its life up to 12 hours, during which the reentry area might shift by thousands of miles. Reentry was predicted between June 27 and July 21; the "footprint" of resulting debris would be about 160 kilometers wide and 6,400 kilometers long. About 24 hours before reentry, it might be possible to predict the most likely area where debris might reach the surface, but with a wide margin of error. "Drag modulation" would offer the possibility of shifting Skylab's orbit to pass over less populated areas, reducing the chance of damage or injury. (NASA Release 79-80; JSC Release 79-37)

June 2: NASA launched *UK 6* from WFC at 7:26 p.m. EDT on a Scout into an orbit with 656 kilometer apogee, 607-kilometer perigee, 55° inclination, and 97.5-minute period. Under the terms of a contract of March 16, 1976, between NASA and the U.K. Science Research Council, the launch was the second on a fully reimbursable basis, at an estimated cost to the United Kingdom of $4,956,733, including booster, support services, tracking and data acquisition, and use of U.S. facilities.

The British-built spacecraft, weighing 340.6 pounds carried an experiment to measure the charge and energy spectra of galactic cosmic rays, and two X-ray astronomy experiments on structure and position of low-energy sources and on fluctuations in X-ray emission from low galactic latitude sources. *UK 6* would carry two experiments for the Royal Aircraft Establishment to study performance in orbit of new types of solar cell and the susceptibility of metal-oxide semiconductor devices to radiation in a space environment. NASA judged the mission successful as of October 1979. (NASA Release 79-61, 79-78; NASA MOR M-490-301-79-02 [prelaunch] May 14/79, [postlaunch] Oct 18/79)

June 4: The $220 million requested by the President as an amendment to NASA's Space Shuttle program was "essential to allow the. . .program to proceed in a reasonable manner," Dr. William J. Perry, undersecretary of defense for research and engineering, told the Senate subcommittee on science, technology, and space. Noting that NASA's launch predictions were based on the supplemental funding, Perry said DOD was concerned about the adequacy of the Shuttle fleet to meet traffic demands sure to build rapidly "once the Shuttle is operational." DOD planned to transfer "several programs important to our national security" to Shuttle launch by 1983, and delays in orbiter delivery would mean further use of expendable launch vehicles, with "adverse operational and economic impact." A House appropriations subcommittee had dropped $70 million for construction of Shuttle facilities at Vandenberg Air Force Base from FY80 budget requests, and the full committee was not likely to ignore the subcommittee's recommendation. (Text, June 4/79; *Today,* June 6/79, 1A)

June 6: DOD launched a Block 5D defense meteorological satellite (DMSP) from Vandenberg Air Force Base, Calif., at 11:22 a.m. local time on a Thor booster into an orbit with 837-kilometer apogee, 818-kilometer perigee, 101.5-minute period, and 98.8° inclination. DOD made no announcement, but *Aviation Week & Space Technology* reported that the 1,131-pound spacecraft would be tested for about 15 days before being put into operation in its near-polar Sun-synchronous orbit. (NASA wkly SSR, May 31-June 6; *AvWk,* June 18/79, 56)

June 7: The Soviet Union launched *Bhaskara,* an Earth-observation satellite, for the Indian Space Research Organization (ISRO) from the Kapustin Yar cosmodrome at 2 p.m. local time on an SS-5 Skean vehicle into an orbit with 541-kilometer apogee, 518-kilometer perigee, 50.7° inclination, and 95.2-minute period. Named for an ancient Indian astronomer, the 1,000-pound India-built spacecraft was the second launched for India by the Soviet Union; it carried television cameras and equipment for studying hydrology, meteorology, and forestry. India's first satellite, launched about four years ago, was still in orbit and functioning well. (NASA wkly SSR, June 7-13/79; *Spacewarn* SPX-308; *W Post,* June 8/79, A-15; *AvWk,* July 23/79, 59; *D/SD,* June 11/79, 200; July 3/79, 10)

June 10: DOD launched a "classified payload" at 9:38 a.m. local time from Cape Canaveral on a Titan 3C into a geosynchronous orbit with 36,261-kilometer apogee, 35,802-kilometer perigee, 1,448.6-minute period, and 2.0° inclination. The U.S. Air Force had no comment on press speculation about the launch. The *New York Times* said "such satellites are used to monitor Russian and Chinese launches [and to warn] American officials if a missile is launched from a submarine at sea." *Aviation Week & Space Technology* said that the payload had "orbital characteristics of previously launched early warning satellites." (NASA wkly SSR, June 7-13; *NY Times,* June 11/79, B-6; *W Post,* June 11/79, A-9; *Today,* June 11/79, 1A, 8A; *AvWk,* June 18/79, 13)

June 11: MSFC announced that on June 13 it would begin flight-qualification testing of a Space Shuttle solid-fuel rocket booster at the Thiokol range near Promontory Point, Utah, to demonstrate the production, assembly, and firing cycle for a full series of Shuttle flights. Assembled from four segments, the 35-meter-long motor would first be static-fired to demonstrate "ablative safety factors" of the motor nozzle, which would be gimbaled to simulate control during a launch. Designed to move 8° in any direction, the nozzle would be part of the Shuttle guidance system. Insulation and ablative materials would protect the motor from heat during firing. (MSFC Release 79-54)

The first flight-qualification firing of a Shuttle motor was "quite satisfactory," said George Hardy, manager of the booster project at MSFC. After witnessing the firing in the Utah desert, Hardy said that the amount of thrust developed and the performance of the steering nozzles was "well within specifications." The motor and igniter had been modified as a result of test firings of four development motors during the past two years. Static tests of the flight-configured solid-fuel rocket booster that each Shuttle mission would use in pairs would complete qualification testing. (MSFC Release 79-60)

June 12: After almost a month of waiting for good weather, the first man-powered flight across the English Channel took off at 5:50 a.m. from Folkestone, arriving at Cap Gris Nez in 2 hours, 55 minutes. Bryan Allen, 26, a cyclist, hang-glider, and biologist from California who, at 137 pounds was nearly twice as heavy as his craft, pedaled the 70-pound gossamer Albatross (built of carbon-filament tubing and covered in transparent mylar) nonstop for 25 miles. Rules were that the craft must be heavier than air, must be propelled only by the crew, must not fly higher than 160 feet, and must not discard any parts in flight. Allen had traveled an average of 6 to 8 feet above the water but had dipped to within a foot of the surface several times when strong winds arose about halfway over.

The flight won a $205,000 Kremer prize ("almost enough to pay the costs") and a niche in history for aeronautical designer Paul MacCready, who also built the Gossamer Condor that in August 1977 won a $102,500 Kremer prize for the world's first controlled man-powered flight, steered by Allen around a 1.15-mile figure-8 course in California. The Condor was now on display in the National Air and Space Museum. U.K. industrialist Henry Kremer had established the prizes to be awarded by the Royal Aeronautical Society, which called the Channel crossing "a tremendous achievement." (*NY Times,* June 13/79, A-1, A-8; *W Post,* June 13/79; A-1; *W Star,* June 12/79, A-1; June 14/79, A-18)

• The May 25 crash of a DC-10 aircraft killing 275 was predictable in view of previous problems with that plane, Rep. John L. Burton (D-Calif.), chairman, told a House subcommittee on transportation June 11. He asked Federal Aviation Administration (FAA) Administrator Langhorne Bond why the FAA had twice previously grounded the DC-10s for inspection and twice sent them into the air again. After the accident, the FAA waited for 13 days to ground the DC-10s, "and then only because a federal judge. . .acting on a suit brought by the Airline Passengers Association ordered them to do it," *Washington Star* columnist Mary McGrory noted.

Engine-mounting pylons, which an FAA memo from California not seen by Bond had called a design fault, apparently caused some of the problems. Bond said that what McGrory called "the worst plane tragedy in U.S. history" was "a single, severe event" when "that pylon experienced an overload of that wing and those fasteners," insisting that FAA's actions were proper at the time. Rep. Burton said that since 1974 the FAA had had many pylon problem reports; Bond said they did not form a pattern, as they concerned "individual and random defects in an entire area. . .there was no trend." In 1975, McDonnell Douglas had suggested some remedies for problems with the pylons; Bond told the subcommittee that manufacturers' suggestions were not mandatory, and the FAA did not make the airlines follow them. (*W Star,* June 12/79, A-2, A-4)

• Neil Armstrong, "America's reluctant space hero," said the United States should develop a permanent manned orbiting space station for long-duration exposure of people and equipment to the space environment. At an interview about the 10th anniversary of the moon landing, the University of Cincinnati engineering professor who in 1969 had been the first man to walk on the moon said that, if the United States had an ongoing manned space program, "we could have solved the problems" with Skylab. (*Today,* June 12/79, 16A)

June 14: MSFC reported that the seven-member science crew for the first Spacelab mission was conducting a three-day crew-station review, using a Spacelab mockup just completed in MSFC's Materials and Processes Laboratory. The review would evaluate experiment designs together with written procedures, the ensure proper crew-equipment interface, especially the location of switches, controls, and displays. (MSFC Release 79-57)

• MSFC said a long-duration test firing of the Shuttle main propulsion system scheduled June 12 was successful, even though a glitch in the automatic-cutoff instrumentation had terminated the test about 50 seconds into the 520 second program.

Frank Stewart, test manager for MSFC's Shuttle projects office, said that the test was successful "in the sense that the system performed as predicted and yielded a great deal of valuable data" needed before the first Shuttle flight. Stewart said the firing sequence was excellent. For the first time in test firing of three flight engines, the rated power level was attained, and the test produced pogo pulsing (a deliberate oscillation from very low to very high frequencies generated by a piston in the liquid-oxygen manifold, to show if vibrations in flight would constitute resonance dangerous to structures).

This first long-duration firing of the clustered flight-type engines and propulsion system had already been delayed by malfunction of a development engine during single-engine tests. Inspection after the failure revealed a crack in the coolant pipe, requiring removal of the engine nozzle. Engineers modified a spare nozzle for installation in the test article. Stewart said the event should not delay the total test schedule, which included extra time for unforeseen difficulties. System verification should be complete "in ample time for the first Shuttle flight," he said. (MSFC Release 79-58)

June 15: LaRC announced it would crash a twin-engine aircraft June 20 as part of an FAA/NASA general aviation crash test program. The test, using a swinging pendulum approach, would aid studies of the plane's structure, seats, restraints, and emergency locator transmitters, to increase the probability of survival and lessen the probability of injury. (LaRC Release 79-37)

• Ceremonies at Block Island, R.I., dedicated the third NASA-Department of Energy wind turbine, designed to provide 5% to 15% of the island's power and up to half in winter when winds are strongest. The windmill's 125-foot aluminum blades would interfere with local television reception, officials said; DOE would spend about $700,000 for a cable television system, besides $2.3 million for the windmill. Later versions might have wooden or fiberglass blades to avoid interference.

Residents said that their electric rates were the nation's highest—20% more than New York City's and double those of the mainland 12 miles away. The island used diesel generators, with fuel brought by barge. (*W Post,* June 16/79, A-3)

June 20: NASA announced an MSFC award to General Dynamics Convair of a $250,000 contract to study feasibility of a space platform in geostationary Earth orbit carrying many separate payloads. The platform would contain plug-in equipment to accommodate communications, Earth resources, meteorology, and similar studies now flown on separate satellites.

Preliminary MSFC investigations indicated that a platform could be built in space and located in a synchronous orbit at 40,000 kilometers to offer power and other functions to "tenant" missions parked there for a fee-like rent. Platform services such as power, available to all tenants, would eliminate the need for antennas, solar arrays, or batteries on individual payloads, reducing size and launch weight. Locating packages on a single platform would also simplify in-orbit repair and servicing. (NASA Release 79-82; MSFC Release 79-63)

June 20-21: Newspapers nationwide reported that NASA was now predicting Skylab reentry between July 7 and 25, probably July 16. Thomas O'Toole wrote in the *Washington Post* that the descending space station would be visible in the sky over Washington, D.C., this week for the Last time before it broke up and fell to Earth. Atmospheric friction would destroy most of it, NASA said, but two heavy pieces (an airlock shroud and a lead-lined film vault) weighing 3,900 pounds and 5,000 pounds would probably hit Earth about 500 miles apart, the airlock being outside the station and the vault inside. The *Washington Star* said JSC controllers had "prodded" the Skylab into a sidewise attitude that might allow them to steer the station away from inhabited areas. NORAD agreed that reentry was probable on or before July 16. (*W Post,* June 20/79, A-11; *W Star,* June 21, A-4)

June 25: MSFC said the propellant tank for Columbia's engines was ready for flight and would leave the Michoud Assembly Facility June 29 for KSC, where it would be fitted to the orbiter and two solid-fuel rocket boosters. The Martin Marietta-built 154-foot tank with 140,000 gallons of liquid oxygen and 380,000 gallons of liquid hydrogen was the only part of the Shuttle assembly that was expendable; like the boosters, it would separate from the Shuttle at about 75 miles altitude and drop into the ocean but would not be recovered. (MSFC Release 79-66)

June 26: NASA issued a press kit on *Voyager 2*'s coming encounter with Jupiter July 9, describing the modifications resulting from *Voyager 1* findings. As the images from the latter in its January approach revealed changes on Jupiter differing from observations by *Pioneer 11* four years earlier, so *Voyager 2* had sent back images that differed in the shorter term on its approach. Its pictures of Jupiter relayed from 56 million kilometers had already exceeded the best resolution possible with Earth telescopes. (NASA Release 79-86)

June 27: NASA launched the NOAA-A at 11:52 a.m. EDT from the Western Test Range (WTR) on an Atlas into an orbit with 823-kilometer apogee, 807-kilometer perigee, 101-minute period, and 98.7° inclination. It carried six devices to measure Earth's atmosphere, surface, and cloud cover, and near-Earth proton/electron flux. It would also receive, process, and relay data from balloons, free-floating buoys, and remote automatic stations. Named *Noaa 6* in orbit, it should have a 2-year lifetime. (NASA wkly SSR June 28-July 4/79; NASA MOR E-615-79-01 [prelaunch] May 8/79; daily actv rept, June 28/79; AFSC *Newsreview,* Sept 79, 12)

June 29: MSFC reported completion of flight-certification test firings of the Space Shuttle main engines June 27, with a simulated abort mission requiring the engine to fire 823 seconds. To detect potential weaknesses in systems or hardware, engineers would remove selected components and inspect them for wear and tear; after inspection and analysis of test data, the same test series would be repeated on the same engine to simulate typical mission profiles. J.R. Thompson, MSFC's main-engine project manager, said that engine performance and operation during the test series was very satisfactory. Rockwell conducted the tests at NSTL. (MSFC Release 79-69)

June 30: NASA said that it had turned off *Applications Technology Satellite 6* (*ATS 6*) and would boost it to a higher orbit August 6. *ATS 6* had lost three of its four thrusters and would be a hazard to other spacecraft if it failed on station. Launched in May 1974, it had exceeded its design lifetime by three years; transmitting directly to small ground receivers, it had relayed educational, scientific, and health programs to stations worldwide. "Firsts" included the first educational courses by satellite, first two-way teleconference and "telemedicine," and first successful satellite-to-satellite communications. (NASA Release 79-81)

During June: NASA announced that Arnold W. Frutkin, associate administrator for external relations since November 1978, would retire June 27. For 18 years before his present appointment, he had headed NASA's Office of International Affairs and was credited with "an extraordinarily successful series" of international space endeavors and policy initiatives including *ATS 6* broadcasts, U.S.-USSR arrangements for Apollo-Soyuz, ESA Spacelab agreement, and multinational work on NASA science and applications missions. He had come to NASA from the National Academy of Sciences, where he was deputy director of the U.S. committee for the International Geophysical Year (IGY). (NASA anno June 1/79; NASA Release 79-85)

JSC announced the appointment of Kenneth S. Kleinknecht, veteran NASA manager for manned spaceflight projects, to direct JSC operations at KSC, completing installation of the thermal protection tiles and internal vehicle systems on the orbiter Columbia. Kleinknecht, who had joined NACA in 1942, would report to KSC from permanent assignment in Paris as deputy associate administrator for STS (European operations). (JSC Release 79-39)

WFC announced that its associate director, Abraham Spinak, would be on special assignment as executive assistant to a special NASA senior-staff group evaluating management of the STS. The group would study Shuttle funding problems, uncertainties of program predictions, and information flow and control. (WFC Release 79-12)

• ESA reported successful completion of exercises at Kourou, French Guiana, to prepare for Ariane launches, including assembly of a test launcher, filling and draining of propellant, and automatic countdown. The operation was to verify the launch team's competence and the suitability of the site for the launch program scheduled to begin in September. (ESA/CNES Release June 6/79)

• FBIS continued to report the status of the *Soyuz 32* crew aboard *Salyut 6.*

Beginning their 14th week in orbit, the crew prepared the shower stall and used it; they also used the Splav (alloy) furnace to make "foam metals" in a Soviet-Bulgarian experiment for low weight and high mechanical qualities. (On June 2, Reuters reported that a joint Soviet-Hungarian flight had been called off because of "serious trouble" with the *Salyut 6* and predicted delays of 4 to 5 months or even a year in further joint manned flight. This would have been the 5th USSR joint mission with eastern-bloc countries.) On June 4, in the 15th week, the crew observed Far Eastern forests and corrected *Salyut 6*'s orbit using the *Progress 6* engines. On June 5, the crew was congratulated by the *Soyuz 29* record-holding crew for completing 100 days in orbit.

Soyuz 34, an unmanned ferry vessel launched June 6 "to check a crucial engine that failed during a manned mission in April," might serve as return vehicle for the *Soyuz 32* crew besides bringing supplies, press reports said. The April mission that failed to dock (*Soyuz 33*) had been crewed by Nikolay Rukavishnikov (veteran of *Soyuz 10* and *16*) and Georgy Ivanov, first Bulgarian cosmonaut. A June 6 report said the specific part found at fault in *Soyuz 32* had previously been tested 8,000 times with no defect evident; nevertheless, the modified *Soyuz 34* was launched unmanned to prevent possible casualty. *Soyuz 34* docked successfully June 9 in the space formerly used by *Progress 6,* which had been set loose June 8 to deorbit over the Pacific Ocean.

The crew sent away *Soyuz 32,* loaded with used equipment and experiment material, for a soft landing June 13. Later June reports from scientists studying the returned material said that future stations would allow for larger numbers of meteorite impacts; for the first time, returned equipment was available for analysis, such as devices that operated for 600 days rather than the planned 100, and lamps that "had not worked out their term." (FBIS, Tass in English, Intl Svc in Russian, Dom Svc in Russian, June 1-30/79)

July

July 3: JSC reported that it had amended its contract with Rockwell International Corporation to cover 56 engineering changes in the Space Shuttle orbiter. The first amendment, covering 32 changes, would cost $14,338,000; the second, covering 24 changes plus testing, repairs, and spares, would cost $2,869,833. The control value was now about $3.43 billion. (JSC Release 79-48)

• INTELSAT reported from its meeting just ended in Washington, D.C., that international telecommunications by satellite would increase nearly 100% by 1983. More than 200 delegates representing more than 100 nations at the week-long meeting had pooled forecasts of services needed from INTELSAT's satellite system. The biggest growth would be in the Atlantic region, where traffic might increase 114% by year-end 1983. The new Intelsat V satellites soon to be launched could carry 12,000 simultaneous phone calls plus two television channels—double the capacity of present satellites. Planning was under way for satellites with 40,000-circuit capacity. (INTELSAT Release 79-16-I)

July 6: ESA reported signing a contract with NASA July 5 authorizing the order of long lead-time materiel and components for construction of a second Spacelab flight unit to be delivered "progressively" to NASA in 1982-83. ESA had signed a simultaneous contract with ERNO of Bremen, Germany, as prime contractor. ESA said that this was the first time the United States had placed an order for "work of such importance" with the European industrial consortium representing some 50 firms, headed by ERNO. (ESA Release July 6/79)

July 9: NASA announced that MSFC had appointed a board to investigate the automatic cutoff of a test firing July 2 at NSTL of the Space Shuttle main-engine test article (three main engines mounted in an orbiter aft section and attached to an external tank). A liquid-hydrogen leak from a main fuel valve caused the cutoff after 18.5 seconds; no explosion occurred, and the gaseous nitrogen and water fire-control systems put out an external fire resulting from hydrogen accumulation around the test article's aft area. Inspection revealed damage to the aft heat shield and charring of external-tank insulation, but the engines appeared generally in good condition. (NASA Release 79-92)

July 9-13: NASA's *Voyager 2* passed within 404,000 miles of Jupiter July 9, making its closest approach at 6:29 p.m. EDT and sending from more than

570 million miles a flood of scientific data and "stunning photographs of the planet and some of its moons," as the *New York Times* described them. Scientists at the JPL, control center for the mission, said that the flight was continuing to provide them with "new surprises." They had modified observing sequences on *Voyager 2* to benefit from discoveries by *Voyager 1* on its encounter in March. Changes included more darkside images of the planet to measure lightning and aurora; images of Jupiter's ring, taken away from the equatorial plane; and about nine hours of continuous imaging of Io for volcanic activity. *Voyager 2*'s inward track past three of the four "Galilean" satellites had let it see regions not viewed by *Voyager 1*; its path was "more conservative," as it passed 10 Jupiter radii above the visible clouds compared to *Voyager 1*'s 4.9 radii, for "complementary observations." *Voyager 2* studies began April 25 and would continue for a seven month look compared to *Voyager 1*'s three month look. *Voyager 2* had been launched August 20, 1977; *Voyager 1*, launched September 5, 1977, on a faster and shorter course, had overtaken its sister ship before the end of the year.

Scientists found that Jupiter and its moons did not resemble planets or satellites nearer the Sun, nor one another. Surprises in the findings were due, they said, to real differences between the outer and inner solar system and lack of previous knowledge, a result of the distance separating Earth from Jupiter. Before *Voyager 1*, "we thought we had some idea of what planets were like," said Laurence A. Soderblom of the U.S. Geological Survey after seeing Europa images from *Voyager 2*. Instead of a sphere heavily pocked such as Earth's moon and Mars from meteor impacts, *Voyager 2* images showed Europa "as smooth as a billiard ball," with hardly any craters on a surface covered by a mantle of slushy snow and ice up to 60 miles deep, with far-reaching shallow marks like cracks in an eggshell. The spacecraft passed Callisto and Ganymede on its way toward Europa and, after its encounter with Jupiter, had begun a 10-hour watch for Io, where it photographed six volcanoes erupting. On its approach to Jupiter, *Voyager 2* had encountered radiation so intense that JPL had turned off a sensitive ultraviolet (UV) detector six hours earlier than planned; however, project director Ray Heacock declared "no problems and no failures in any of our instruments." (JPL Release 901; NASA MOR S-802-77-01/02, June 26/79; *NY Times*, July 10/79, C-1; *W Post*, July 10/79, A-10; *W Star*, July 11/79, A-4; July 13/79, A-10)

July 10-15: Amid disaster predictions, Skylab deorbited over the Indian Ocean with pieces falling on Australia: impact at 1637 GMT (about 11:37 a.m. EDT, or 37 minutes after midnight local time) July 11 sent debris across the Australian outback, with no reports of damage or injury. Australian officials had only an 8-minute notice of Skylab's approach: "We nearly had a heart attack" when told that it would cross the coast, said one. (NORAD had lost contact at 12:02 a.m. local time and assumed splashdown into the Indian Ocean, with debris coming no closer to Australia than a few hundred miles.)

The PRC news service told of the difficulties encountered by Skylab and the U.S. government's offers of assistance and compensation in case of damage or injury, noting that some airlines had suspended flights during the critical period. Tass said that western Australia authorities had "warned the population that some parts of Skylab might be radioactive and urged. . .caution in approaching them." At a NASA press conference a few days earlier, a reporter asked how NASA could tell if someone brought in a piece of debris claiming falsely that it was part of Skylab. Richard G. Smith, deputy associate administrator, space transportation systems, who had been "actively in charge of Skylab activities for NASA," replied that "it is very easy to identify an object that's been in space. The high-energy particles that penetrate it in orbit give an extremely low-level but characteristic radiation background—no radiation for anybody to be worried about. . .But it's very easy to determine that." United Press International (UPI) reported July 13 that the Kalgoorlie town hall had squeezed into its lobby the biggest fragment recovered so far, a 6.5-foot by 3.25-foot cylindrical piece of metal bearing a stamped number 102: "very good for the tourist industry," said Mayor Ray Finlayson. (NASA press conf July 6/79; coord ctr bltns July 9, 10, 11/79; *NASA Dly Actv Rept* July 12/79; *W Star,* July 12/79, A-1; UPI, July 14/79, A-7; FBIS, Xinhua in Chinese, July 12/79; Tass in English, July 13/79; *AvWk,* July 16/79, 22)

July 12: INTELSAT would mark the 10th anniversary of its global communications satellite system begun July 15, 1969, when an *Intelsat 3* satellite went into service over the Indian Ocean; *Intelsat 3* satellites were already covering the Atlantic and Pacific. It had been just over 5 years since launch of the first commercial communications satellite (Early Bird, nickname of *Intelsat I*) April 6, 1965. "Best of all," INTELSAT said, its charges for leased telephone circuits by satellite had decreased 71.2% over 10 years despite inflation. (INTELSAT Release 79-17-I)

July 13: Pioneer 10 had become the first U.S. craft to fly beyond Mars, *Today* reported. An Associated Press (AP) story said *Pioneer 10,* now 2 billion miles from home, had crossed the orbit of Uranus July 11 on its way out of the solar system. Launched in March 1972, *Pioneer 10* sent back the first close-up views of Jupiter 21 months later and continued to transmit "valuable data about unexplored space and the outer solar system," said NASA spokesman Duke Reiber. A spokesman for TRW, which built both *Pioneer 10* and *Pioneer 11,* said *Pioneer 10* would cross Pluto's orbit in 1987. (*Today,* July 13/79, 10A; NASA Release 79-84)

• The House Committee on Science and Technology announced that it would hold a joint hearing July 19-20 with the House Select Committee on Aging on space technology applications for the elderly and handicapped, to mark the 10th anniversary of the first Moon walk. Committee chairman Rep. Don Fuqua (D-Fla.) said that the hearings would emphasize the importance of space program spinoffs in solving problems here on Earth. NASA would release a report "Technologies for the Handicapped and Aged" on innovations such as a lunar-gravity simulator to speed rehabilitation therapy; a voice-controlled vehicle for paraplegics that could pick up packages, open doors, and handle eating utensils; a human-tissue stimulator to reduce chronic pain; health-monitoring systems; and fabrics to prevent bedsores. (H Rept Release 96-60)

• The *Washington Star* reported that DOD would begin next week a long-awaited fly-off to see who would get a $2 billion contract to produce air-launched cruise missiles. The U.S. Air Force said that the missile was "desperately needed" to fill a gap in the U.S. weapons system created by President Carter's decision to scrap the B-1 bomber. Launched from a B-52 flying off the coast of California, the missiles would fly to a target southwest of Salt Lake City, Utah. *W Star,* July 13/79, A-4)

July 15: Astronauts interviewed in Las Vegas, Nev., on the eve of an *Apollo 11* 10th anniversary commemoration noted the lack of funding and support for the space program on the part of the U.S. government. James McDivitt, who commanded *Apollo 9,* said that he foresaw nothing like the Apollo program coming along. Ron Evans, command-module pilot for *Apollo 17,* said that spectacular space events were not in the cards for the next 20 years. Charles Duke, 10th man to walk on the Moon; Al Worden, *Apollo 15* command-module pilot; and Dick Gordon, *Apollo 12* command-module pilot, said the Shuttle system was not as safe as craft used in previous manned programs, as "Congress isn't ready to give NASA the money it needs." (*Today,* July 15/79, 20A; *W Post,* July 15/79, A-4; *P Inq,* July 17/79, 11)

July 16: ComSatCorp announced the official beginning of the new International Maritime Satellite Organization, INMARSAT, to operate a global maritime communications network. ComSatCorp would represent the United States in the new body. INMARSAT's board, which would eventually represent 22 member nations, had met for the first time this date at Brighton, England. The new group would begin its operations in the 1980s after taking over from Marisat (developed and managed by ComSatCorp's wholly owned subsidiary Comsat General), which for three years had provided communications services to the U.S. Navy and commercial shipping and offshore industries. (ComSatCorp Release 79-28)

July 16-21: U.S. observances of the 10th anniversary of *Apollo 11*'s Moon walk included a July 16 Library of Congress exhibition opening attended by only one of the *Apollo 11* crew: Michael Collins, pilot of the module that circled the Moon awaiting the return of astronauts Neil Armstrong and Edwin Aldrin, Jr., from the surface. At the reception, James Webb (head of NASA during *Apollo 11*) said that national interest in the space program had waned during the last decade. Barry Jagoda, former Carter advisor who had headed CBS News coverage of *Apollo 11,* said "on the way over here I couldn't help but compare the difference of the price tag for the energy effort—$142 billion stretched over a 10-year period versus the $20 billion the Apollo program cost us for 10 years."

The *Washington Star* said July 19 that all three *Apollo 11* astronauts would attend an Air and Space Museum ceremony the evening of July 20; on July 20 it reported that the ceremony had been held at 11 a.m. A *Star* editorial July 20 asked why the United States had stopped abruptly after taking "our first steps into the universe," concluding that the United States was reluctant to pay for more space missions; assumed that "Americans had become bored by space voyages"; and now leaned "toward introspection and consumption." Like the *Star* editorial, a Tom Wolfe commentary in the July 20 *New York Times* drew a parallel between the Apollo program and Columbus's voyages, with support and excitement at the beginning and loss of public interest at the end.

The July 21 *New York Times* said that the Air and Space Museum ceremony drew "some 2,000 people"; the "engineers and managers and astronauts who made possible" the giant leap for mankind had gathered for a "family reunion. . .When they spoke of the future, they wished it somehow could recapture the spirit of the past they remembered." Later, the three astronauts took copies of the NASA history, *Chariots of Apollo* to the White House; President Carter said "We will win energy security for our nation in the same way we won the race to the moon."

As part of the observance, the Senate Committee on Commerce, Science, and Transportation and the House Committee on Science and Technology held a symposium July 19: "Next Steps for Mankind—The Future in Space." Moderated by Jules Bergman of ABC News, speakers were Professor Carl Sagan, Cornell University; Dr. Noel Hinners, Air and Space Museum director; and George Jeffs, president of Rockwell International's aerospace operations. A NASA release had recalled events of the *Apollo 11* launch July 16, 1969, and an MSFC release announced a nine-day observance in Alabama, home of the center and its Saturn V that made the mission possible. (NASA Release 79-74, 79-76; MSFC Release 79-72; *W Star,* July 17/79, D-1, D-2; July 19/79, B-1; July 20/79, A-10, A-11, B-2; *NY Times,* July 20/79, A-12, A-25; July 21/79, A-1, A-21; symp rept, Sen Cte Comm/H Comm Sci, July 19/79)

July 18: NASA announced it would test a modified U.S. Air Force jet July 20 at DFRC to see if winglets (9-foot airfoil sections) attached to wingtips of a KC-135 could improve performance and save fuel. Dr. Richard T. Whitcomb, LaRC's inventor-engineer, had had the idea of using normal drag from a wingtip vortex as lift to improve performance. NASA would vary the winglets' cant angle and incidence between test flights to measure effects of different positions; DFRC had already flown the plane without winglets to obtain baseline measurements for comparison. (NASA Release 79-94; DFRC Release 27-79)

July 19: The Library of Congress Science and Technology Division's NASA support project issued two news alerts, the first on a Soviet "space mini shuttle" like the French project Hermes, reportedly designed to carry five or six crew members (or the equivalent in cargo) to visit and replenish orbital stations. The vehicle would use a normal expendable Soviet rocket for launch and make a gliding reentry into Earth's atmosphere. The translation pointed out that the Soviet concept differed from the United States reusable Shuttle, more closely resembling the CNES manned hypersonic glider.

The second notice covered government and CNES decisions affecting the scope and timing of Hermes. The French Council of Ministers on March 7 had approved a Hermes launch capability of seven tons to carry a materials-processing program called Minos, using a space transport vehicle like a mini shuttle to bring back products made in the space factories. A Hermes would be launched by the last of five versions of the Ariane vehicle; development of the Hermes and the Ariane 5 would take from seven to eight years. (LC/S&T Alerts 5498, 5499)

July 20: The *Washington Star* reported that the Federal Communications Commission (FCC) had voted to let American Telephone and Telegraph Company (AT&T) and GTE Satellite Corporation, operators of the Comstar satellite system, integrate their domestic communications satellite and ground networks. Before the decision, AT&T could use only ground lines to transmit private line communications. The FCC had put a moratorium on AT&T in 1972 to keep it from cutting circuit costs and further dominating the telecommunications market; since then, the company had been able to use its satellites for some phone service but not for transmission of commercial private-line service. AT&T Comstar craft were currently providing the U.S. mainland with communications to Hawaii, Puerto Rico, and the Virgin Islands.

FCC said AT&T would have to file rate schedules if it operated a satellite-only service; the company would integrate the satellites into its "national telephone network," the *Washington Star* said. American Satellite Corporation, which already had an operating satellite, wanted the FCC to limit AT&T use of its satellites to services provided through separate subsidiaries; Satellite Business Systems had asked FCC to ensure that AT&T did not fund its satellite services with money from telephone ratepayers. (*W Star,* July 20/79, E-10)

• *Today* newspaper said that representatives of Western Union and Hughes Aircraft Company had announced plans to launch Westar 3, an $8.3 million spacecraft bought in 1974 as a ground-based spare to supplement *Westar 1* and *Westar 2,* launched in 1974, and now in orbit over the equator south of Dallas and southwest of San Francisco, respectively. Western Union said Westar 3, needed because of increasing demands on the other two satellites, would be stationed over the Galapagos Islands in the Pacific west of Ecuador. Western Union had made "substantial savings" in buying the spacecraft five years ago when prices were lower: the same item would cost about $14 million if built today. The firm was holding electronic parts for a fourth Westar in a Delaware warehouse. NASA would launch *Westar 3* on a Delta from Cape Canaveral Air Force Station on or about August 9, it said in a release. (*Today,* July 20/79, 16A; NASA (press kit) Release 79-96)

July 23: "Once again," wrote editor Robert Hotz in *Aviation Week & Space Technology* magazine, "the American public is far ahead of its political leadership" in grasping the significance of NASA's program of planetary exploration. NASA Headquarters was "astounded by the vast amount of unsolicited public reaction to the Viking and Voyager missions," in the form of 17,000 letters it received in the first weeks after the Mars pictures reached Earth; the "Voyager flybys of Jupiter. . .have aroused similar public interest." In Europe and Japan, interest in U.S. planetary exploration was even stronger; media coverage there "far surpasses domestic interest." Hotz criticized the "penny-wise, pound-foolish policy" that would force NASA to use a single spacecraft for future planetary missions, not the dual-spacecraft approach used through Voyager. "Some day," he added, "the high price for this folly will be paid in spectacular 'low cost' failures." (*AvWk,* July 23/79, 9)

July 24: NASA announced plans to demonstrate emergency use of commercial tugboats as auxiliary fireboats, by mounting lightweight firefighting modules on their decks. A program jointly supported by NASA, the DOC's Maritime Administration, and the U.S. Coast Guard had produced the Firefly, a portable fire pump made by Aviation Power Supply Company, Burbank, Calif., after a prototype originated by NASA for Coast Guard use on small patrol craft, based on pumps developed for space liquid propulsion systems.

The Maritime Administration had as a primary mission the improvement of fire protection equipment in ports; studies had shown the need for a small number of modules in custody of the local port authority's fire service for regular use in emergency firefighting. NASA's module used an aerospace-type gas turbine to drive a two-stage pump providing 7 meters (22 feet) of suction from the nearest source of water (river, ocean, or lake) for up to four hours on ordinary diesel fuel. Automatic controls offered a continuous range of pressures to emit steam, fog, or foam.

The city of St. Louis, Mo., and the St. Louis Port Authority would work out arrangements for a series of tests, maneuvers, and operations, including public demonstrations of the module in training and simulated emergency situations. The Port Authority and a contractor would compile information for evaluating the concept and would make it available to other port cities. (NASA Release 79-95; MSFC Release 79-77)

July 25: FBIS reported that the *Salyut 6* cosmonauts were working on experiments to find out "whether tulips will flower in outer space" (see *During May*). In five months of scientific research, they had found that plants under weightless conditions generally would develop only to a certain stage: "tulips produced a nearly half-meter (18 inch) shoot, yet the buds refused to open." Scientists had decided that weightlessness affected normal plant development at the cellular level. The cosmonauts would try to verify this theory through experiments to lessen "the negative influence of weightlessness" through "artificial gravitation" available in a "biogravistat," a centrifuge producing acceleration "equal to what we experience on earth," with a rotating disc containing seed holders in which plants would grow. The station also kept a similar disc without rotation, planted with the same samples, and simultaneous tests were proceeding on the ground. First results showed the shoots produced under artificial gravity were much larger than those in weightlessness. Tass said the tests were "of tremendous importance." (FBIS, Tass in English, July 25/79)

July 26: NASA reported successful demonstration July 24 of in-flight switch from helicopter mode to airplane mode, by a research aircraft combining features of helicopters and conventional turboprop airplanes. The aircraft, designed and built by Bell Helicopter Textron under a joint program of ARC and the U.S. Army Research & Technology Laboratories, had a 7.5-meter (25-foot)-diameter rotor at each wingtip, each powered by a turboprop engine and capable of pivoting from a straight-up to a straight-ahead position. Oriented up, the rotors would take the craft up or down and hover like a helicopter; rotated forward, the blades would function as propellers, and the craft would fly like an airplane. The demonstration at the Bell plant of conversion from helicopter to airplane mode proceeded gradually, with steady-state flight at each 5^0 of nacelle rotation; the craft was designed to be much quieter than current helicopters and turboprop planes. The XV-15 craft had logged about 15 flight hours since tests began in April, in preparation for delivery to ARC for a proof-of-concept flight program. (NASA Release 79-98)

July 27: ESA announced that, pending an INMARSAT decision on the configuration of its worldwide maritime space system, member states in the Maritime European Communications Satellite (Marecs) program had agreed at a July 26 meeting in Paris to prefinance a third maritime communications satellite, *Marecs-C,* under a new arrangement whereby, instead of ESA's offering INMARSAT the *Marecs-A* and *Marecs-B* satellites through Interim European Telecommunications Satellite (Eutelsat), ESA would offer three Marecs satellites directly to INMARSAT. The agreement authorized ESA to sign with the satellite contractor for about 45 MAU (million accounting unit) and begin arranging for a Pacific-area ground station. (ESA Release July 27/79)

July 30: NASA announced that Russell L. (Rusty) Schweikart had resigned to take a position with a State of California commission on energy resources that plans and regulates the state energy system. Schweikart flew the first lunar module on *Apollo 9* in 1969 and was commander of the backup crew for the first Skylab mission. In May 1974 he became director of user affairs in the

Office of Applications at NASA Headquarters; in September 1976, he was named assistant for payload operations in Planning and Program Integration and was detailed in September 1977 to the State of California as assistant to the governor for science and technology. (NASA anno July 30/79)

July 31: KSC reported that NASA's third spectacular of the year would come in August-September when *Pioneer 11* passed within 13,300 miles of Saturn's cloudtops. Launched April 5, 1973, the craft would give scientists a first close look at the giant planet with rings and 10 moons. Data from *Pioneer 11* would help them plan Saturn flybys in 1980-81 of *Voyagers 1* and *2,* now headed there after passing Jupiter in March and July this year. The Saturn encounter would be the second planetfall for *Pioneer 11,* which had used Jupiter's gravity in 1974 to put it on a trajectory toward Saturn. (KSC Release 142-79)

During July: Aviation Week & Space Technology noted a record number of USSR spacecraft launches in the first six months of 1979 compared to the past year: 49 launches through June, compared with a previous record of 45 in the first half of 1978. The record year for Soviet launches, 1976, had seen 99 launches; the 1978 total was 88. (*AvWk,* July 9/79, 11)

• FBIS carried almost daily reports on *Salyut 6* cosmonauts Valery Ryumin and Vladimir Lyakhov, from unloading *Progress 7* beginning July 2 to performance of new metal-combination experiments on the newly installed Kristall furnace at month's end. Noting that the current crew had broken the previous record of 140 days in space on or about July 14, the *Washington Post* picked up a Tass report that Valery Ryumin had achieved another space first: he had added a "svelte" 1.5 pounds, first weight gain in orbit. The Soviet press attributed the gain to "space meals" like those on Earth, including about 70 items—"meat and diary products, confectionery, fruits, juices and spices." A July 16 story said that the new spaceflight record was "double the overall duration of manned expeditions aboard American Skylab." Unfolding a 30-foot-wide radiotelescope antenna made of fine wire petals and pushing it into space was done by July 20, when *Progress 7* undocked for reentry. (FBIS, Tass in English, July 2-30/79; *W Post,* July 15/79, A-14; *AvWk,* July 9/79, 20; July 16/79, 23)

August

August 1: As decided earlier in 1979 [see June 30], NASA took the first steps to take *ATS 6* out of geostationary orbit and boost it to a higher altitude to keep it from colliding with other spacecraft. On the evening of July 30, NASA fired the minus-pitch attitude-control thruster; the firing was successful, but *ATS* lost Earth acquisition because of intermittent telemetry problems. In order to reacquire Earth, the spacecraft was put in a Sun-acquisition mode the morning of July 31; boost procedures resumed about 1:30 p.m. and proceeded as planned, with completion expected in about 30 hours.

Since its May 1974 launch, the five-year-old communications satellite had exceeded its planned lifetime by three years, but three of its four station-keeping thrusters had failed, and the fourth was shaky. GSFC would use the remaining thruster to lift *ATS* to a level several hundred kilometers higher, where it would remain in orbit indefinitely. (NASA Release 79-81; *NASA Dly Actv Rpt* Aug 1/79)

• NASA announced that it would accept on an annual basis applications to become Space Shuttle astronauts; the 1979 time for civilian applications would begin October 1 and end December 1. Successful applicants would report to JSC for a year's astronaut training, after which NASA would choose pilot and mission-specialist candidates to be assigned by the Astronaut Office to jobs that would continue to train them in their scientific or technical field. NASA now had 27 selectees, including 11 scientists, available as Shuttle crew; 35 more candidates were in training to qualify for selection. The number of candidates to be selected in 1980 would depend on mission requirements. (NASA Release 79-101; JSC Release 79-50)

• NASA announced that JPL had selected TRW's Space Systems Division, Redondo Beach, Calif., to negotiate a contract estimated at $80 million for designing, building, and testing one of two spacecraft to explore the Sun's polar regions in the 1980s. A second spacecraft would be developed by ESA. The solar-polar mission sponsored jointly by NASA and ESA would study the Sun, cosmic rays, and magnetic fields in uncharted areas of the solar system. The four-year mission would begin with launch of both spacecraft by the Space Shuttle in 1983; a gravity-assist flyby of Jupiter in 1986 would put the craft over the solar poles in 1986 and again in 1987. This would be the first mission using spacecraft out of the plane in which Earth and other planets orbit the Sun. JPL would manage the project for NASA's Office of Space Science. The TRW contract covered the spacecraft system and ground-support equipment, integration of the science payload, tests and launch preparation, and spacecraft-system support during the mission. (NASA Release 79-100)

• FBIS carried a Tass report that "local monitoring services" had revealed launch of a "carrier rocket" by the People's Republic of China, "with the aim of putting into orbit an artificial satellite." The satellite was not orbited because the carrier rocket malfunctioned and "fragments fell on the territory of the PRC," the dispatch said, adding that this was PRC's fourth abortive attempt to launch a sputnik. (FBIS, Tass in English, Aug 1/79)

August 2: ComSatCorp announced that it was considering a system to provide subscription television service directly to homes by satellite. For a monthly fee, the service would offer programming over a number of channels simultaneously, broadcast by satellite to small antennas on subscribers' roofs. Programming "without commercials" would include first-run movies, sports events, educational and cultural programs, transmissions of data or text, and other formats. Dr. Joseph V. Charyk, chief executive officer of ComSatCorp, said technology for such a system already existed and was being tested in Japan; Canada and the United States had already tried it, and ComSatCorp had demonstrated use of Canada's CTS satellite with a ComSat-developed antenna. The new service could begin as early as 1983, but would require approval by the FCC. (ComSatCorp Release 79-32)

August 3: NASA reported that LeRC engineers had worked for six years on perfecting a new power transmission system: the Nasvytis multiroller traction drive, capable of transmitting high-power loads at high-speed ratios without using toothed gears. Between 1879 and 1971 about 34 patents had been issued on various fixed-ratio traction-drive concepts; 8 of these were issued to Dr. Algirdis L. Nasvytis. NASA engineers working with Nasvytis had made key design changes in traction-drive roller geometries to produce a test rig that could operate in a 15-to-1 speed ratio. LeRC had developed for an automotive gas-turbine engine a similar drive that could transmit 7 horsepower per pound compared to conventional gears with about 4 horsepower per pound.

Stuart H. Loewenthal, lead LeRC engineer on the project, said the "quiet, almost vibrationless means of transmitting power [could aid in] minimizing the noise pollution that now surrounds us." The device would be cheaper to make because it needed no gear-tooth design or cutting; it was lighter and smaller than conventional gearboxes; it had performed at 95% efficiency for 15-to-1 ratios at speeds to 73,000 rpm, and was more reliable, being less susceptible to wear and breakdown. (Lewis RC Release 79-104)

August 7: NASA reported that the *Viking 2* lander cameras had photographed a new layer of frost on the Utopia Planitia site, creating "a scientific puzzle" for researchers. In September 1977, the lander recorded frost on the surface of Mars during its northern winter (one Mars year and almost two Earth years ago); scientists had explained the frost as the result of a major dust storm, during which atmospheric particles picked up moisture that wound up as frost on the surface. However, latest observations of Mars showed the atmosphere clearer than it had been since the Vikings arrived in 1976, so that the frost could not be explained as before. (NASA Release 79-107; JPL *Universe* Aug 17/79, 1)

• MSFC reported that it had delivered most of the hardware that would be needed by the first Shuttle mission: main engines, external tank, and solid-fuel rocket boosters. All three main engines had arrived at KSC; two had been installed, and the third was scheduled for next week. The first external propellant tank had been barged to KSC and installed in the VAB to await arrival of Columbia from the processing facility nearby. Flight hardware for two solid-fuel rocket boosters, except for the loaded motor segments, had been delivered to KSC, and the loaded parts were to arrive about September 20. (MSFC Release 79-82)

• The *Washington Star* reported that faulty aluminum might have been built into the Space Shuttle and newly constructed military and civilian aircraft. A German aircraft firm, Fokker, had discovered the problem in May; Reynolds Aluminum Company, the manufacturer, told a high-level team of officials from NASA, DOD, and FAA that the plates might have "soft spots" because they were not cooled properly during fabrication.

Walter Williams, NASA chief engineer, said that, until records of the disposition of the faulty aluminum were located, "we have to worry about everything." The agency suspected that the large external tank (which would carry the Shuttle during blastoff) might contain some of the metal, as might the Shuttle itself, as well as its solid-fuel rocket engines. External-tank strength was crucial because it bore the weight of the liquid-oxygen and liquid-hydrogen fuel under high pressure, as well as the solid-fuel rockets during liftoff. Spokesmen for Reynolds and the Pentagon were "vague about the amount of aluminum involved," the *Star* said, but an internal NASA memo said it was about 15 million pounds of aluminum plates. (*W Star,* Aug 7/79, 1)

August 9: NASA launched *Westar 3,* the last of three craft built for Western Union by Hughes Aircraft, from ETR at 8:20 p.m. on a Delta into a transfer orbit before going into synchronous orbit at 91-f8-W over the equator south of New Orleans, La. Launch was 53 minutes behind schedule because of two problems: a USAF computer at ETR shut down about 4 minutes before liftoff and took 37 minutes to correct; then, 30 seconds before liftoff, a liquid-oxygen valve door showed open, and several checks were needed to confirm that the door was shut before launch. McDonnell Douglas was to get a million-dollar incentive bonus for 15 straight successful launches. (NASA MOR M-492-203-79-03 [prelaunch] Aug 7/79, [postlaunch] Oct 25/79; *Today,* Aug 10/79, 14A; *D/SD,* Aug 13/79, 205; Aug 17/79,233; NASA Hq *WB* Aug 20/79)

August 10: Enterprise, the first Space Shuttle orbiter built, began its last trek across the United States from KSC to DFRC, where "its flight log books will be closed," said the *Marshall Star.* DFRC said the craft, which served as prototype in all Shuttle tests to date, would be trucked to Rockwell's Palmdale facility, where parts would be removed for additional testing and possibly used in constructing future orbiters.

Enterprise had made eight captive and five free-flight approach-and-landing tests at DFRC in 1977; it then was ferried to MSFC for ground vibration tests, then to KSC in April this year to check out facilities for handling Columbia, first Shuttle scheduled for launch. JSC *Roundup* later reported that 750,000 people had crowded airports during the return to California and that Enterprise was a two-day front-page story in area papers at each of the six stopovers and a lead story on television and radio. Donald "Deke" Slayton, now program manager for Shuttle flight-test operations, piloted the T-38 chase plane flying with Enterprise and was spokesman for the Shuttle program during press briefings. (DFRC Release 29-79; *Marshall Star,* Aug 8/79, 1; JSC *Roundup,* Aug 24/79, 1)

August 11: The *Washington Post* reported that India's "problem-plagued space program" had suffered another setback August 10 when a seven-story-tall launcher, product of 11 years of work, crashed 5 minutes 15 seconds after liftoff and dropped its payload into the Bay of Bengal 300 miles from the takeoff point. The failure was a real disappointment, following USSR launches of two India satellites, both of which developed serious problems: the first, orbited in April 1975, lost power after a few days. A much more complex satellite launched in June 1979 from a Soviet site would have mapped India's surface using television cameras to record mineral deposits, water reservoirs, forests, and Himalayan snowcover; the cameras failed to switch on, and scientists got only the data from lesser experiments on oceans.

This launch was India's first attempt to orbit its own spacecraft on its own launcher from its own site (the small island of Sriharikota north of Madras, whose residents were moved to the mainland as a precaution). Though reporters were not allowed to attend, government cameramen were present. All publicity on India's space program discussed mineral location and other social uses, but the *Washington Post* noted the military element: India was trying to join the "club" that included the United States, France, the Soviet Union, China, and Japan; India had lost a border war with China in 1962 and had been at war with Pakistan three times in the past 30 years. A rocket able to orbit a spacecraft could give India intermediate-range ballistic-missile capability; a satellite transmitting television images of mineral resources could also monitor troop movements. The lost booster was a four-stage rocket with solid-propellant motors designed to orbit an 88-pound satellite. The launch had been successful until first-stage burnout; the anomaly had occurred in second-stage flight. (*W Post,* Aug 11/79, A-13)

• The JSC *Roundup* carried a report by J.M. Jones, public affairs officer, on the trip to Australia by four MSFC employees acting as a Skylab investigating team to check up on the path of debris over an area 20 miles wide and several hundred miles long. The team left Huntsville, Ala., July 13, two days after the midnight spectacular that occurred as the 77-ton Skylab descended and broke up over the Indian Ocean. NASA needed interviews with eyewitnesses and finders of the fragments to verify the location of the trajectory and the condition and precise location of the debris, and if possible to get samples for examination of the effects on spacecraft materials of more than six years of exposure.

Arriving in Canberra, the team held press conferences to explain the assignment and assure finders that they could keep any fragments they found, which would be returned if submitted for scientific study. At the coastal town of Esperance, local groups similar to U.S. rescue squads had spread the word and gathered about 30 numbered and cataloged specimens laid out in a warehouse for examination; most of them were "apparently really Skylab." The team expressed appreciation of the local people's helpfulness. Going inland several hundred miles to the goldfield region where heavier pieces were more probable, the team found the people just as friendly and helpful. When light-plane flights over 30 or 40 miles of uninhabited territory produced no further finds, the team returned with a stop at Canberra to thank officials for the "extraordinary assistance and friendliness" they had met. (JSC *Roundup*, Aug 10/79, 3)

August 16: NASA pronounced the mission of international ultraviolet explorer *Iue* successful: observatory performance had "substantially exceeded design and mission objectives." Gyros used on *Iue* would serve the Space Telescope (ST); the spectrograph and cameras would influence the design of those on the ST; and operational software and guest-observer operations would provide an experience base for the ST. (NASA MOR S-868-78-03 [postlaunch] Aug 16/79)

August 21-24: At a NASA Headquarters press conference on the *Pioneer 11* encounter with Saturn expected about September 1, reporters heard predictions of the findings from Dr. Thomas A. Mutch, associate administrator for space science; Fred D. Kochendorfer, program manager for Pioneer Saturn; and Dr. John Wolfe of ARC, project scientist for Pioneer Saturn. A self-styled space exploration buff, Mutch recalled his experience with Viking lander imaging and the delight of a first look at pictures relayed from a planetary mission. Kochendorfer described the Pioneer spacecraft and instruments, explaining how power was obtained at great distances for guidance and transmission, and lauding the Deep Space Network's remarkable support in getting "absolutely the most we can wring out of this [communications] system."

Wolfe said that all the experimenters who worked on the mission in 1969 were still alive, and only one had been changed (the principal investigator for infrared, who had taken a sabbatical). He called the media coverage of the *Pioneer 10* and *Pioneer 11* Jupiter encounters in 1973 and 1974 "outstanding." A plaque in the National Air and Space Museum described Pioneer as "a spacecraft designed to fly by the planets Jupiter and Saturn"—Wolfe congratulated the museum on its forecast. He enumerated the options for imaging, explaining how the Pioneer would approach Saturn and its moons and how the information returned would assist the upcoming Voyager encounters.

A NASA release August 21 said controllers at ARC had ordered a "left turn" for *Pioneer 11* to permit one-at-a-time activation of its onboard instruments. Images of Saturn's rings from 16 million kilometers looked no larger than a penny; by August 26, investigators expected them to be better than any taken from Earth and 20 times better by September 1. (NASA Release 79-108 [press kit], 79-109; ARC Release 79-37; text, press conf, Aug 21/79)

During August: NASA announced selection of a number of investigators and experiments for its missions.

—NASA selected 24 scientists to use data from the laser geodynamics satellite *Lageos* launched May 4, 1976. Having completed an initial phase of settling into orbit and checking out its laser tracking system, the satellite was now ready to provide mobile and fixed receivers around the world with ranging data on crustal-plate motion, density distribution within the Earth, and polar motion/Earth rotation. The investigators would become part of a working group chaired by Dr. David Smith, *Lageos* project scientist and were to meet August 29 and 30 at GSFC. Seventeen investigators were from U.S. universities (six), private firms (five), or other government agencies (six); others were from France (four), the United Kingdom, the Netherlands, and West Germany (one each). (NASA Release 79-102)

—NASA selected 32 research proposals that would use global measurements of the near-Earth magnetic field from Magsat, scheduled for launch in October. The 19 U.S. investigators represented universities (12), private firms (6), and government agencies (1). The 13 foreign investigators were from Canada (4), France and Australia (2 each), and Brazil, India, Italy, Japan, and the United Kingdom (1 each). The 6-month mission managed by GSFC would remedy shortages and discrepancies in data from many geographic areas. (NASA Release 79-103)

—NASA selected 40 scientific investigations for Spacelab/Shuttle flights scheduled between 1983 and 1985; 33 of those chosen were from the United States, and 7 from other nations (Canada, France, Japan, and Belgium) each funding its own experiments. The studies, chosen from some 200 responses to a request for proposals, would be on astronomy, solar physics, upper-atmosphere physics, space-plasma physics, and high-energy astrophysics. (NASA Release 79-112)

• NASA announced a number of personnel changes.

—Eldon D. Taylor, formerly of the NASA Headquarters Office of Space Science and Applications, most recently assistant director of administration for the NSF was approved by the president July 30 as NASA's first inspector general. He had also been deputy assistant administrator for resource management at the Environmental Protection Agency (EPA) before going to NSF. (NASA anno Aug 3/79)

—Dr. Lee R. Scherer, director of KSC since January 1975, would become associate administrator for external relations at NASA Headquarters September 2, succeeding Arnold W. Frutkin, who retired June 22. Scherer, who retired in 1964 from the Navy as a captain, was program manager for the lunar orbiter manned spacecraft while on assignment from the Navy in 1962 and was director of DFRC 1971-1975. (NASA Release 79-106; NASA anno Aug 8/79)

—Succeeding Scherer as KSC director would be Richard G. Smith, the deputy director since 1974 of MSFC who had been on detail to Headquarters as deputy associate administrator for STS (the Shuttle program). Smith had been in charge of operations during the Skylab reentry. At MSFC, he had been program manager for the Saturn 5 rocket engine that made Apollo possible. (*W Post,* Aug 9/79, A-11; NASA anno Aug 8/79)

—Dr. Walter B. Olstad, chief of space systems division at LaRC since July 1975, would become deputy associate administrator for aeronautics and space technology at NASA Headquarters effective October 1, succeeding Dr. John M. Klineberg, who became deputy director of LeRC July 1. Olstad had begun as a research engineer at the NACA Langley laboratory in 1954, working first with transonic tunnels, then in reentry physics. (NASA Release 79-110)

—JSC announced that Clifford E. Charlesworth had become acting deputy director August 10, succeeding Sigurd A. Sjoberg, who retired May 18. Charlesworth for three years had been deputy manager of the Shuttle payload integration and development program office, responsible for coordinating JSC technical management and Shuttle users. He was deputy manager of the Skylab program 1970-1972, then manager of JSC's Earth-resources program office. He joined JSC as a flight controller in 1962, working on Gemini and Apollo missions and was one of the flight directors during *Apollo 11*'s 1969 Moon landing. (JSC Release 79-51)

• Rep. Don Fuqua (D-Fla.), chairman of the House Committee on Science and Technology, sent committee members a report prepared by staff of a review of cost, performance, and schedule aspects of the Space Shuttle program, based on NASA's request for a $220-million addition to the FY80 budget request. The staff director wrote that recommendations in the report would, if implemented, improve budget requirement estimating, program cost, and schedule control, as well as NASA communications with the committee. (Text, oversight rept Aug 79)

• August 19 saw the end of the record-breaking flight in the *Salyut 6* space station of *Soyuz 32* cosmonauts Vladimir Lyakhov and Valery Ryumin, returned safely in the *Soyuz 34* capsule after 175 days in space since launch February 25. FBIS had carried daily reports of their progress. Besides the experiments in materials processing (alloys and coating processes) and the intensive physical routines designed to assist long-term assignments in space, the crew in their last days in orbit had worked with the KRT-10 radiotelescope sent last month by cargo craft and unfurled in space to study extraterrestrial radio sources and nonatmospheric radioastronomy. As early as August 15, they had begun to pack the return capsule with items demonstrating the results of their space stay.

Difficulty with the radiotelescope had presented another challenge to the crew; upon completion April 9 of the scheduled scans, the antenna was to be jettisoned, leaving the docking unit free. "Space sprung another surprise," Tass reported, when the antenna became entangled with a projection on Salyut's surface. The crew tried to free it by "a minor jerk of the station," which was not successful. A space walk was already scheduled to check the exterior of the station, dismantle outside scientific equipment, and retrieve samples of materials exposed for a long time to outer space. Ground control wanted to spare the cosmonauts the stress of an extra task in outer space, but the crew insisted it was the only sure way to solve the problem.

On August 15, the crew in "full pressure suits" opened the hatch, and flight engineer Ryumin moved to the attachment point, releasing the 10-meter (30-foot) antenna with pliers, and "imparted the antennae acceleration relative to the station" (in other words, pushed it away toward the Earth for reentry). Then, Ryumin and Lyakhov disassembled and brought in the micrometeorite registration instruments and the panels with samples of structural, optical, insulation, and polymer materials, some of which were in orbit since *Salyut 6*'s launch in September 1977, others installed by the *Soyuz 29* crew in July 1978. Total time of the space walk was 1 hour, 23 minutes: Tass noted that the suits, "fitted out with metal shielding against cosmic radiation and possible concussions" from meteorites, had previously served Kovalenok and Ivanchenkov of *Soyuz 29* and Grechko and Romanenko of *Soyuz 26.* The cosmonauts landed safely August 19 and appeared to be in the best shape yet: they wanted to walk but were not allowed to do so immediately, although they did get brief dips in the hotel swimming pool. Later reports praised the exercise routine for its good effects on the crew, who agreed that even longer flights were possible. (FBIS, Tass in English, Aug 1-25/79; *CSM,* Aug 14/79, 2; *NY Times,* Aug 16/79, A-19)

September

September 1-7: NASA's *Pioneer 11* had encountered Saturn's bow shock (where the solar wind—a stream of electrified particles from the Sun—bent around Saturn's magnetic field), project manager Charles Hall reported from ARC, adding that solar storms during the past few days had played havoc with Pioneer's radio signals. Pioneer was not designed in 1967 to fly to Saturn; that mission arose only after a successful Jupiter flyby in 1974, calling at first for Pioneer to fly through Saturn's rings on what the *Washington Post* called a "kamikaze mission." The most dangerous moment of the 6.5-year 2-million-mile journey would be crossing September 1 through belts of unknown material beyond the ring systems around Saturn that had been visible from Earth, during which Pioneer would risk a potentially fatal collision.

Because of intense radiation (solar-particle interference was degrading the quality of Pioneer images), mission controllers at ARC had reduced the data transmission rate by half. Solar storms had occurred late in July and in mid-August, and high-energy particles from the second storm had reached Saturn at the same time as slower particles from the first storm. Reducing the transmission rate would diminish effects of interference and also the quality of the images. Pioneer would enter the dangerous area outside the visible ring system at 10:44 a.m. EDT, but scientists would not know for 86 minutes whether it had survived (the time the signals needed to reach Earth). No one knew the composition of the 2 minute-wide third ring; if it consisted of boulders, Pioneer could probably get past it safely, but a ring of dust particles could riddle the fast-moving craft and end its career. Project scientist Dr. John Wolfe said chances for survival were half and half; pictures already transmitted by Pioneer were better than any yet taken from Earth telescopes.

The *Washington Post* reported September 1 that solar storms had increased the noise level in space to 10 times normal. In early afternoon, Pioneer had flown into a detectable magnetosphere, showing that Saturn was surrounded by a strong and sizable magnetic field estimated at 700 to 1,000 times the size of Earth's but roughly equivalent in strength. The *New York Times* reported September 2 that, as of 12:31 p.m. EDT September 1, *Pioneer 11* had survived a hail of fine particles to get within 13,000 miles of Saturn for a 4-hour first encounter. During the approach, scientists were keeping watch on the plane of the visible rings through which Pioneer was descending: Dr. James Van Allen of the University of Iowa was first to note Pioneer's approach to "dangerous ring debris" in its path. However, the 10:30 a.m. crossing at a speed of 48,000 mph had taken only a second, though ARC had to wait until 2:02 p.m. to learn what had happened; when the radio signals continued past that moment without interruption, "a cheer went up."

LaRC's Donald H. Humes said that *Pioneer 11* might have had a close call, as the micrometeoroid detector had registered two impacts during the crossing: this was the limit of the instrument's counting ability, and more impacts might actually have occurred. The impacts apparently caused no damage. The sharp rise in radiation encountered by Pioneer before it flew under the rings had fallen as abruptly as it rose, and by the time Pioneer was under the rings (closer to the planet) the radiation reading had disappeared completely. Dr. John Simpson of the University of Chicago said the rings were big enough to "scour out" nearly all the radiation trapped by the planet's magnetic field. (The *New York Times* quoted Dr. Van Allen as saying that the radiation count while Pioneer flew under the rings was even lower than while the spacecraft was sitting on its launching pad at Cape Canaveral, Fla., 6.5 years ago. Saturn's radiation, although it would be lethal to an unprotected human, posed no hazard to spacecraft, Van Allen added.)

After its close approach, Pioneer swung behind the planet, out of radio contact for 78 minutes, during which its on-board instruments recorded data for later transmission. Upon reemerging, the spacecraft had to cross the ring plane again on its outward journey; the outbound crossing came at 2:32 p.m., and controllers again had to wait for indication that the spacecraft was safe. At 3:55 p.m. the signals affirmed that *Pioneer 11* had survived another crossing. This was the last predicted hazard for the spacecraft, which would continue past Saturn to the outer edge of Earth's solar system and enter interstellar space in 1993, by which time its radio would no longer be audible.

The safe passage meant that Pioneer could spend September 2 and 3 photographing Titan and measuring Saturn's rings from the dark side of the planet; also, that the two Voyager spacecraft following Pioneer could approach without fear of damage. In its two-hour passage, besides recording impacts, Pioneer had photographed a new ring previously undetected by Earth telescopes, called the F ring: scientists already knew of four rings called A through D (in order of discovery, not location), three of them bright enough to be seen from Earth telescopes, and a fifth (or E) ring had been suspected close to the A ring although Pioneer did not report it. Pioneer had also tracked what might be a new Saturn moon orbiting about 70,000 miles out; some thought it might be a known moon, Janus, but it was in a position indicating that it was an entirely new satellite that would bring Saturn's count to 11, one short of Jupiter's 12.

Pioneer 11 photos of Saturn showed dark blue and green stripes across it just below the north pole; the colors, not so vivid from Earth, probably came from sunlight scattering in upper-atmosphere clouds. Jet streams like those seen on Jupiter appeared to whirl around Saturn at speeds of 300 mph. Pioneer images could give a better idea of the dimensions and composition of the rings when compared with Earth-based photographs.

In the six years it had taken to reach Saturn, *Pioneer 11* had reported a space-particle strike only once every two months or so, LaRC's Humes recalled. Once past Saturn, Pioneer was to photograph Titan from about 221,000 miles, record its temperature and atmospheric methane, and try to detect "life chemicals"; as no life was evident on Venus or Mars, this might be the last chance to find extraterrestrial biology in the Earth's solar system. First images of Titan had shown a fuzzy ball of light indicating a stratospheric layer of orange smog with blue streaks that might denote an atmosphere beneath the smog and clouds. The closest approach at 2:04 p.m. September 2 was 220,000 miles, and Pioneer had taken the first pictures at 260,000 miles. The pictures would be enhanced by computer before scientists could make detailed analysis. On September 3, Pioneer was already more than a million miles from Saturn, relaying no ill effects from the planet's rings or radiation belts.

Early on the morning of September 2, NASA reported loss of about two hours of Titan data from Pioneer transmissions to the Madrid station; ARC controllers did not know whether the loss occurred between spacecraft and station or between Spain and the control center about 40 miles south of San Francisco. A loss between spacecraft and station would be irretrievable: Pioneer had only the one opportunity for Titan observations after its close approach. It was not sending images at the time, but about 15 minutes of a CalTech infrared sensor's readings on Titan temperature were lost. The cause might have been electrical storms in space or on Earth, or passage of the signals close to the surface of the Sun on their way to the Earth, any of which would make it difficult or impossible for the Madrid station to lock on to the signals. A dramatic difference in day-night Titan temperatures would suggest a thin atmosphere; a thicker, warmer atmosphere might be more hospitable to life forms.

Project manager Charles Hall reported September 4 that the Titan data loss previously attributed to radiation disturbances was now thought to result from radiofrequency interference by a Soviet satellite. Both *Pioneer 11* and three USSR satellites had been operating on a frequency reserved for scientific use. The Soviet Union had twice agreed to shut down during Saturn encounter, and Hall said NASA had "no doubt the Soviets would have acted" if they had been asked; "we did not request them to turn off their satellite on Monday," U.S. scientists did not realize at first that signals from a recently launched Soviet satellite might interfere with reception of Pioneer data, being "between 100 and 1,000 times stronger than the signals we were receiving from our spacecraft."

Aerospace Daily said September 6 that the three Soviet satellites that had stopped transmitting September 1-2 for the benefit of Pioneer's Saturn flyby were early-warning satellites designed to detect U.S. ballistic missile attacks on the Soviet Union. *Cosmos 1024, 1109,* and *1124* had suspended transmissions September 1 and 2 at NASA's request; however, no request was made regarding September 3, and *Cosmos 1124* had operated as usual. Western analysts questioned, *Aerospace Daily* noted, "whether the U.S. would suspend communications with any of is early-warning satellites if the Soviets made such a request" during a planetary mission.

Pioneer project officials told a September 6 news briefing that the loss of

Titan data was not the fault of the Soviet satellite, which was broadcasting before but not during the lost transmission. Poor data had resulted from the combination of solar storm and poor transmission from Madrid. Some data had in fact reached ARC, but was so "noisy" as to be useless. Scientists said the moon discovered by Pioneer was inside the orbit of Janus, previously the innermost known satellite of Saturn; the new ring (labeled G) was between the orbits of Rhea and Titan, beyond the rings visible to Earth telescopes. (*NY Times*, Sept 2/79, 1; Sept 3/79, A-1; Sept 4/79, C-1; Sept 7/79, A-1; *W Post*, Sept 1/79, A-3; Sept 2/79, A-1; Sept 5/79, A-10; *W Star*, Sept 1/79, A-4; Sept 2/79, A-1; Sept 7/79, A-1; *A/D*, Sept 6/79, 17; *Today*, Sept 1/79, 4A; Sept 2/79, 1A)

September 6: NASA reported that an unmanned Soviet Cosmos satellite to be launched in mid-September would carry 13 experiments from the United States along with some from the Soviet Union and other countries, all designed to study effects of weightlessness on physiological processes. ARC would manage the U.S. portion of the project, in which 40 scientists representing 18 U.S. universities and research groups would participate.

Major payload would be 38 white rats and 60 fertile Japanese quail eggs, scheduled to orbit about three weeks. The Soviet Union would make a first attempt to breed rats in space, separating males and females until the second flight day; two control sets of rats on Earth would be housed and fed like those in space, one exposed to stresses such as launch and reentry but not zero gravity. Three U.S. experiments would use material handcarried to Moscow a week before launch and returned to ARC after recovery. (NASA Release 79-114; ARC Release 79-39)

• Neil E. Goldschmidt, nominated as secretary of transportation, told a Senate commerce committee hearing that after confirmation he intended to look into FAA safety policies, the *Washington Star* reported. FAA was criticized after two major crashes: the collision over San Diego of a small plane and a jetliner that killed 144 persons and the crash of a DC-10 jet near Chicago that killed 273. Sworn in as a recess appointee in August, Goldschmidt would require confirmation to continue in the position. (*W Star*, Sept 6/79, A-20)

September 10: JSC reported on trials of a Buck Rogers-style maneuvering unit designed for moving about and working outside the Space Shuttle. Officially named Manned Maneuvering Unit (MMU), the device worn on the back of a spacesuited astronaut would allow movement in the weightlessness of space using nitrogen gas jets to control direction.

Martin Marietta, the manufacturer, had submitted a prototype the previous week for three months of testing on different-sized astronauts (including female candidates) for fit and mechanical performance in use. Astronaut Dr. Bruce McCandless had successfully checked out the unit's compatibility with the self-contained portable life-support system, wearing a spacesuit and backing into the maneuvering unit as it would be located in the orbiter cargo bay, "like backing into a phone booth with a large knapsack on your back," KSC would get the first flight unit early in 1980. (JSC Release 79-55)

September 11: NASA declared the International Sun-Earth Explorer (ISEE) missions 1, 2, and 3 successful. The international cooperative effort of NASA and ESA, as a joint contribution to an international magnetospheric study, had used three spacecraft (two launched in October 1977, the third in August 1978) to measure Earth's magnetosphere and the solar wind from widely separate orbits to better understand processes controlling Earth's near-space environment. Maximum value of ISEE stated in 1977 was simultaneous operation of all three spacecraft for several solar rotations; the mission operations report signed by Harold Glaser, director of the solar terrestrial division, Office of Space Science, on September 5 and by Dr. Thomas A. Mutch, associate administrator for space science, on September 9 declared the mission a success with respect to prelaunch mission objectives. (NASA MOR S-862-77-01/02/03 [postlaunch] Sept 1/79)

• MSFC reported that *Industrial Research and Development* magazine had chosen the power-factor controller invented by aerospace engineer Frank J. Nola [see *A&A 75,* May 2] as one of the "100 most significant new technical products marketed in 1978." Nola's invention could sense the amount of power required by an electric motor and automatically vary the power to provide only as much as actually needed at a given time. NASA had licensed 26 U.S. firms to produce and market the device; about 30 others had applied for licensing. Results of MSFC tests had indicated that, if all electric typewriters in the United States (for instance) were equipped with the device, the energy saved would equal that generated by 2,000 to 3,000 barrels of oil per day. Nola and other winners would attend an awards banquet September 20 at the Science and Industry Museum in Chicago, which would display the 100 products for a month afterward. (MSFC Release 79-92; *Marshall Star,* Sept 12/79, 2)

September 13: NASA said it would join the Canadian Department of Communications and France's CNES in a 15-month demonstration in 1982 of a search-and-rescue system to speed detection and location of distress signals by use of satellites. The three countries would set up ground stations and conduct simulated search-and-rescue. A satellite in polar orbit could cover the globe every 12 hours, listening on the emergency frequencies used by ships and aircraft. Minutes after receiving an alert, ground computers could pinpoint its origin within 20 kilometers (13 miles) and flash it to coordination centers.

Canada would provide transponders, and France receiver-processors, to fly on NOAA satellites in polar orbit; the United States would modify, fit with antennas, integrate, and launch the satellites and develop emergency beacons for ships and aircraft to use with the systems. The parties to the agreement were also negotiating for cooperation with the Soviet Union. (NASA Release 79-118)

September 14: NASA announced it would deploy seven laser satellite-tracking systems in the United States and the Pacific Ocean as part of a global network to extend conventional measurements of strain in the Earth's crust and to seek the causes of earthquakes. The lasers, to be in full operation by October, would work with microwave devices using signals from satellites and radio stars to measure crustal movements and the buildup of strain.

Laser systems using corner-cube reflectors put on the Moon by the United States and the Soviet Union were operating in Texas, Australia, and West Germany; satellite-laser systems were operating in France, Spain, Germany, Greece, Egypt, England, and the Netherlands. The Smithsonian Astrophysical Observatory had laser systems in Peru, Brazil, and eastern Australia. NASA had joined NOAA, the U.S. Geological Survey, NSF, and the Defense Mapping Agency in a program using space technology to reduce earthquake hazards and possibly to develop a capability of predicting them. (NASA Release 79-117)

September 17: In a move "necessary and proper to achieve the objective of national technical superiority through joint action with U.S. domestic concerns," NASA administrator Dr. Robert A. Frosch announced that the agency would offer industry "equity partnership ventures" in use of the Space Shuttle, NASA technical advice, data, equipment, and facilities for commercial purposes.

NASA had set up guidelines to ease U.S. industry entry into an area that, because of high technology and high economic risk, had traditionally been left to the federal government. Such a government-industry relationship would combine industry's risk capital and experience with NASA's resources to ensure U.S. leadership in space processing of materials. Areas of potential commercial interest included semiconductors, infrared and nuclear detectors, metallurgy, microwave devices, and medicine. (NASA Release 79-119)

• ESA announced that the first stage of its Ariane launcher had undergone its last ground qualification test September 13; CNES had scheduled the launch phase to begin October 1, with first launch between December 8 and 18. Aerospatiale had shipped the flight-qualification model from Le Havre September 15, bound for the launch site at Kourou, French Guiana. (ESA Release Sept 17/79)

September 19: The *Washington Star* said that three jet planes in four days had lost large parts while in flight: on September 15, a Boeing 707 passenger jet operated by American Airlines on a flight from Detroit to San Francisco had dropped a wing flap into San Francisco Bay; on September 17, a DC-9 passenger jet of Air Canada, 60 miles north of Boston's Logan International

Airport en route to Nova Scotia, had dropped is tailcone into the Atlantic Ocean from 25,000 feet up. An American Airlines Boeing cargo jet had scattered 200-pound chunks of its left wing over Chicago September 18 before landing safely at O'Hare airport. No one had reported injuries from falling debris. (*W Star,* Sept 19/79, A-9)

September 20: NASA launched the high-energy astronomy observatory *Heao 3* at 1:28 a.m. EDT from Cape Canaveral Air Force Station on an Atlas Centaur into an orbit with 492-kilometer apogee, 477-kilometer perigee, 94.3-minute period, 43.6° inclination. It was third of a series designed to survey the sky for X-ray sources, measure gamma-ray flux, and define the composition of cosmic-ray nuclei.

The first Heao, launched in 1977 with a 6-month design lifetime, measured and mapped X-ray and gamma-ray sources for 17 months, reentering Earth's atmosphere in March 1979. It had increased the number of known X-ray resources from 350 to 1,500 and had discovered a new black-hole candidate as well as a dust cloud enveloping a supercluster of galaxies. The second, called Einstein, carrying the largest X-ray telescope ever built, was launched November 1978 with a 1-year lifetime to examine in greater detail the findings of *Heao 1.*

Heao 3 carried a gamma-ray spectrometer and experiments on a cosmic-ray isotopes and heavy cosmic-ray nuclei. Data from the three observations would cast light on the origins of high-energy radiation in space and the formation of elements and of the universe. (NASA Release 79-113; NASA MOR S-832-79-03 [prelaunch] Aug 10/79, [postlaunch] Sept 20/79; prelaunch summary, Sept 10/79)

• NASA announced that JSC was studying two ways to repair Space Shuttle tiles in orbit, both requiring crew members to go outside the Shuttle. JSC director Christopher Kraft called it "prudent" to be ready for in-orbit repairs, in case the tiles did not come up to specifications in actual fight: the thousands of heat-resistant blocks covering the underparts and sides of the orbiter might be damaged at launch and need patching before reentry.

The first idea, using an extendable boom carrying television cameras and a platform, would relay images of a damaged area into the cockpit and sustain a spacesuited astronaut making external repairs. The other concept would use a jet backpack to maneuver an astronaut around the orbiter to inspect it and make repairs wherever necessary. JSC had three studies under way by General Electric, Martin Marietta, and McDonnell Douglas on repair materials and tools suitable for outer space. (NASA Release 79-120; JSC Release 79-58)

September 24: KSC reported receipt of two experiments that would form part of OSTA 1, first Shuttle payload to fly into space: an imaging radar antenna and an ocean color experiment. The 30-foot by 7-foot imaging radar antenna would test the potential of such a system for geological use in mineral location and fault mapping; the ocean color experiment would test a technique for mapping concentration of color-producing phytoplankton in the open ocean.

All seven OSTA 1 experiments would have Earth-resources applications. The five others would be an infrared radiometer; a device to measure air pollution (levels of natural and synthetically carbon dioxide) in the orbiter's flight path; a system of identifying and locating surface features or clouds; a day/night survey of thunderstorm and lightning; and a study of the amount of moisture needed for plant growth in zero gravity. (KSC Release 161-79)

September 26: FBIS reported a Tass announcement that the Soviet Union had launched a geophysical rocket for shortwave solar-radiation research. Vertikal 8 was launched at 6:20 a.m. Moscow time from an unspecified point in European Soviet Union to an altitude of 505 kilometers. At 100 kilometers on the upward trajectory, a high-altitude astrophysical probe carrying instruments from Poland, Czechoslovakia, and the Soviet Union separated from the rocket; a recoverable package containing measurement results separated from the probe at 95 kilometers on the downward flight path and launched by parachute. Tass said the participating countries would process the information obtained from the probe. In an interview on Moscow domestic service, a Vertikal experimenter, Academician S.L. Mandelshtam, said some of the equipment was unique and could obtain a television image of the Sun in the shortwave band, which they had never done before. Evaluation of the magnetic tapes had been "a weak point with us," he said, sometimes requiring a year or two, but must be dealt with in five to seven months because "it is the active year of the sun." (FBIS, Tass in English, Sept 26/79; Moscow Dom Svc, Sept 26/79)

September 26-October 3: After a two-month delay, a 100-foot high balloon with a crew of four took off Wednesday, September 26, from Tillamook, Oreg., to try a nonstop balloon crossing of the United States. The planned six-day 229-mile trip of the DaVinci TransAmerica carrying 8,488 pounds of gear under 216,000 cubit feet of helium had lasted out continuous westbound instead of eastbound winds, court battles between two major television networks, and investigation by a federal agency, said the *Washington Post.*

The crew consisted of Vera Simons, German-born artist and balloon pilot from McLean, Va., who had been planning the flight since 1971; Dr. Rudolf J. Engelmann, director of the DaVinci project and an employee of NOAA at Boulder, Colo.; Dr. Fred Hyde, an eye surgeon from Prairie Village, Kans.; and Randy Burch, a cameraman for NBC television. In August ABC television had sued the group to prevent NBC from having exclusive coverage of the flight; the suit was thrown out of court, but Simons said it had upset her and delayed flight preparations.

The flight, originally called a blend of science and art, had lost its science aspect two weeks previously when NOAA reclaimed $28,000 of equipment for measuring air pollutants, ozone levels, and radiation on the cross-country flight. NOAA said it had acted because "an agency employee" might have sought "personal gain," and agency lawyers were investigating any illegal conflict of interest. Englemann said he knew of no conflict of interest, calling charges against him "a helluva thing," according to the *Washington Post.* The 7-Up Company, which put 100 empty containers on board for distribution after the flight, would cover most of the $250,000 cost. Other sponsors included NBC; Louisiana Pacific, a wood and paper combine whose small balloons DaVinci would drop for finders to exchange for free trees; and camera manufacturer Nikon Inc.

The transparent plastic balloon "larger than the Goodyear blimp" had lifted off at 8:16 a.m. September 26 into strong westerly winds, rising 300 feet per minute and drifting at about 50 mph toward the western slope of the Rockies. Over the Teton mountains of Wyoming the crew had to don oxygen masks and stay 4,000 feet above the peaks, to escape downdrafts that could put the balloon into an irreversible drop. In this "most dangerous" part of the flight, the crew found that its 9-radio system was not working and they could communicate only on a radiotelephone with meteorologists in Massachusetts; they guessed that an antenna on the balloon had snagged in the rigging during launch. The private meteorologists in New England reported that crew members, frequently on oxygen, sounded "strange. . . not as sharp, like having a couple of drinks"; they had postponed discussing plans until the craft descended to lower altitudes. Traveling at between 17,000 and 18,000 feet, DaVinci had gone down to about 10,000 feet over Denver, Colo., but dropped ballast to regain altitude east of that city. More than 500 miles south of their planned route, the crew on Saturday was flying at 1,000 feet over Kansas, having covered more than 1,380 miles in 4 days. Governor John Carlin tried to radio thanks for DaVinci's visit "even if they didn't intend to come."

DaVinci stayed over Kansas for 2 days, about 24 hours behind schedule for an arrival at Norfolk, Va., or Kitty Hawk, N.C. The crew complained of small planes flying close to the balloon: the FAA told them to note the registration numbers so that the agency could "deal with" the offending pilots. (Under federal rules, balloons—lighter-than-air craft—had right of way over all other aircraft.)

The balloon had unexpectedly crossed the Mississippi River at St. Louis, Mo., world headquarters of the 7-Up Company that was major sponsor of the flight; officials had thought the route would be 50 miles north. Air traffic controllers at St. Louis's Lambert Field (11th busiest in the United States) had diverted airline flights because of the balloon, which had right of way over all other aircraft.

On its stray southward, DaVinci set a new long-distance record for balloon flight over the United States: 1,084 miles at Denver, breaking a 1,058-mile record set in 1924. As it sailed over Kansas and Iowa in a more northerly direction toward its original course, it also passed the 100-hour mark to approach the 137-hour endurance record set by Double Eagle II in August 1978 on its transatlantic crossing. While the crew ate its Sunday dinner over

Nebraska wheatfields, waiting for good winds, they got a call from Boston: Maxie Anderson, the Albuquerque balloonist who had been aboard Double Eagle II on the first transatlantic balloon trip, said "We're pulling for you."

Nearly six days after takeoff, at 11:56 p.m. Monday, October 2, DaVinci was forced down in a northwest Ohio bean field after a thunderstorm chased it across Missouri, Illinois, and Indiana, caught it in the dark (after 11 p.m.), and dumped snow and heavy rain into the gondola. Three of the crew came down safely, but Vera Simons fractured her left leg. DaVinci had not broken Double Eagle II's endurance record (which would have occurred at 4:23 a.m.), but it had achieved the longest overload wind-borne balloon flight, 2,003 miles, surpassing the nearly 1,897 miles flown 65 years ago by a European balloon. (*W Post,* Sept 26/79, B-1; Sept 27/79, A-1; Sept 30/79, A-1; Oct 1/79, A-22; Oct 2/79, A-1; Oct 3/79, A-1; *W Star,* Sept 28/79; Oct 1/79, A-3; Oct 2/79, A-1; *NY Times,* Oct 3/79, A-16)

September 28: NASA announced that it would launch the third applications explorer mission, AEM-C, from Vandenberg Air Force Base on a Scout on or about October 29. Called Magsat (magnetic-field satellite), the craft would map Earth's magnetic field and record distribution of crustal anomalies with a resolution of 350 kilometers, first global vector measurements of the near-Earth field. Magsat was a cooperative effort of NASA and the U.S. Geological Survey, which would use the data to update its magnetic charts. (NASA MOR E-662-79-01 [prelaunch] Sept 28/79)

During September: The White House Office of Science and Technology Policy announced that the United States and Japan had formally agreed to extend their research and development cooperation into nonenergy fields. A meeting in Tokyo September 20-21 had issued a U.S.-Japan joint communique recalling summit talks in May between President Carter and Prime Minister Ohira on cooperative efforts in basic and applied research; working groups at the September meeting had looked at possible joint projects in areas such as environment, health, and outer space development. Further meetings would be held, the next in Washington. (Executive Office of the President release, no date)

• NASA announced that a special staff of consultants appointed in May 1979 to assess Shuttle management had submitted its report to Deputy Administrator Dr. Alan M. Lovelace. The report contained eight major conclusions (and comments).

1) When the Shuttle program began, NASA managers took an economical approach to space transportation. Subsequent budgets challenged managers to bring in a difficult technical program with limited funds.
—(NASA originally envisioned a $5.15 billion program, predicting first manned orbital flight in 1978.)

2) Shuttle management had achieved "a commendable level of accomplishment. . .considering fiscal constraints placed upon the program since its inception."

(Though this report necessarily focused on deficiencies, it noted that Shuttle-program personnel had individually and collectively achieved a great deal in a large and very complex program,)

3) Shuttle management, in an effort to proceed toward completion even under funding limitations, had set up work schedules demanding more performance than could be delivered.

(This approach had resulted in deferment of some of the planned work each year, as funds required exceeded those available. When critical new work became necessary within a fiscal year, as technical problems came up, even more scheduled work had to be deferred. This resulted in continual planning adjustments that precluded establishment of a stable baseline and led to program inefficiency.

(Example: subcontractor work increased or decreased repeatedly as funding changed in critical areas such as tile manufacturing. Program changes and associated up-and-down expenditure rates had led to termination of experienced contractor and subcontractor personnel, who became unavailable later because of aerospace industry demand. The subsequent employment of inexperienced personnel reduced overall efficiency. The report called this a major cause for concern, especially in the production phase of the program, also, costs due to delays in solving technical problems had increased.)

4) Long-range planning and status reporting were lacking: emphasis was on the current fiscal year with only secondary attention to work remaining to be done. Near-term planning took so much attention that long-term impact of deferred work was not integrated into the budgets.

(Effective long-range planning requires clear understanding of what has been accomplished, plus accurate prediction of remaining work. Shuttle management faced budgets showing unrealistic costs of its goals, with no effective status-reporting system. Most program planning consisted of constant near-term replanning to count up expenditures in a timely manner, although measuring the work achieved through these expenditures and estimating work still needed were weak. Management tools lacking in some major Shuttle contracts, such as cost reporting integrated with work measurement, were useful but did not provide an automatic solution.

(The only available means of assessing even the partial funding requirements of the Shuttle was an agencywide budget plan called POP [program operating plan] inadequate for program control: it appeared only twice a year and contained little pertinent data between July and March. NASA needed a reliable way—lending itself to independent evaluation—to know program baseline and status, with realistic cost and schedule projections.

Management must overcome the cumulative impact of previous constraints and pressures, while making allowance for the need to rely on contractor input.)

5) The Shuttle organization functioned well from a technical standpoint but not in the areas of schedule and budget. Organization needed strengthening, and two-way communications needed improvement.

(The original concept of Shuttle organization was a Level 1 program director at NASA Headquarters, a Level 2 [integration] program manager at JSC, and Level 3 separate program offices at the various centers: JSC for the orbiter; MSFC for the main engine, external tank, and solid-fuel rocket booster; and KSC for checkout and launch. Prime contractor support to project offices would be Level 4. Time had altered the concept: the Headquarters Level 1 associate administrator had become the de facto program director, who required the directors of JSC, MSFC, and KSC to take more part in activities reporting to them; responsibility for funding shifted from Level 2 to Level 1. This seemed a feasible arrangement, but the report said "none of the management levels in Rockwell and NASA had a good grasp" of undone work and other items needing completion before shipping Columbia to KSC. Investigators said Level 1 "broad and detailed involvement" with technicalities meant less time for cost and schedule. NASA needed cost awareness "independent of contractor input" and sensitivity to "lower-level cost trends.")

6) Schedule changes were no longer a valid way to cope with reduced program or funds; fixed delivery schedules and milestones in the initial operating program not yet achieved required a new management approach.

(Work schedules and budgets must allow for modifications required after the first few Shuttle flights. Users must recognize that initial operations would include development; NASA should make Shuttle users aware of realistic performance and schedule commitments, with priority to successful completion of development.)

7) Transition to the operational phase remained to be worked out; management should ensure that current organization alignments for Shuttle operations are appropriate. The NASA/DOD interface needed clarification.

(NASA Headquarters managed program operations, with operations offices at JSC, MSFC, and KSC; cooperation between the operations and program offices was evident, but transition from development to operations would need work. Since needs and plans of the DOD user community would affect NASA planning and budget, management to forestall problems should maintain "high-level near-term understanding" of DOD plans.)

8) The potential was high for unexpected technical problems, schedule slips, and cost growth. All program planning should include appropriate reserves.

(Although the report noted that some parts of a total management-control and information system were in place and functioning well, significant potential for problems would remain until deficiencies cited in the report were corrected.)

(Shuttle Program Management Assessment rept, Sept 12/79 [issued to press Oct 18/79], HistOfc fls; NASA note to editors NE79-20; JSC *Roundup,* Sept 21/79, 1)

• NASA reported that 28-year employee Dr. James J. Kramer, Headquarters associate administrator for aeronautics and space technology, would retire September 30. In 1951 he had gone to work for the NASA Lewis center where he had managed the quiet-engine project and the 260-inch solid-rocket project and was an aeronautical research scientist. He was manager of the Headquarters refan program office 1971-1973 and directed many Office of Aeronautics and Space Technology (OAST) activities before becoming associate administrator in October 1977. (NASA Release 79-123)

• The Air Force Systems Command (AFSC) *Newsreview* reported that a NASA-USAF pilotless research vehicle called HiMAT (highly maneuverable aircraft technology) made its first flight at the Edwards Air Force Base test center. Purpose of the HiMAT program was to improve maneuverability of U.S. fighter craft at transonic speeds (700-780 mph) and in air-to-air combat. No other remotely piloted vehicle or aircraft had the design features used on HiMAT, which would be incorporated into future USAF vehicles if successful: winglets (airfoils at the end of each wing) and unique close-coupled canards (small winglike surfaces located close to the main wings) to reduce air drag, and aeroelastic tailoring that originated in the early 1970s using the directional properties of graphite composites in the wings and canards (representing about 25% of HiMAT's total weight) to control deformations under aerodynamic loads. The first flight was to test vehicle aerodynamics during separation from the carrier and during approach and landing. Taken to an altitude of 45,000 feet under the right wing of a B-52, HiMAT flew for 22 minutes under control of a NASA research pilot on the ground before landing on skids at a dry lakebed. HiMAT was built by Rockwell International's North American Aircraft Division under contract to DFRC, using concepts from the Air Force Flight Dynamics Laboratory. (AFSC *Newsreview,* Sept 79, 6)

• FBIS continued its reports on the experiences of cosmonauts Vladimir Lyakhov and Valery Ryumin during their 175 days aboard *Salyut 6.* At a Kremlin ceremony September 8, General Secretary Leonid Brezhnev conferred the titles of heroes of the Soviet Union and the orders of Lenin and Gold Star; Lyakhov also received the title "Pilot Cosmonaut of the USSR." A September 10 report said that they told a press conference that the most important thing about their flight was not the duration but the volume and diversity of the research; they also said they looked forward to future "lengthy expeditions."

Dr. Konstantin Feoktistov told Soviet and foreign journalists of plans for an investigation of *Salyut 6*, which had been in orbit for two years; future use would depend on results of a check of on-board systems (which would take several months). A postflight talk with Feoktistov and A.S. Yeliseyev reported that the big design difference in *Salyut 6* was the change to two docking units plus a new propulsion system, which made the supply service possible and enabled successive crews to occupy the station: "in practical terms, we were limited only by the life of those systems. . . impossible to replace in flight," Yeliseyev noted.

Salyut 6 saw 17 dockings and 6 refuelings and produced 6 times as much work as previous stations; about 80 flight corrections were performed, and 3 space walks were made. Fourteen cosmonauts had spent more than a year on the station. Without extensive repair and maintenance, "the station would be already defunct," Feoktistov said. Breakdowns that did not affect the main system were the videotape recorder, some control consoles, and communications equipment that had stopped working. Access to items that had been used on the station had proved important: a harmful-contaminants filter returned from the station exhibited corrosion, and the experts could have spent a long time looking for the answer without having the actual filter to work with. (FBIS, Tass in English, Moscow Dom Svc, Aug 23/79-Sept 5/79)

October

October 1: Effective this date, Air Force Secretary Dr. Hans Mark announced that the U.S. Air Force would realign its space and missile systems research, development, and acquisition elements, establishing two new organizations in the AFSC: Ballistic Missile Office (BMO) and Space Service Division (SSD). The SSD would assume space-related activities for which SAMSO (the U.S. Air Force space and missile systems organization) had been responsible, realigning operations on the east and west coasts: the Eastern Space and Missile Center (ESMC) would be formed at Patrick Air Force Base, Fla., and the Western Space and Missile Center (WSMC) at Vandenberg Air Force Base, Calif. These centers would report through a Vandenberg unit not yet named. ESMC would include the present Eastern Test Range (ETR), the 6,555th aerospace test group, and 6,550th air base wing. WSMC would include the Western Test Range (WTR) and the 6,595th aerospace test wing. (AFSC *Newsreview,* Sept 79, 1)

• ESA reported that the West German firm, Dornier System, leader of the STAR industrial consortium, would be prime contractor for a European spacecraft to participate in the international solar-polar mission (ISPM), a cooperative ESA-NASA project. The contract would cover design, development, manufacture, and testing, at a cost of more than 47MAU (million accounting units, worth U.S. $1.2 in 1979). The ISPM would make measurements outside the ecliptic plane and observations of the Sun using two spacecraft, one each from ESA and NASA, to be launched in February 1983 on the U.S. Space Shuttle. (ESA Release 25)

October 2: Today reported launch of an unannounced classified payload from Cape Canaveral Air Force Base on a Titan 3C at 7:22 a.m. Monday, September 30. The craft was a reconnaissance satellite, military sources said later, and would be used to photograph Soviet troop movements. (*Today,* Oct 2/79, 8A)

• NASA reported it would speed up development of the MMU to be built by Martin Marietta for astronaut use in inspecting and repairing Space Shuttle insulating tiles while in orbit. The MMU, an improved version of a gas-jet backpack tested inside the orbiting Skylab in 1973-1974, should be fully developed by next August for the second Shuttle flight in October 1980. NASA would not consider further an alternate method of tile inspection (an extendable platform on a boom with a television camera). (NASA Release 79-125)

October 5: MSFC announced that it had issued requests for proposals to design a 25-kilowatt power system to provide supplemental solar power for long-duration Shuttle missions or support free-flying payloads. In early spring of 1980 NASA would award two or more parallel contracts at $1 million each for studies to be completed within 12 months.

Development would begin in 1982; the system would fly its first mission in 1984-1985 attached to a Shuttle orbiter carrying a Spacelab, to provide additional power and attitude and heat control. The power system on this mission would carry an experiments pallet and would be left in space (after the orbiter completed its mission) to power the long-duration experiments riding on the pallet. Luther E. Powell, MSFC project manager, said the power system would be forerunner of future large systems in space, such as service platforms and other unmanned large space structures. (MSFC Release 79-103)

October 6: FBIS reported that U.S. scientists and engineers visiting tracking stations, research institutes, and "cosmic centers" in the People's Republic of China had seen their achievements in rockets and cosmonautics. At one center, the Chinese showed their U.S. counterparts the latest "spy in the sky" satellite planned for launch in late 1979. (FBIS, Moscow to Asia in English, Oct 6/79)

October 8: KSC reported another step toward Space Shuttle launch: mating of the first two segments of the solid-fuel rocket motors to aft skirt assemblies. The first major element of the system, the orbiter, was in the KSC processing facility being prepared for launch: the three main engines had been installed, and work was in progress on other items, especially installation of the thermal protection tiles. The second major element, the huge external tank, had been delivered to KSC for checkout before being mated to the rest of the system. The third major element, the two solid-fuel rocket motors that would fire in parallel with the orbiter engines at liftoff, had been built in sections to be assembled at KSC and were designed for reuse after cleaning, refurbishing, and reloading.

Before the first test flight in 1980, the remaining tiles would be installed; orbiter systems checked out; remaining motor segments delivered and stacked; major elements mated on the mobile launch platform; assembly rolled out to the launch pad; and three main engines actually test-fired, in a final systems checkout. (KSC Release 174-79)

October 9: NASA announced creation of a new Headquarters program office called Space Transportation System Operations, headed by an associate administrator not yet appointed, to be responsible for Shuttle operations including scheduling, pricing, launch-service agreements, the Spacelab program, and expendable launch vehicles (except Shuttle upper stages). Dr. Robert A. Frosch said the move would centralize Shuttle services in a user-oriented organization.

The former Office of Space Transportation Systems (STS) was renamed Office of Space Transportation System Acquisition; John Yardley would continue as associate administrator for STS development and acquisition, including the Shuttle and its upper stages, associated ground facilities and equipment, and system improvements. (NASA Release 79-127)

October 10: NASA reported a prediction by NORAD that the *Pegasus 2* spacecraft assembly launched by NASA in May 1965 would reenter Earth's atmosphere about November 5. *Pegasus 2,* one of three satellites launched in 1965 to gather micrometeoroid data for use in designing future spacecraft, weighed considerably less at 10,430 kilograms than the 70,300-kilogram Skylab that reentered over Australia in July. The predicted descent area would be 31.7° north and south of the equator, an area three-fourths water. After the reentry of *Pegasus 1* and *3* (September 1978 and August 1969, respectively), no parts of either spacecraft were found or recovered. (NASA Release 79-126)

October 12: FBIS reported completion of the 19-day flight of *Cosmos 1129* and recovery of rats, insects, plants, and other items flown on it [see September 6]. Tass said a field laboratory—a huge inflated shed made of several hermetically connected tents—was set up at the landing site so that "morphologists, biochemists, and physiologists" could inspect the samples and do the first research.

Samples then went to the Moscow Institute of Medico-Biological Problems where scientists from the Soviet Union, Bulgaria, Czechoslovakia, France, Hungary, German Democratic Republic, Poland, Romania, and the United States would make early estimates of the results obtained. Some of the materials would be sent to laboratories in participating nations. (FBIS, Tass in English, Oct 14/79)

October 15: NASA reported that scientists and engineers from five countries (Australia, Canada, India, Japan, and the United States) had met at WFC to compare techniques of gathering data on ozone in the stratosphere. Instruments in use worldwide had used different techniques of measurement and had never compared for system errors or other biases. The joint effort was sponsored by the World Meteorological Organization, FAA, and NASA.

Over a 14-day period beginning October 21, the group would perform 20 rocket-borne experiments to establish instrument precision and comparability; the resulting information should define ozone variability during the period. Measuring instruments would fly on four kinds of rockets (Orion, Nike Orion, Super Arcas, Super Loki) scheduled to coincide with orbiting-satellite passes, to compare rocket measurements with those from the satellites. Ozone data would also come from meteorological rockets and balloons as well as from ground-based equipment. (NASA Release 79-130; WFC Release 79-17)

October 16: NASA reported that pictures taken by *Voyager 2* in July during its trip through the planet Jupiter's system had revealed a new moon in the ring plane. CalTech researchers David Jewitt and G. Edward Danielson, the latter a member of the Voyager imaging-science team, had found a starlike object in pictures of the ring plane taken less then 24 hours before the closest approach to Jupiter. When exhaustive search found no star to account for the trace in the photograph, the searchers examined another higher resolution image showing the same portion of the ring, trails of known stars, and the same unidentified object. The presence of a moon was shown by differing angles and lengths of actual star trails compared with the trail left by the object. Jewitt and Danielson would make a further study of pictures taken four months earlier by *Voyager 1* in an effort to identify the same object. (NASA Release 79-132)

• JSC announced that all Space Shuttle orbiters would have an optical landing aid presently used by pilots of more than 20 U.S. and foreign commercial and military aircraft. Rockwell International, prime contractor for the Shuttle, would provide for the commander and pilot of all orbiters a "head up" system to project instantaneous displays of spacecraft speed, rate of descent, altitude, and other critical flight factors on a transparent viewing glass located above the cockpit window to be pulled down like the sun visor of an automobile. The system would be placed on Columbia in time for the first operational flight, expected early in 1981 after completion of the flight-test program, and in JSC simulators and trainers. (JSC Release 79-64)

October 18: The *New York Times* said that Dr. Thomas A. Mutch, NASA's associate administrator for space science, had told a House subcommittee that problems with the Space Shuttle would delay flight of the Galileo mission for two years. NASA now planned to launch the mission in 1984 in two parts: one Shuttle flight would take a Galileo orbiter into Earth orbit for launch toward Jupiter, and another Shuttle flight would take another spacecraft for launch into the atmosphere of Jupiter carrying instruments to record its composition. Earlier mission plans were for a 1982 Shuttle launch carrying a single Galileo package including orbiter and Jupiter probe; the change would add more than $184 million to the cost of the project, previously estimated at about $450 million.

NASA had had problems not only with the Shuttle insulating tiles but also with the rocket engines. An improved engine was to be standard after the first test flights. Angelo Guastaferro, NASA's head of planetary programs, said that the 4,600-pound Galileo spacecraft would be too heavy for the Shuttle to carry into Earth orbit without the improved engines. (*NY Times,* Oct 18/79, A-15)

• ESA reported a fifth Japan/ESA meeting October 15-17 in Paris, with Roy Gibson, ESA director general, and N. Kozu, of Japan's science and technology agency, leading the delegations. In several working-group sessions the parties reviewed continuing exchange of information on use of communications satellites; acquiring data from each other's remote-sensing satellites; flying Japanese scientific instruments on Spacelab launches; mutual use of Japan and ESA tracking stations; and using Spacelab for research in materials and life science. A sixth meeting was set for Tokyo in 1980. (ESA Info Bltn 26)

ESA reported a design review of the Marecs project October 9-10 with the prime contractor, British Aerospace, after which the agency approved a start on satellite assembly so that a flight unit would be ready for launch by the Ariane L04 vehicle. (ESA Info Bltn 27)

October 20: FBIS carried a Tass report that U.S. and USSR scientists had agreed on joint research headed by Moscow University and CalTech on gravitational waves. The agreement covered development of extrasensitive instruments and of laboratories insulated against acoustic and seismic noises, as well as coordinating simultaneous measurements taken at two widely separated laboratories, in Los Angeles and in Moscow. Soviet physicists would use cryogenic electronic devices; the United States would develop laser systems to record small-scale oscillations. (FBIS, Tass in English, Oct 20/79)

October 22: NASA held a press conference on the launch of Magsat, scheduled for the end of the month from the WTR. Pitt Thome, director of space and terrestrial applications, described the mission as an effort to obtain a global picture of Earth's magnetic field, data previously available mostly from ground or aerial surveys and therefore both fragmentary and unreliable. A series of satellites (POGO) in the 1960s and 1970s had done some magnetic mapping, and this would be the first update of that information, used for navigation and for locating natural resources. Magsat would carry both scalar and vector magnetometers, so that it could measure not only the extent but also the direction of magnetic forces in Earth's crust. Variations in the data from those in previous studies would also shed light on tectonic plate motion, the constant though small movement of rigid plates forming the Earth's crust. The project scientist, Dr. Robert A. Langel of GSFC and John Denoyer of the U.S. Geological Survey described potential use of the Magsat data. Denoyer said he had been in southeast Asia recently with officials interested in oil prospecting, who would use the data in the next few years to look for petroleum as well as minerals. (NASA Release 79-129 (press kit); briefing text, Oct 22/79)

October 23: MSFC reported the launch at 7:40 a.m. CDT October 17 from White Sands Missile Range, N.M., of the sixth in a series of space-processing applications rockets (SPAR) carrying four experiments to be performed during five minutes of near weightlessness in the coast phase of the suborbital trajectory. The payload landed at 6,000 feet in mountains 50 miles downrange from the launch site; on impact the package tumbled and landed on a rock, knocking a hole in the side of the container and damaging one of the experiments. The payload would be returned to MSFC for disassembly and inspection; two of the experiments would be refurbished and reflown. Investigators should begin forwarding results of SPAR 6 experiments to MSFC within two weeks. (MSFC Release 79-113)

• NASA reported delivery of a second experimental turbofan engine produced by AVCO Corporation for a program called QCGAT (quiet clean general-aviation turbofan) to LeRC for testing. The program aimed at decreasing noise and exhaust emissions while maintaining or reducing fuel consumption, compared with present general-aviation turbofans. The first engine in the program arrived at LeRC last winter from its designer/builder Garrett AiResearch; results of tests on that engine showed noise reduction of about 10 decibels and emission reduction of 54% for carbon monoxide and 76% for unburned hydrocarbons.

Preliminary AVCO results showed noise-level reduction of at least 14 decibels compared to the quietest business jet now in service, and emission levels even lower than those of the first engine. Noise reduction in the AVCO engine resulted from improved design of internal engine parts (using sound-absorbing materials to muffle noise from fan, compressor, and turbine) and reduced engine-exhaust velocity. LeRC project manager G. Kenneth Sievers said test results from both engines showed "noise need not be a major constraint" on use of turbofan-powered aircraft for general aviation. (NASA Release 79-137)

October 24: NASA reported that *Pioneer 11* was working well on its way out of the solar system after a successful flyby of Saturn, during which it found two new rings and possibly a new moon of the planet. Barring a failure, the Pioneer could continue to return useful data until the late 1980s when it would pass beyond radio contact with Earth. The spacecraft was built by TRW Systems Inc., and the project was managed by ARC in California.

After a six-year trip of more than 3.2 billion kilometers (2 billion miles) in space, *Pioneer 11* spent 10 days photographing and measuring the ringed planet. The spacecraft experienced at least two hits from meteroids above the rings of Saturn and three more hits below the rings; it recorded no damage from high-velocity ring particles, showing that spacecraft could operate safely near the visible rings. Major findings of the flyby included a magnetic field around Saturn; analysis of the gravity field and composition of the planet's core; radiation into space of 2.5 times more heat that Saturn received from the Sun; and low temperatures on the moon Titan that might remove the possibility of life there. (NASA Release 79-135; ARC Release 79-42)

• ESA announced the signing of an agreement in Vienna October 17 giving Austria an associate membership for five years, during which it would take part in general studies of future space projects and contribute to the costs of those studies, being represented on ESA's council by no more than two delegates. (ESA Info Bltn 29)

October 25: NASA declared the August 9 launch of WESTAR-C (known as *Westar 3* in orbit) to be satisfactory. The satellite, third of Western Union Telegraph Company's communications satellites to be launched by NASA, was performing satisfactorily on its station at 91°W over the equator. (NASA MOR M-492-203-79-03 [postlaunch] Oct 25/79)

NASA declared satisfactory the January 30 launch for U.S. Air Force SAMSO of the SCATHA mission into a transfer orbit from which it went into operational mode, a controlled westward drifting of 5° per day as planned. (NASA MOR M-492-303-79-01 [postlaunch] Oct 25/79)

• MSFC reported cancellation of a Shuttle propulsion-system static test firing October 24 because of a hydrogen leak in the orbiter's aft compartment near the main engines. Sensors detected hydrogen in the compartment about 10 a.m. during tanking; attempts to isolate the leak continued until 3 p.m. without success. Frank Stewart, MSFC test manager, said the leak apparently came from a 17-inch or smaller hydrogen feed line in the aft compartment. "It is an inert area," he said, "and if we could have isolated it to one of the lines. . .disconnected after ignition we could have safely fired the engines."

Since the exact source and cause of the leak could not be established with hydrogen in the system, officials decided to postpone firing, drain the propellants, and give engineers access to the area for additional checking. While isolation checks went on, the countdown continued through fuel loading procedures; several tests of the main propulsion system were conducted, such as inspection for ice and frost on the external tank after the fuel was loaded.

Stewart said the problem had no connection with the main fuel valve leak that started an external fire during a July 2 test. This postponement, he said, should have "very little impact on our target date" for completing main propulsion system tests. (MSFC Release 79-116)

October 29: NASA reported that DFRC in conjunction with the FAA was conducting tests with a Boeing 747 aircraft to generate wake vortices for probing by small instrumented aircraft. The tests, performed both in a simulated approach and in actual approaches and landings, would try to verify optimum spoiler arrangements suggested by wind-tunnel tests.

Wake vortices, normally invisible turbulent airflows that stream in funnel shape from wingtips and flaps of aircraft in flight, could be hazardous to smaller aircraft; for this reason FAA required spacing of 3 to 6 miles between aircraft approaching terminals for landing, to allow time for vortices to break up. However, the spacing had slowed flight operations and added to delays experienced by passengers because of airport congestion. To allow closer spacing of aircraft and reduce delays, NASA had begun using wind-tunnel and other experimental techniques to study reduction of strength in wake vortices; one method was partial deployment of wing spoilers, normally used to decrease lift after landing. (NASA Release 79-140; DFRC Release 79-38)

• MSFC announced that NASA would buy from Rocketdyne Division, Rockwell International, 12 more main engines for the Space Shuttle under a $365.7 million amendment of the original 1972 contract that would bring its value to $1,263,215,058. The original contract was for purchase of 27 engines; the amendment would bring the total ordered to 19. The amendment also called for overhaul and test of 10 engines to 109% of rated power level, plus a second overhaul and flight test of the 3 engines being used for propulsion testing.

Rocketdyne had delivered the engines for the first Shuttle flight, three ground-test engines, and a spare flight engine under the original 1972 contract. The three flight engines delivered to KSC had been installed on Columbia for next year's first spaceflight. (MSFC Release 79-117)

October 30: NASA announced that Space Shuttle flights through early 1984 were almost completely booked up for payloads, with firm commitments for the first 37 operational flights beginning in 1981. The 47 payloads scheduled for those flights belonged to 14 government, commercial, and foreign users and ranged from launches of ESA's Spacelab to navigation, communications, and weather satellites. NASA payloads would account for 32% of the number; DOD, about 15%; and all other users, about 53%. Payloads normally received assignments on a first-come first-served basis, but missions affecting national security would get priority, as would missions with time-critical launch windows or prime scientific or technical objectives. Flights for which NASA would be fully reimbursed would take precedence over routine scientific or technical launches.

Services available to Shuttle users would include a basic launch with support and options (available at extra cost) such as special hardware, tests, and analysis; use of KSC services and facilities; or special operations such as extravehicular activity or longer duration. In addition to the 47 large payloads designed for the cargo bay, more than 200 organizations and persons had reserved (at a cost of $3 thousand to $10 thousand) space for up to 300 small self-contained payloads called getaway specials (GAS), research-and-development packages weighing 200 pounds or less. (NASA Release 79-142)

• MSFC reported the successful conclusion October 26 of three separate static-firing tests of the Space Shuttle main engine. The three test engines had completed a scheduled total of 1245 seconds of firing time in less than 12 hours; two engines were tested at NSTL in Mississippi; the other, in California. One of the pair tested in Mississippi fired for 520 seconds, the running time needed for Shuttle launch; the other fired for 665 seconds, the time required for a mission abort. Both these tests were part of a preliminary flight certification series. NASA had postponed a 510-second static test scheduled for October 24 [see October 25] because of a faulty sensor that indicated a hydrogen leak. (MSFC Release 79-119)

October 31: NASA announced a short-term research program using the human-powered Gossamer Albatross 2, sister ship of the craft that flew over the English Channel this summer, powered by a pilot pedaling a bicycle-like system to drive the propeller. The study, funded jointly by DFRC and LaRC, would fly a lightweight data system on the aircraft to measure its stability, control, and performance characteristics in human-powered flight; under tow (in propeller-off flight); and under electric-motor in steady-state conditions. NASA would use results of the study in future low-speed lightweight aircraft flying at extreme altitudes. (NASA Release 79-141)

During October: NASA reported personnel actions.

—Dr. Lee R. Scherer, associate administrator for external relations at NASA Headquarters and former director of KSC, received for a second time the agency's highest honor, the distinguished service medal, from Dr. Robert A. Frosch in a Headquarters ceremony October 4. Scherer previously received NASA's exceptional service medal and exceptional scientific achievement medal. (KSC Release 169-79)

—L. Michael Weeks, formerly with General Electric, would be deputy associate administrator for Space Transportation Systems Acquisition under John Yardley at Headquarters effective November 5. (NASA Release 79-138; NASA anno Oct 29/79)

—The AP reported the death October 22 of Dr. Hans Gruene, 69, KSC director of launch vehicles from 1964 to his retirement in 1973. Born in Germany, he entered the United States in 1945 with a group headed by Wernher von Braun assigned to launch V-2 rockets captured from the German army. He had come to Cape Canaveral in 1952 to set up a joint long-range proving ground that became the ETR. He had concluded his career with the four Skylab launches in 1973. (*W Star,* Oct 25/79, B-5; *Spaceport News,* Oct 26/79, 1)

November

November 2: NASA announced a new five-year development program to retain U.S. leadership in satellite communications and assigned LeRC to work with private industry, DOD, and other NASA centers to launch a sophisticated communications satellite in 1985 or 1986. Daniel J. Shramo, LeRC director of space applications, explained that NASA in 1973 had "phased down" its work in communications satellite technology because of budget pressures and "the strong capabilities present in the private sector." Industry since then had been improving antenna performance, increasing the number of circuits per satellite, and decreasing satellite weight per channel. Technical studies already under way at LeRC should result in a communications satellite system capable of transmitting data anywhere regardless of population size or electronic sophistication. (NASA Release 79-143)

November 3: NASA's public affairs office reported that the 23,000-pound *Pegasus 2* satellite reentered the Earth's atmosphere at about 4:20 p.m. EST, coming down in the Atlantic Ocean northwest of Ascension Island. The "footprint" of descending debris would have spread over a path 60 miles wide by 1,500 miles long over the South Atlantic, the report said. (Hq PAO, Nov 3/79)

November 5: The *Washington Post* said NASA's inspector general and the DOD were investigating charges that Rockwell International's Space System Group beginning in 1977 had hidden cost overruns by charging expenses to the wrong projects. Work on the USAF's Navstar satellite was charged to NASA's Space Shuttle contract, employees alleged, and current costs of Shuttle development were charged to future operations, in violation of government budget rules.

Present and former Rockwell employees had provided company documents to back up their statements. Ray Sena, an employee who had complained to higher management and to NASA officials, was formally suspended by Rockwell. Company officials admitted an investigation was in progress but refused comment. Although NASA learned of the situation in 1977, it only recently admitted that the Shuttle was at least $500 million over budget. (*W Post,* Nov 5/79, A-2)

• The *New York Times* said President Carter planned to meet with NASA officials to review Shuttle management and funding. The report said NASA administrator Dr. Robert A. Frosch would ask for more money to prevent further serious delays in Shuttle production and testing. Estimated Shuttle spending for FY81 would be $1 billion. NASA's original estimate of Shuttle cost was

$5.15 billion in 1971 dollars, to include delivery of two of four of the planned spacecraft; current estimate was $6.1 billion in 1971 dollars, a 20% increase. Rockwell International had delivered only one flight vehicle, now at KSC for preflight checks and installation of insulating tiles. (*NY Times*, Nov 5/79, A-1)

• NASA reported that a scheduled 510-second firing of the main Shuttle propulsion system test article's three-engine cluster at the National Space Technology Laboratories had failed November 4 when a sensor detected excessive pressure in the oxygen pump of the No. 3 engine and shut the test down after 9 seconds. The No. 1 engine was damaged during the cutoff sequence, when a hydrogen line ruptured near the base of the engine nozzle. Extent of the damage was unknown; the engine would be sent to Rockwell's California plant for inspection and repair.

MSFC and the contractor were investigating the failure and the possibility of replacing the damaged article in the test stand. Impact on Shuttle schedules had not been assessed. Meanwhile, the orbiter Columbia had successfully passed a series of " hot fire" tests at KSC of the auxiliary power units to steer main-engine nozzles during launch and to drive control surfaces during atmospheric flight. The tests simulated ascent and descent phases of a Shuttle mission. Next milestone for Columbia would be an integrated test of all systems. (NASA Release 79-146; MSFC Release 79-122)

• NASA declared successful the May 4 launch of *FltSatCom 2* from ETR on an Atlas Centaur into a transfer orbit. An apogee kick motor fired May 6 had put the spacecraft into the desired synchronous orbit. All spacecraft systems were operating normally. John F. Yardley declared November 1 that NASA objectives had been accomplished. (NASA MOR M-491-202-79-02 [postlaunch] Nov 5/79)

November 7: NASA announced flight demonstrations of an experimental pilot advisory system for high-density uncontrolled airport environments (where more than half of midair collisions occur). The WFC test program used a computer-generated voice technique to send messages on air-traffic location and headings every 20 seconds, airport advisories every 2 minutes and collision warnings as necessary. (NASA Release 79-145; WFC Release 79-18)

• NASA reported that, after five years of continuous service, *Landsat 2* had begun having difficulty with its on-board attitude-control system November 5 and might have to be retired like *Landsat 1* (launched in 1972 and serving until 1977). In that event, *Landsat 3* would be the only Earth-resources monitor in orbit until Landsat D's launch in 1981. *Landsat 2*'s design life was only one year, but NASA hoped it could supplement *Landsat 3* coverage until 1980.

GSFC controllers said the aging lubrication of a spacecraft flywheel governing yaw motion might have caused it to jam; they had succeeded in pointing the solar panels at the Sun, trying to maintain attitude until the flywheel could be freed or an alternate procedure could be tried. (NASA Release 79-148)

November 8: NASA announced that it and the ESA had asked scientists to propose experiments for an international mission to comets Halley and Tempel 2. The total journey would span four years and cover more than 2.5 billion kilometers (1.6 billion miles). A spacecraft using solar-electricity propulsion engines for the first time in deep space would fly past Halley's comet in 1985, release an instrumented probe, and proceed to an encounter with Tempel 2 in 1988, flying side by side with it for a year or more on its path around the Sun. Science objectives would be to define the chemical-physical nature of the comets' nuclei, of the comas, gases, and dust surrounding the nuclei, and of the comets' tails. As comets differ widely, NASA wanted to make sure of this opportunity to sample two different types. (NASA Release 79-147)

November 9: NASA reported that JPL had awarded a 16-month $1.2 million contract to General Electric's Space Division for three dish-shaped prototype units 12 meters (40 feet) in diameter with a sun-tracking mechanism, able to produce solar energy for electric power to small communities and rural areas. JPL acted for DOE in the second phase of a program to develop a point-focusing solar concentrator that would give best thermal performance for the lowest cost. (NASA Release 79-149)

• NASA reported that LaRC had developed a microwave device under test at Norfolk General Hospital to destroy cancerous tissue by heating tumor cells. Used outside the body and emitting no radiation, the device had already demonstrated that it could locate tumors in 14 known cancer patients and in one patient had found a cancerous site undiscovered by conventional means. The applicator could sense cancerous tissues, hotter than normal tissue, much deeper in the body than could infrared thermography, limited to finding tumors near the body surface. (NASA Release 79-150)

November 11: FBIS carried a story from Tokyo *Kyodo* in English that a Japanese fact-finding mission to the People's Republic of China cited as evidence of the PRC's "superior space technology" its CSSX-4 rocket fueled by liquefied oxygen and hydrogen, able to carry up to 700 kilograms; Japan's latest could carry only about 130 kilograms. As vehicle for an intercontinental ballistic missile (ICBM), the CSSX-4 could take a 3-megaton nuclear warhead more than 10,000 kilometers (6,000 miles), in range of both the United States and the Soviet Union. The three-stage rocket, 43 meters long, and 3.3 meters in diameter, reportedly weighed about 200 tons. (FBIS, *Kyodo* in English, Nov 11/79)

November 15: NASA announced that tests of the Shuttle's main propulsion system would resume about December 14. A November 4 test stopped when a sensor detected overpressure in a turbopump and rupture of a hydrogen line damaged one of the engines. Upcoming tests would use a stub nozzle like those used in successful ground tests conducted since April 1978; other tests with flight nozzles would be scheduled later. (NASA Release 79-153)

November 18: The *Washington Post* reported that five states were vying for the Large Space Telescope "even though it will be 300 miles above everybody's head." The actual bone of contention was the science institute that would direct use of the unique orbiting observatory. One astronomer said the location of the institute would be "the astronomical capital of the world" for the next 30 years; it was "the biggest astronomical prize to come along since the 200-inch was built at Palomar for the Hale Observatory."

The five competing states were Maryland, New Jersey, Illinois, Colorado, and California (the University of Arizona and University of New Mexico, where numerous ground-based telescopes were already located, were considered "occasional" contenders). Competition for the institute was so serious that three of the competing groups represented 74 universities: the University Research Association (URA), with 53; Associated Universities, Inc. (AUI), with 7; and the Association of Universities for Research in Astronomy (AURA), with 14. URA backed the Fermilab outside Chicago; AUI wanted it at Princeton; AURA wanted it at Johns Hopkins University in Baltimore. Princeton boasted of Einstein's work there for over 20 years. Hopkins said that it had been doing spaceborne astronomy for 20 years and was closer to Washington and to GSFC, which would track and control the Space Telescope. NASA said it would not decide for a year; the *Washington Post* said that nobody at the agency would talk about it. (*W Post,* Nov 18/79, A-4)

November 19: NASA reported that failure of a hydrogen line on the nozzle of a Shuttle engine being tested November 4 resulted from use of improper welding wire that "severely decreased the strength of the weld" on a segment of hydrogen line near the base of the nozzle. Rupture of the line caused an oxygen-rich combustion that damaged the test engine. Investigators from MSFC and Rockwell would check all similar welds, using an oxalic-acid etch to identify the weak welds and would decide what remedial steps to take. (NASA Release 79-157)

November 20: President Carter designated the NOAA to manage all civilian remote sensing from space. A space policy review committee chaired by Frank Press had assessed future U.S. civilian remote sensing requirements and decided that a single agency could best handle operational satellite activities. NOAA had managed three generations of weather satellites to prepare it for responsibilities in land remote sensing as well as atmosphere and ocean. The directive said the United States would continue to supply Landsat data to foreign users; the DOC would foster private-sector involvement in remote sensing and would coordinate and regulate civil remote sensing through a board representing federal and state organizations including NASA and DOD. (Text, Nov 20/79)

• NASA declared successful the launch of *Magsat,* third in the applications explorer mission series, from WTR October 30, delayed for a day because of high winds. Orbit had 351.9-kilometer apogee, 578.4-kilometer perigee, 93.9-minute period. The sensor boom deployed November 1, and star cameras were turned on November 2. Magnetic-field data analysis that began November 3 already showed substantial differences from 1970s measurements. Cesium cells on the scalar magnetometer exhibited random interference, but the 60% of scalar data unaffected was enough to fulfill mission objectives. (NASA MOR E-662-79-01 [postlaunch] Nov 20/79)

November 23: FBIS reported from Tass that Soviet scientists had found no pathological changes in animals that underwent weightlessness on biosat *Cosmos 1129* September 25-October 14. The animals in orbit gained as much weight as others of their species in the control group on the ground. Lack of gravity was also no obstacle to the development of embryos. The tests established that weightlessness had no effect on formation of seeds and flowers; plants bloomed in space, and their seeds were obtained later on the ground. Observation of biological material flown on *Cosmos 1129* was continuing at the Moscow Institute of Medico-Biological Problems, with scientists of France and the United States participating. (FBIS, Tass in English, Nov 23/79)

November 27: ESA announced that it had scheduled the first test flight of its Ariane launcher for December 15 from Kourou, French Guiana. Firing of an Eridan sounding rocket November 14 had confirmed operational status of the launch base and downrange stations in Brazil and on Ascension Island. (ESA Info Bltn 32)

November 28: NASA said the launch of a FltSatCom scheduled for December 4 had been postponed to January 1980. A leak in the Atlas vehicle's high-pressure pneumatics system detected during routine testing November 26 was traced to a cracked sleeve and nut assembly; defective parts were removed and replaced. Analysis of the sleeve showed that it had been made from stainless steel that did not meet specifications; NASA immediately began investigating all similar sleeves on the launch vehicle and made changes as necessary. Investigation revealed that the problem was more serious: other sleeves located in stock did not meet specifications, and NASA now planned to check all appropriate fittings on the launch vehicle. (NASA Release 79-163)

November 30: NASA set June 30, 1980, as the date of the first Shuttle launch, depending on several milestones: Columbia rollout from the orbiter-processing facility to the vertical-assembly building in late March 1980;

rollout of the complete Shuttle stack (orbiter, solid-fuel rocket boosters, and external tank) from the VAB to launch pad 39A in mid-April; and a flight-readiness (20-second) firing of the Shuttle's main engine on the launch pad in mid-May. Also needed to make this schedule was certification of the Shuttle main engine by June 30, 1980. Administrator Dr. Robert A. Frosch said that "some time in August or September" would be a much more likely date as unforeseen problems could delay the launch. NASA planned nine unmanned launches in 1980, eight of them reimbursable by other organizations. (NASA Release 79-162)

During November: NASA announced appointment effective immediately of Glynn S. Lunney, manager of JSC's Shuttle payload and integration development program, as acting associate administrator for STS operations at Headquarters. Lunney would set up the new office that resulted from NASA's decision to separate STS acquisition from operations, reporting to Deputy Administrator Dr. Alan M. Lovelace. Lunney had been with NASA since 1959, serving at LeRC and LaRC and going to Houston when the MSFC was created. There, he was technical director of the Apollo-Soyuz test project 1972-1975 and was deputy associate administrator for space flight at Headquarters before taking the position at JSC in August 1977. (NASA Release 79-156; NASA anno Nov 16/79)

—NASA announced appointment of A. Thomas Young as director of GSFC, succeeding Dr. Robert Cooper, who left government service in June. Young, deputy director of ARC since February 1979, had been with NASA since 1961 and had worked at LaRC as mission director for the Viking mission to Mars and mission-definition manager for the lunar orbiter project. Before assignment to ARC, he had headed the Headquarters Office of Space Sciences planetary program. (NASA Release 79-164; NASA anno Nov 30/79)

—NASA announced that John W. Boyd, on detail as deputy director of DFRC since January 1, would return January 1, 1980, to his post as associate director of ARC. He had begun working at ARC in 1949 as an aeronautical engineer, becoming research assistant to the director of ARC in 1966 and deputy director for aeronautics and flight systems in 1970, serving in that position until his detail to DFRC. He was named associate director of ARC in July 1979. (NASA anno Nov 19/79)

—DFRC announced that Robert P. Johannes would become deputy director of DFRC, effective December 1, replacing John W. Boyd. Formerly with the U.S. Air Force Flight Dynamics Laboratory, Johannes joined NASA in 1979 and had been director of engineering at DFRC. (DFRC Release 79-40)

• The *Washington Star* reported that MSFC engineer Frank J. Nola had received the first Excalibur award for his invention of a device that could cut power consumption of electrical appliances by 30 to 60% [see September 11]. A committee selected Nola from 120 nominees to receive the award, set up to honor the contributions of federal workers. (*W Star,* Nov 30/79, D-1)

• The *Washington Post* reported the death November 17 of Dr. Immanuel Velikovsky, 84, Russian-born author and scholar "whose theories of cosmic evolution unleashed decades of scientific controversy." He had come to the United States in 1939 and had done the research for his book *Worlds in Collision* (1950) at Columbia University Library in New York. His ideas in this and other books were widely denounced, but evidence gathered later by deep space probes appeared to bear out some of his predictions. When *Worlds in Collision* had its 72nd printing in 1974, Velikovsky said he looked forward to ultimate vindication: "I have been proven correct too many times," he added. A *Washington Star* editorial said that, "however farfetched his theories, he arrived at them honestly and stood by them courageously." (*W Post,* Nov 19/79, B-7; *W Star,* Nov 21/79, A-8)

December

December 3: The ESA reported from its November 29 meeting that British Aerospace, chosen as prime contractor for ESA's Large Satellite, would receive a contract for the first part of a study phase. Contracts for payload studies would go to Selenia (Italy) for a television broadcast payload and a 20-30 GHz transponder payload; to BTM (Belgium) for a 20-30 GHz beacon payload; to United Kingdoms Marconi Space and Defense Systems for a specialized-services payload; and to Marconi with Telespazio (Italy) and Philips (Netherlands) for mission studies related to the 20-30 GHz transponder. Contractor work would be done by April 1980, with launch scheduled for early 1984.

Objectives of the Large Satellite program were to build a multipurpose space platform to match user requirements in telecommunications and to demonstrate a service payload that would advance ESA technology, assess potential of new satellite services, and promote satellite usage. (ESA Info Bltn 33)

ESA reported that *Meteosat 1* had put itself into standby mode November 24, one day after its second anniversary of successful operation in orbit, because of an apparent power overload. Attempts to switch it back to full operating mode succeeded only briefly. ESA had begun a step-by-step unit switching to detect the area of failure and isolate it; the fault apparently occurred in the electronics that turned off the main power supply in case of overload.

Periodic instability had appeared in this protection unit, but the data collection function was fully operational and *Meteosat 1* was able to collect and relay data from meteorological platforms within its field of view. ESA was analyzing the problem for possible effect on *Meteosat 2,* scheduled for launch in September 1980. (ESA Info Bltn 34)

December 4: Rockwell International said that its Autonetics Strategic Systems Division would develop an airborne imaging-sensor autoprocessor under a $1 million contract with the U.S. Air Force Avionics Laboratory covering design, fabrication, and testing. The device would automate functions such as target recognition and cueing for sensors such as the forward-looking infrared sensor (FLIR) used in tactical fighters for air-to-ground combat. (Rockwell Release ESG 19)

December 5: The *Washington Post* reported that the Air Force had taken an "unusual step" December 4 in formally defending the Pratt & Whitney F100 engine powering the F-15 and F-16 fighter planes. Robert J. Hermann, assistant secretary for research, said the U.S. Air Force had no plans to use another engine because of F100 problems. Conceding that F100 engine durability was "less than anticipated," Hermann said F-15 engine-related safety was better than that of any Air Force fighter after comparable service.

On November 21, the head of the USAF Systems Command told the Senate Armed Services Committee that "as many as 43" F-15s and F-16s would be without engines by next summer because of F100 production delays and other problems; at Congress's insistence, the Pentagon had financed limited work on General Electric's F101X engine as a possible alternative. Pratt & Whitney and General Electric were competing "hotly" for flight-engine contracts, the *Washington Post* said, and Pratt & Whitney had announced plans to spend $10 million on expansion of its jet production capabilities. (*W Post,* Dec 5/79, D9)

December 6: Gen. Lew Allen, Jr., U.S. Air Force chief of staff, told the annual meeting of the Military Operations Research Society that the priority of the Space Shuttle program had "shifted to matters of national defense," the *Santa Barbara News Press* reported [see October 30]. Whatever else the Shuttle does and whatever other purposes it will have, "the priority, the emphasis, and the driving momentum now has to be those satellite systems which are important to national security," said Allen, a member of the Joint Chiefs of Staff.

Emphasizing the "change from what had been true a year or so ago," Allen said the change was "apparent and accepted now, and it's a change which will, if there are additional technical difficulties..., become more and more significant." The Shuttle, he said, was "quite critical for concerns of national defense and for...verification of treaties...Confidence in the Shuttle and its reliability must be sufficiently high for us to place what is a substantial amount of the security of the nation on the performance of that system." (*Santa Barbara News Press,* Dec 6/79, 14)

• NASA reported that researchers from JPL and the U.S. Geological Survey had carried out measurements using radio noise from distant quasars that indicated rapid increase in southern California's width.

Dr. Arthur E. Niell of JPL's astronomical radio-interferometric Earth-survey team reported an increase of 20.3 centimeters (8 inches) over 7 months between JPL and NASA's Goldstone deep-space station about 193 kilometers (120 miles) away. At the American Geophysical Union meeting in San Francisco, Niell and J.C. Savage of the U.S. Geological Survey described making simultaneous recordings at the two radiotelescopes of radio noise from quasars and comparing the signals' time of arrival using extremely precise clocks. Changes in distance between the telescopes could be measured with accuracies of 5 centimeters (2 inches) or less, and could be important to the Survey's earthquake prediction mission. (NASA Release 79-166)

• NASA reported results of a 22-month government-industry study of possible damage to electrical equipment from release of carbon fibers in fires after accidents to civil aircraft. R. R. Heldenfels, LaRC director for structure, told a conference at LaRC that public risk from use of carbon fibers on civil aircraft was so small as to be insignificant.

The President in July 1977 had directed the Office of Science and Technology Policy to study potential problems of using carbon-composite materials and to provide a plan for federal action if needed. NASA got the assignment to assess risks of such use in civil aviation, with support from the National Bureau of Standards, some DOD laboratories, and private firms. Other federal agencies studying the problem were DOC, DOT, DOE, and EPA.

The perceived risk was that breakdown of composite materials in burning would put into the atmosphere short lengths of carbon fiber thought to be hazardous to electrical equipment because of their high heat resistance and electrical conductivity; their extreme light weight would allow them to float for miles before touching electrical equipment, causing short circuits or malfunctions. (NASA Release 79-171; LaRC Release 79-85)

• NASA announced that it had selected 33 scientific investigations for 4 satellite missions scheduled for launch in 1982-1985. The investigations, 23 from the United States and 10 from 6 other nations, would be in climate and upper-atmosphere research. The 23 U.S. investigations represented 11 universities, 1 private organization, and 2 government agencies. Foreign countries represented were Canada, the Federal Republic of Germany, France, Italy, Japan, and the United Kingdom. Each country would fund its own investigations; the cost of the U.S. studies would be about $5 million over the next five years, including instruments. Spacecraft used would be the earth radiation-budget satellite, two polar-orbiting NOAA metesats, and Spacelab 3. (NASA Release 79-165)

December 11: The *Washington Post* reported that technicians at Cape Canaveral had lost touch with Satcom 3 December 10 after firing a small engine at 1:57 p.m. to put it on station over the Pacific. RCA spokesman John Williamson said that no one knew what had happened and "there is certainly cause for dismay." Launched December 6, the 1-ton communications satellite designed for television and telephone relay was in a temporary elliptical orbit at the time of loss. (*W Post,* Dec 11/79, A-6)

—On CBS Evening News, Walter Cronkite and Charles Osgood broadcast a "Night Before Christmas" parody on the loss of Satcom 3, concluding with, "And from somewhere in space comes the seasonal call: Merry Christmas. Good night. And you can't win 'em all." (Text, Dec 11/79)

—The *Washington Post* December 12 ran a feature story about cable television companies that planned to use Satcom 3 for alternative programming, such as Ted Turner who wanted a 24-hour news "superstation" (channel

17 in Atlanta), and two religious networks ("I guess they didn't pray hard enough," said an RCA spokesman). NASA had charged RCA $19.9 million to launch Satcom 3, most of it already paid, but RCA had insured the spacecraft with Lloyds for more than its $50 million market value. (*W Post,* Dec 12/79, C-1)

• JSC said that Columbia, first Shuttle orbiter, would undergo a first major simulated-flight all-systems test on or about December 15 at KSC. Astronauts and ground-support teams would conduct a 24-hour 5-day critical operations test including five launch-and-ascent flight profiles; on-orbit operations; and one entry simulation. John W. Young and Robert Crippen, crew members for the first flight, would take part in the test along with the backup crew, Joe Engle and Richard Truly. First actual launch was scheduled for June 30, 1980. (JSC Release 79-73; KSC Release 246-79)

• NASA adjudged the mission of *Heao 2* successful. Launched November 13, 1978, the observatory had made more than 5,000 discrete observations and had worked well for more than 11 months, though design lifetime was only 9 months.

On the basis of significant new findings (X-ray detection of more than 60 known quasars and discovery of more than a dozen previously unknown; the absence of hot neutron stars at the center of historic supernovas, calling for new theories to explain the remnant cores; X-ray emissions far more intense than predicted from main-sequence stars) and of "an active and enthusiastic guest observer program," Dr. Thomas Mutch, associate administrator for space science, recommended extension of the mission. (NASA MOR [postlaunch] S-832-78-02)

December 12: NASA announced that it would ask scientists to propose experiments for a satellite-measurements program called OPEN (origins of plasmas in Earth's neighborhood) that would attempt for the first time to explain collective behavior of components of the geospace system: the interplanetary medium near Earth, magnetosphere, ionosphere, and upper atmosphere.

Previous programs detected extensive interaction among all geospace components. The new mission would use a minimum of four spacecraft in widely different orbits in key regions of space for measurement and remote sensing of electromagnetic radiation, fields and particles, and plasmas (electrified matter) and defining the flow of mass, momentum, and energy through the solar wind and electrified environment near Earth. Launched during a year in the mid-1980s by the Shuttle, each spacecraft would be capable of significant orbit changes over a four-year lifetime to permit observing a vast volume of space. GSFC would manage the project. (NASA Release 79-173)

December 13: NASA announced that JPL had selected Martin Marietta Aerospace and Hughes Aircraft's Space and Communications Group for award of $500,000 contracts for study of an unmanned Venus mapper to fly in the mid-1980s. Upon completion of the study in summer 1980, NASA might choose one company to develop a Venus-orbiting imaging radar (VOIR) spacecraft for a two-month gravity study of the planet followed by a 120-day radar mapping sequence, if Congress approved the mission. (NASA Release 79-176)

• INTELSAT reported that it would turn off *Intelsat 3 F-3* this date after 10 years of service that gave the organization the first truly global telecommunications system. The Intelsat 3 series of nine communications satellites was built by TRW Systems Inc., three of them having failed to orbit or destroyed at launch; *Intelsat 3 F-3* was the last of the series in operation. Original design life was five years.

Launched into synchronous orbit in February 1969, the communications satellite operated over the Indian Ocean until July 1972, carrying among others a worldwide telecast of Prince Charles's investiture as Prince of Wales. It was placed on standby in May 1977, and its mechanically despun antenna stalled in April 1979, more than 10 years after launch, rendering it inoperable. As it had enough fuel remaining to push it 4,000 to 5,000 kilometers further out into space, INTELSAT would turn off spacecraft electronic systems and activate small propulsion motors to put it where it would need 4 to 5 million years to return to its old altitude, drifting at the rate of a meter a year. (INTELSAT Release 79-28-I)

December 14: NASA announced that it had lost contact with *Voyager 1* late December 13 after a maneuver to refine its path to Saturn. Launched in September 1977, *Voyager 1* was now 996 million kilometers (660 million miles) from Earth, heading for encounter with Saturn in November 1980. The maneuver, commanding the spacecraft to turn and fire its thrusters, should automatically orient the antenna toward Earth; the maneuver occurred, but the alignment was faulty. The agency said it had had previous problems with orientation.

Several hours later on December 13, controllers at JPL acquired a faint intermittent signal confirming that *Voyager 1* had received and executed the initial command signals to switch to the low-gain antenna and put it into a two-way mode. JPL would now try to analyze the difficulty and correct alignment without wasting attitude-control gas. (NASA Release 79-180)

• NASA announced that its manned oblique-wing research aircraft would make its first flight December 19 at DFRC with pilot Tom McMurtry at the controls. The AD-1 (so named for Ames and Dryden centers) would use a pivoting wing to reduce noise and fuel consumption. Studies at ARC indicated that such planes flying at 1,600 kilometers (1,000 miles) per hour would use half as much fuel as conventional swept-wing aircraft. Built by Ames Industrial Co., Bohemia, N.Y., the 907-kilogram (2,000-pound) aircraft was about 12.2 meters (40 feet) long with a wingspan of 9.7 meters (32 feet), and was powered by two small 99.8-kilogram (220-pound) thrust turbojets. (NASA Release 79-177; DFRC Release 39-79)

• NASA announced award of a $4.7 million contract to Goodyear Aerospace Corp., Akron, Ohio, for fabricating a high-speed image-processing computer (called massively parallel processor) to analyze data from future Earth-observation spacecraft. Current computers had to process one at a time the thousands of picture elements (pixels) constituting a satellite image, a time-consuming and expensive procedure. The new computer would use 16,384 simple interconnected elements to process the pixels simultaneously, 10 to 100 times faster than now possible and at a greatly reduced cost. Scheduled for delivery to GSFC in 1982, it would process data in the hundreds of images received there from NASA's Earth-resources spacecraft. (NASA Release 79-181)

• The *Washington Star* reported on RCA's plans to launch within 18 months a replacement for the $20 million Satcom 3 that vanished from orbit December 10. The company said that it wanted FCC authority to launch a spare satellite now being built; a complete search for the missing communications satellite could take several weeks, but so far "contact has not been regained." (*W Star,* Dec 15/79, C-8)

December 17: The *Washington Star* reported that NASA had reestablished radio contact with *Voyager 1* speeding toward Saturn after the spacecraft apparently became disoriented December 13 during a commanded course correction and aimed its antenna in the wrong direction. JPL controllers had managed to make it "reorient itself and aim its antenna directly at earth." (*W Star,* Dec 17/79, A-4)

The press reported that a 14-hour dry-run test of Space Shuttle orbiter Columbia got under way at Cape Canaveral December 16 after a day's delay for routine checks. The orbiter integrated test would check out Columbia's systems using equipment and engineering teams in control centers at the Cape and JSC. (*NY Times,* Dec 17/79, D-15; *W Star,* Dec 17/79, A-2; *W Post,* Dec 17/79, A-28)

Dr. Paul MacCready, builder of the lightweight Gossamer Albatross that made the world's first manpowered flight across the English Channel in June this year, saw his creation go on display in Philadelphia's Franklin Institute, the *Washington Star* reported. MacCready was now planning a solar-powered Albatross, the paper said. (*W Star,* Dec 17/79, A-2)

• The *Washington Post* reported that the Soviet Union had launched an uncrewed *Soyuz T,* an improved version of its usually crewed Soyuz craft, to join the Earth-orbiting *Salyut 6* station. Tass said the launch at 1530 Moscow time December 16 put the *Soyuz T* into an orbit with 232-kilometer apogee, 201-kilometer perigee, 88.6-minute period, and 51.6-f8- inclination. Tass reported linkup with *Salyut 6* December 19, the station's 16th docking with another spacecraft in its 26-month flight.

Dr. Konstantin Feoktistov said *Soyuz T* would test a new propulsion unit combining former autonomous systems for orientation, orbit correction, and docking, and new life-support, flight-control, and descent systems. Other new on-board systems included radiocommunications, orientation, movement control, and a computer complex to handle maneuvers, systems control, and transmission of processed data. (*W Post,* Dec 17/79; FBIS, Tass in English, Dec 16-19/79)

December 18: NASA reported successful completion December 17 at NSTL in Mississippi of a full-duration 9-minute 10-second run of the Space Shuttle main-engine test article, a time longer than that needed to launch an actual Shuttle into orbit. This was the first time the whole system was operated for full duration. No problems occurred, and MSFC test managers said that all goals were achieved.

The test article consisted of a cluster of three main engines mounted in a simulated orbiter aft section, drawing propellants from a flight-type external tank. The three engines were throttled back from 100% rated power level to 90%, 80%, and 70%; engine gimbaling and pulsing were successful. To check out two-engine performance, one engine was cut off early as planned, and the remaining two were operated at 70% rated power level for the last 5 seconds of testing. (NASA Release 79-178; MSFC Release 79-133)

December 19: Continuing flight tests of the orbiter Columbia were halted December 18 after two technical failures. Simulated liftoff occurred at 4:30 p.m. EDT with backup crew members Joe Engle and Richard Truly in the cockpit, but two minutes later they failed to receive signals of the simulated separation of the solid-fuel rocket boosters; 8 minutes 50 seconds into the flight, they failed to receive a signal showing successful separation of the external tank. (*W Star,* Dec 19/79, A-4)

• ESA announced that a halt in Ariane's launch sequence December 15 resulted from a faulty sensing of operating pressure in one of the four engines that inhibited the release command. The engines functioned normally, and liftoff would have proceeded normally except for the erroneous reading. After detailed checks of the launcher and launch pad, subject to satisfactory reports, ESA said the launch countdown would resume December 22 for launch December 23. (ESA Info Bltn 39)

December 20: The *Washington Post* said the empty Soviet spacecraft that linked up December 19 with *Salyut 6* was probably a three-person version of the vehicle the Soviet Union had been launching for 10 years. The *Soyuz T* (probably for Transport) docked on ground command at one end of the two-part space station in the fourth unmanned test of the new configuration (the first was *Cosmos 869,* November-December 1976; the second, *Cosmos 1001,* April 1978; the third, *Cosmos 1074,* January, 31-March 1, 1979). The *Washington Post* said the interior of the Soyuz "command craft" probably was changed to accommodate three instead of two cosmonauts, making it easier for the Soviet Union to use the *Salyut* as a permanent orbital station with interchangeable crews, difficult with only two men at a time. (*W Post,* Dec 20/79, A-27)

• ESA announced appointment of Erik Quistgaard of Denmark as its director general, to succeed Roy Gibson on May 15, 1980. (ESA Info Bltn 40)

December 21: The *Washington Star* reported that three U.S.-built Singapore air force jets had disappeared simultaneously at noon December 19 during a training flight from Clark Air Force Base near Manila, Philippines, toward a bombing range 20 miles away. Maurice Baker, Singapore ambassador to the Philippines, said "the astonishing thing is that they all disappeared at the same time without a trace." The planes were on the same route flown by four Philippine air force planes when they mysteriously disappeared more than 5 years ago. (*W Star,* Dec 21/79, A-7)

December 24: ESA announced the successful launch of its Ariane LO1 at 17 hours, 14 minutes, 38 seconds GMT from Kourou; all three stages functioned normally and the fairing was jettisoned as planned. Achieved orbit was close to planned orbit. Space center facilities and all downrange stations functioned "faultlessly" and permitted continuous tracking of launcher telemetry. (ESA Info Bltn 41)

December 27: NASA said that it would stop acquiring *Goes 3* data after February 1980; on July 1 it had shut down the altimeter, primary experiment device. DOD would use the C-band transponders to calibrate tracking and would monitor and control *Goes 3* after March 1, 1980. (NASA MOR E-855-75-01 [postlaunch] Dec 27/79)

During December: The AFSC *Newsreview* reported completion of the first phase of construction at Vandenberg Air Force Base's Space Shuttle facility. Launch complex 6, built in the 1960s for the Manned Orbiting Laboratory program, had never been used (the MOL program was canceled in 1969) and was available to WSMC as a Shuttle launch site. Phase 1, carried out by Morrison-Knudsen, Inc., under a $3.9 million Army Corps of Engineers contract, had moved 680,000 cubic yards of earth and 10,000 cubic yards of reinforced concrete and had dismantled 2,400 tons of steel. (AFSC *Newsreview,* Dec 79, 6)

• A United Airlines newsletter reported the first solar-powered flight of an aircraft: Larry Mauro's Solar Riser, a homemade tailless biplane with about 600 solar cells in upper-wing panels, generating about 60 pounds of thrust to turn a 3-foot fiberglass propeller, enough to carry a 165-pound pilot and 125-pound craft aloft. Mauro flew his plane about a mile at a height of 40 feet during the annual experimental-aircraft convention in Oshkosh, Wisc. Astronaut Neil Armstrong had watched assembly of the craft, now in a Wisconsin museum. (UA rept Dec 79)

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January

January 4: NASA announced that proposals for establishing a space telescope institute in the United States were due March 3 at Goddard Space Flight Center (GSFC).

The institute, at a sight to be chosen [see November 18, 1979], would be a national facility for receiving and evaluating data from the space telescope and should be fully operational in the early 1980s. It would be responsible for selecting and supporting users of the telescope; science planning and scheduling; routine console operations; and data archiving, calibration, and analysis. The winning contractor would staff and operate a science support center at GSFC and would staff the institute with personnel and facilities needed to house and support principal investigators and general observers.

The space telescope itself, scheduled for launch in 1983 or 1984, would observe about 350 times the volume of space visible from ground-based observatories. The data it acquired would go through a tracking and data-relay satellite to a control center at GSFC, then to the science institute for processing and analysis. The telescope should remain in orbit until the end of the century, visited at 30-month intervals by astronauts from the Space Shuttle to perform maintenance and replace instrumentation. If needed, the Shuttle could return it to Earth at five-year intervals for major repair, which would take about 1 year, then could launch it again.

Marshall Space Flight Center (MSFC) would be project manager for the space telescope; GSFC would manage the on-board instrumentation and the science institute; the Headquarters Office of Space would have overall responsibility for the program. (NASA Release 80-1)

• *Today* reported that Rockwell International, prime Space Shuttle contractor, had made "key management changes and major organizational realignments. . .similar to ones made within the space agency recently." The paper said NASA now hoped to launch the Shuttle in September, two years behind schedule. (*Today*, Jan 4/80, 12A)

January 8: NASA announced that, contrary to recently published reports, it was not taking reservations for travel on Space Shuttle missions. Recent articles on NASA plans to carry small experimental payloads on the Shuttle had mentioned a deposit of $500 to reserve payload space; the reference to a reservation had been taken to imply passenger space. NASA said that it would not offer seats on Shuttle flights to paying passengers. (NASA Release 80-2)

• The *Washington Star* said that Boeing Company had awarded Fairchild Industries, Germantown, Md., a multimillion-dollar contract to build forward-fuselage parts for a new-generation 757 jetliner. The award by Boeing Military Aircraft Company as subcontractor for Boeing Commercial Aircraft Company was the third given to Fairchild, which received in October a contract for fuselage above the wing and in November a contract for leading-edge wing slats. The twin-engine 757 would fly in 1982. (*W Star*, Jan 8/80, B-4)

—The United States should develop a way to send nuclear wastes into outer space, Stanley G. Rosen told an American Association for the Advancement of Science meeting in San Francisco. The *Washington Star* said Rosen, a test manager for the U.S. Air Force Defense Satellite Communications system, described the problem of "extremely toxic" residues from nuclear-power programs around the world. Extraterrestrial disposal of such wastes would have a "short-term risk" during launch and injection, but "zero risk" thereafter, he said. (*W Star*, Jan 8/80, A-5)

January 9: The *New York Times* reported from Beijing that the United States had agreed to sell the People's Republic of China (PRC) a ground station for reception of Landsat Earth-resources data that might have military applications. Defense Secretary Harold Brown, on an eight-day tour, made the announcement after a two-hour meeting with PRC Deputy Prime Minister Deng Xiaoping. The PRC sought to buy such a station more than a year ago; Landsat instruments collected data for agriculture, forestry, drought prevention, and oil and mineral exploration, and 20 nations (none Communist) had already bought Landsat ground stations.

Brown's trip, the first by a senior Department of Defense (DOD) official to China since the Communists came to power in 1949, originally was for general broadening of contacts to inform the United States of Peking defense strategy in the post-Mao era. The Carter administration apparently decided last week to use the visit to give Moscow the impression of greater cooperation between Beijing and Washington, in view of the Soviet thrust into Afghanistan. (*NY Times*, Jan 9/80, A9)

January 10: Johnson Space Center (JSC) announced that it had extended for 18 months a cost-plus-award-fee contract with Boeing Company for safety, reliability, and quality-assurance engineering support. The extension, valued at $11,184,430, brought the total value of the JSC contract with Boeing to $36,712,703. The extension would cover current and future JSC programs for space vehicles and for ground-support equipment, facilities, and payloads. (JSC Release 80-001)

January 11: U.S. Air Force Chief of Staff Gen. Lew Allen, Jr., said in an interview that a current chill in U.S.-USSR relations would accelerate the development of weapons designed to wage war in outer space or knock down USSR satellites for spying, navigation, and communications.

Allen said that, although he still hoped for an agreement on continued noninterference with satellites maintained in space by both the United States and the Soviet Union, the U.S. Air Force was experiencing pressure to move quickly on antisatellite weapons. He indicated that extra money would go for weapons already in the works such as the "flying tomato can" (operating by collision with a target) rather than more distant possibilities such as lasers. (*W Post,* Jan 11/80, A-1)

January 12-14: The newspaper *Wen Hui,* published in Shanghai, reported that the People's Republic of China was training astronauts for space travel and that the forthcoming first issue of a publication called *Science Life* would contain photographs of "pilots in space clothes in a simulated spacecraft, lying on a vibration platform or being thrown down from a height of 20 meters in a shock test," as well as in a weightless environment, according to the Foreign Broadcast Information Service (FBIS).

This was the first time the Chinese press had mentioned training of space crews. FBIS said that the new publication would contain an article on space food and that the simulations of space life had already been made into a documentary film. The *Wen Hui* article did not say when or if China would send someone into space; however, during U.S. Defense Secretary Harold Brown's visit, a deputy chief of staff for PRC armed forces said a manned space program was not one of China's top priorities. FBIS also reported publication in a Shanghai paper of pictures of a dog that had returned from space; an editorial in that paper called China the third nation to master the technology of satellite retrieval. (FBIS, Beijing *Xinhua,* Jan 12/80; Hong Kong *Wen Wei Po,* Jan 14/80; *W Post,* Jan 13/80, 16)

January 14: Aviation Week & Space Technology reported that Rocketdyne officials had decided that widespread modification of Space Shuttle flight-engine welds made with welding rods from a suspect lot would not be necessary. Last month the company reported that it might have to straighten a large number of welds, but it had now decided to limit the modifications to an area of hydrogen line located near the base of the engine nozzles. The modified engines would be reinstalled on Orbiter 102 by mid-March, the magazine said. (*AvWk,* Jan 14/80, 21)

January 15: NASA reported that X-ray data from *Heao 1,* a high-energy astronomy observatory launched in August 1977 and terminated in 1979, had revealed a superhot superbubble of gas—a gigantic shell about 6,000 light years away from Earth and 1,200 light-years in diameter—in the constellation Cygnus, the Northern Cross. Dr. Webster Cash, of the University of Colorado's Laboratory for Atmospheric and Space Physics at Boulder, and co-investigator, Dr. Philip Charles of the University of California at Berkeley, had analyzed the information from a cosmic X-ray instrument on the observatory that had been devised by Dr. Elihu Boldt of GSFC and Dr. Gordon Garmire of CalTech.

In a speech for delivery to a meeting of the American Astronomical Society in San Francisco January 16, Cash explained that parts of the bubble had been seen before in brief X-ray glimpses, but no one realized what was being observed: one part was thought to be a supernova remnant, another part to be hot gas escaping from a galaxy. Because of its size, the bubble was not visible in its entirety until *Heao 1* picked it up in an X-ray sweep.

Cash said the huge halo was never spotted before because "it flows so energetically that it cools through emission of x-rays" instead of more normal emissions visible in the optical or infrared regions of the spectrum. A cool gas cloud known as the Great Rift of Cygnus, measuring 800 to 1,300 light-years, could be seen obscuring the Milky Way in Cygnus on a dark night; this cloud, containing "enough material to make 5 million stars," lay beside the bubble and served to hide its central area from Earth view. Supernova explosions impacting this cloud over millions of years could compress and heat its interior, forming a shell of superheated hydrogen materials that became the superheated bubble visible in X-ray data today. Cash said that these explosions were a major mechanism for making new stars: Earth's Sun might have formed at the edge of a similar bubble, he said. (NASA Release 80-3)

• The *New York Times* reported that *Apollo 11* astronaut Michael Collins would resign effective January 28 as undersecretary of the Smithsonian Institute, an office held since 1976, to become vice president for field operations of Vought, Inc., in Washington, D.C. Collins had joined the Smithsonian in 1971 as director of the National Air and Space Museum. (*NY Times*, Jan 15/80, C-16)

• Communications Satellite Corporation (ComSatCorp) announced that it had filed with the Federal Communications Commission (FCC) a 5% reduction of its basic charges to U.S. common carriers for international communications satellite services. It claimed frequent price cuts, most recently by 15% in May 1979, since it began commercial service with Early Bird in 1965. (ComSat-Corp Release 80-3)

January 17: A military communications satellite fired into orbit from Cape Canaveral in an Atlas Centaur January 17 had "settled into temporary orbit" and was performing superbly, according to U.S. Air Force Col. George Breton, mission director. The 4,100-pound Fleet Satellite Communications spacecraft originally was scheduled for launch in December 1979. (*W Post*, Jan 19/80, A-9)

• NASA announced that it would extend the mission of *Heao 2*, nicknamed Einstein, beyond its projected lifetime of 11 months. Dr. Thomas A. Mutch, NASA associate administrator for space science, said Einstein, second of the three high-energy astronomy observatories, had not only produced significant results [see December 11, 1979] but had also lent itself to a guest-investigator program that had garnered about 400 proposals from 80 groups in the United States and other nations, including Great Britain, France, West Germany, Italy, the Soviet Union, India, and Japan.

Heao 1, launched in 1977, had mapped about 1,500 X-ray sources and measured for the first time the uniform high-energy X-ray background of space. *Heao 3,* launched in September 1979, was making an all-sky survey of cosmic and gamma rays at higher energies and from a higher orbital inclination than the first observatory. (NASA Release 80-6)

January 18: Langley Research Center (LaRC) announced that it had awarded Computer Science Corporation a 3-year contract valued at $3 million for computational analysis and programming support services to basic and applied research at LaRC, including computer documentation, technical reports, program designs, training courses, and plans for follow-on work. (LaRC Release 80-3)

January 21: JSC reported that it would conduct a 30-hour mock mission of Space Shuttle Columbia beginning at 8 a.m. Wednesday, January 23, running through orbital operations to landing. Flight directors and their teams of controllers would monitor system performance, carry out navigation and targeting, and watch support-crew adherence to mission timelines. Simulation specialists would spring problems on the controllers and on the orbiter crews going through routine duties in the Shuttle simulator and another orbiter mockup.

About 500 persons would participate in the "flight," including prime crew John Young and Robert Crippen and backup crew Joe Engle and Dick Truly. Flight directors would be Neil Hutchinson for the launch team, Chuck Lewis for the orbit team, and Don Puddy for the landing team. This simulation would check out operational procedures over an extended period; previous simulations had not lasted as long. More 30-hour practice flights would occur every six weeks to two months in preparation for the real thing. (JSC Release 80-003)

• The European Space Agency (ESA) reported that detailed evaluation of records from the Ariane's first test flight December 24, 1979, confirmed that it was a complete success. Each of the three powered stages had performed better than predicted, and the results would allow integration of the second launcher to proceed without change except for a pogo-correction device not used on the first flight. The second flight was set for late May or early June 1980. (ESA Info Bltn 1)

January 22: NASA announced that, after five years of studying Earth resources and environment from an altitude of 920 kilometers (570 miles), *Landsat 2* ceased operation when its primary flight-control mechanism failed because of wear. A two-month effort to use other on-board devices to keep the craft pointed at Earth had failed, and NASA staff had put it into an engineering-test mode that would allow further study of the attitude-control problem.

Landsat 2, launched in 1975 with a one-year lifetime, was second of a remote sensing series that could also collect data from beacon platforms in remote areas. A major asset of the Landsat system was its repetitive observation, as often as every nine days with two satellites, which would permit immediate detection of short-term changes. *Landsat 1,* launched in 1972, was retired early in 1978; *Landsat 3,* launched in March 1978, would continue to furnish data to more than 400 U.S. and foreign Earth-resources programs. NASA planned to launch a fourth and more advanced Landsat in 1981. (NASA Release 80-9)

• JSC reported signing of a letter contract with Martin Marietta Aerospace for development and production of an in-orbit tile-repair kit to be used on the Space Shuttle. The letter preceded an official award of contract and authorized the firm to go ahead with design and development of the kit. Estimated value of the contract was $2.1 million. (JSC Release 80-004)

• ESA reported from the Villafranca tracking station near Madrid that its international ultraviolet explorer (*Iue*) had detected comet Bradfield January 11. The comet, named for the Australian amateur astronomer who discovered it in 1979, made its closest approach to Earth January 22 and would be visible in the northern hemisphere by the end of January. (ESA Info Bltn 2)

—ESA noted the second anniversary January 26 of *Iue,* now in a synchronous orbit 18,000 miles above the Atlantic, far beyond Earth's atmosphere and the cloud cover or interference from background light that hinder observations on Earth. The ultraviolet-sensitive television cameras and processors supplied by the Science Research Council (SRC) had garnered "a wealth of information" both physical and chemical on astronomical objects, because the strongest characteristic emissions of many of the most common atoms and ions lie in the ultraviolet.

More than 500 scientists from 20 nations were studying 12,000 ultraviolet spectra of planets, stars, the interstellar medium, and galaxies. ESA said that it expected the spacecraft to exceed its design life of three years, which was fortunate because observation time requested by astronomers was already more than double that available. The sponsoring agencies (ESA, SRC, and NASA) had decided to keep *Iue* operating as long as feasible. (ESA Info Bltn 4)

January 24: The *Washington Star* reported that the Federal Aviation Administration (FAA) had declared the basic design and certification process of the McDonnell Douglas DC-10 satisfactory, but had fined the manufacturer

$300,000 for poor control of quality during the manufacture of DC-10 engine-mounting pylons. The National Transportation Safety Board blamed American Airlines maintenance procedures for allegedly cracking one such pylon on a DC-10 that failed over Chicago May 25, 1979, causing a crash in which 273 persons died. McDonnell Douglas agreed to pay the fine, denied any wrongdoing, and said it was accepting the fine "to avoid further expense and the disruption of business."

After the Chicago crash, Transportation Secretary Neil Goldschmidt asked the National Academy of Sciences to investigate procedures used by the FAA to certify planes [see December 12, 1979]. The academy named a committee of its National Research Council (NRC) to handle the investigation. Jack D. Howell of the Airline Pilots Association (APA) told investigators that a "protective relationship" between the FAA and the manufacturers had allowed the companies to "use their own employees as 'FAA-designated representatives'" to oversee plane design and production. In discussing the FAA report, FAA Administrator Langhorne Bond defended the procedure for certifying planes. (*W Star*, Jan 24/80, A-7)

January 25: NASA announced the first step to stimulate commercialization of space, signing a joint-endeavor agreement with McDonnell Douglas Company on a new technique for materials processing in space. McDonnell and a pharmaceutical firm would investigate separating biological materials by continuous-flow electrophoresis in space, thought to have high probability of producing substances useful against human or animal diseases. These substances were not produced in sufficient quantity or purity by ground-based facilities. The joint-endeavor concept would make NASA and the private firm responsible for specific parts of the effort, with no transfer of funds. (NASA Release 80-12)

January 26: NASA Administrator Dr. Robert A. Frosch conducted a press briefing on the FY81 budget, assisted by Dr. Alan M. Lovelace, deputy administrator; C. Thomas Newman, deputy comptroller; and Dr. Anthony J. Calio, associate administrator for space and terrestrial applications. Warning the reporters that the information was "embargoed" until President Carter formally gave his budget address to Congress January 28, Robert J. Shafer, NASA deputy director of public affairs, cited the releases on Frosch's recent trip to China as "not embargoed." Frosch said that, although NASA's budget was increasing at a slower rate (9.8% for research and development [R&D] and 11.5% for space science), he considered it a "good start" for the decade, compared to last year when extra costs of the Space Shuttle had precluded new space science program starts. The figures included an extra $300 million requested as a 1980 supplement for Shuttle development expenses, which Frosch said were increased by delays last summer that threatened mission schedules.

NASA's 1981 request included new-start money for the National Oceanic Satellite System (NOSS), to be funded jointly with DOD and the National Oceanic and Atmospheric Administration (NOAA), as well as a gamma-ray observatory to explore the most energetic form of radiation known, exploiting the discoveries of the small astronomy satellite *Sas 2*, ESA's *Cos B*, and the first high-energy astronomy observatory *Heao 1*. Frosch replied to a question that NOSS would be the first scientific satellite shared with DOD and said its cost would be split among DOD ($13.9 million) and NOAA and NASA, which would pay about $6.4 million and $5.8 million, respectively.

NASA's total budget request was $5,736 billion, including $4,569.5 billion for R&D, $120 million for facilities construction, and $1,047 billion for program management. (Briefing text, Jan 26/80; NASA Releases 80-7, 80-11, 80-13; *W Star*, Jan 28/80, A-7, B-2; *Nature*, Jan 31/80, 416)

• NASA announced the signing of a memorandum of understanding January 24 in Beijing with the PRC Academy of Sciences covering China's participation in the Landsat program. Under a January 1979 understanding on cooperation in space technology, the People's Republic of China would buy from U.S. industry a Landsat ground station to be installed near Beijing.

The Landsat memorandum, the first formal agreement on space since normalization of U.S.-PRC relations, provided that the People's Republic of China, like other foreign ground-station operators, would make Landsat data available to others according to distribution policies of NASA and other U.S. agencies. The PRC academy would pay an annual fee of $200,000, starting six months after its station began to receive data. Landsat stations already operating outside the United States were two in Canada and one each in Brazil, Italy, Sweden, and Japan; new stations now receiving data in Australia and India would be operational soon, and one was under construction in Argentina. (NASA Release 80-14)

January 28: Rockwell International announced that GSFC had awarded it a $6.5 million contract to produce seven more RS-27 engine systems for NASA's Delta launch vehicle, to be delivered beginning in October. Each of the liquid-fuel systems consisted of a main engine and two vernier engines combining to produce about 207,000 pounds of thrust; Rocketdyne-built hardware left over from the Saturn program would be used in the new system, reducing costs to the taxpayer. Rockwell would static-test the systems at its Santa Susana laboratory in California before delivering them to NASA; it had delivered 60 RS-27 systems since production began in 1973. In the 150-launch history of Delta, 101 launches had used the older Rocketdyne Thor MB-3 engines; the other 49 used the newer, more powerful RS-27s. (Rockwell Release RD-1)

January 29: Dr. Robert A. Frosch, NASA administrator, appeared before the House Committee on Science and Technology to present the agency's budget request for 1981. After reviewing events of last year, Frosch said NASA would need by July 1 the extra $300 million requested as a supplement to stay within Shuttle cost estimates and maintain development and production schedules.

Problem areas had been the Shuttle engines and the thermal protection system (TPS); recent tests had given NASA "increased confidence" in the main engines, but Frosch said that he was "not completely satisfied" with the tiles and their attachment to the Shuttle surface. He said the tiles might not be installed and fully tested before the end of summer, so that the first launch might not come until the end of 1980. The original date of launch was March 1979, and the last previous prediction was June of 1980. Frosch said he expected the first flight "between November and the end of March 1981. A year from now might be a more realistic date." (Text, Jan 29/80; *NY Times,* Jan 30/80, A-17)

January 30: The *Washington Post* said the mystery explosion detected by a U.S. *Vela* satellite September 22, 1979, was still a mystery, although additional data had come to light since the State Department announced a suspected nuclear explosion.

The Central Intelligence Agency (CIA) had told "a few select committees of the House and Senate" that the Union of South Africa was conducting a secret naval exercise in the area where *Vela* saw the explosion. A committee aide briefed by the CIA said the explosion might be "a rocket launched from one of those South African ships." On the same night, scientists using the world's largest radiotelescope had seen a ripple in the ionosphere over Puerto Rico a few hours after *Vela* saw a double flash 4,000 miles away; it had come "from the right direction and at the right velocity to have been caused by a nuclear explosion near South Africa."

Ever since the State Department announcement, the Carter administration had tried to discount the possibility of a nuclear explosion, convening a panel of scientists who first said *Vela* saw a freak lightning strike that coincided with a meteor burnout, then suggested the sighting was either a malfunction or a mistake. However, the Los Alamos Scientific Laboratory said that *Vela* had picked up the "unmistakable" signature of an atomic explosion, a "double flash" caused by a fireball blacked out momentarily by a shockwave surrounding the explosion, then showing 99 times more intense as the shockwave dissipated.

The *Vela,* it turned out, had carried not one but two optical detectors: one very sensitive instrument to spot fireballs from small nuclear explosions and a less sensitive one in case an atomic blast overloaded the first instrument. As both instruments saw the flash September 22, instrument mistake was unlikely. Also, the ripple arrived at the Arecibo observatory at the proper time to have been the shockwave of an explosion seen by *Vela.* No radioactive debris had appeared in southern-hemisphere rainwater to confirm an atomic explosion, but the United States had taken up to three weeks after last year's explosion to sample rainwater in the area. (*W Post,* Jan 30/80, A-1)

• MSFC announced that NASA had signed a $183,960,000 contract with ESA for a second Spacelab to be delivered in 1984. Like the first, the new Spacelab would be built by ERNO of West Germany, prime ESA contractor, with at least 26 subcontractors in ESA nations as well as the United States to make components and subassemblies. MSFC was responsible for technical support; JSC would handle operations; Kennedy Space Center (KSC) would be responsible for integrating Spacelab with the Space Shuttle and for launch. (MSFC Release 80-11)

• Presidential science adviser Dr. Frank Press addressed a conference of the Department of Agriculture science and education administration at Reston, Va., on expanding horizons for agriculture, which he said was of prize importance to the world's future. On the relationship of agriculture and space, Press cited climate and weather research by satellite as a useful guide in future policy; he also said a useful tool in immediate decisions would be the new AgRISTARS system (agricultural resources inventory surveys through aerospace remote sensing), used by five agencies—NASA, Commerce, Interior, and Agency for International Development (AID), plus the Department of Agriculture—to obtain early warnings and quantitative estimates of worldwide crop conditions. (Text, Jan 30/80)

January 31: MSFC reported that it had shipped two segments of a Space Shuttle solid-fuel rocket motor, used during 1979 in mated vertical ground vibration tests, to Thiokol's Wasatch division in Utah to be refurbished and loaded with propellant for use as a flight motor after being combined with other segments shipped earlier in January. (MSFC Release 80P-12)

• *Nature* reported that the ESA council voted to transfer launch capability to the private firm of Ariane-Espace, which would handle production and launch of all future ESA satellites. (*Nature,* Jan 31/80, 422)

During January: The *Washington Post* reported the death January 13 of James J. Donegan, 63, "a pioneer in space technology" at NASA since 1958. An aeronautical engineer specializing in spacecraft tracking, data acquisition, and computing techniques at GSFC, Donegan was an original member of the ground instruments unit attached to the first Space Task Group (STG) formed in 1958 to meet the challenge of Sputnik. He was a designer of the original manned spaceflight network and directed GSFC's manned spaceflight activity until 1973, when he became head of a new Operations Support Computing Division responsible for computer support to both manned and unmanned scientific spacecraft. He was operations director for Project Mercury and coordinated instantaneous computer services for Gemini and Apollo flights, receiving NASA's exceptional service medal in 1969 for his work on Apollo. (*W Post,* Jan 18/80, C-10)

• *Aviation Week & Space Technology* reported the death of John A. (Shorty) Powers, 57, who joined NASA as a U.S. Air Force lieutenant colonel to help manage the original seven Mercury astronauts and became known as "the voice of Mercury control." Powers, who retired from NASA in 1964, was found dead of natural causes January 1 at his home in Phoenix, Ariz. (*AvWk*, Jan 7/80, 21)

• FBIS reported further comment on the joint flight of *Soyuz T* and *Salyut 6*, predicted to continue "for several months" so that experts could test systems and operations before proceeding to build the new spacecraft "in series." The propellant tanks used by the engines for cruise and for docking now formed a single system; in the past, overuse of propellant in attitude control meant a Soyuz would have to return to Earth even if plenty of propellant was left in the cruise engine. This would not be so in the new engine. The on-board computer now carried out duties previously handled by the crew, such as data processing and flight or system control. Also, *Soyuz T* had a panel of solar batteries, which previous spacecraft did not have. The commentary said that previous Soyuz spacecraft would continue to be used for the immediate future, the present trial flight serving as dress rehearsal for the "many novel technical features." (FBIS, Moscow Wrld Svc in Russian, Jan 8/80)

February

February 6: NASA announced that a joint government-industry team would design, fabricate, and test a solar-power 20-kilowatt generator for use by small communities, industries, farms, military bases, and similar users. Sponsored by the Department of Energy (DOE), the project would foster inexpensive ways to use solar energy to produce electric power and industrial heat. Under a $1.3 million Lewis Research Center (LeRC) contract, AiResearch Manufacturing Company would build the engine, and Jet Propulsion Laboratory (JPL) would develop the solar power system including the solar mirror and receiver. (NASA Release 80-17)

February 7: NASA reported that it had selected Boeing and General Electric for contract negotiations to design, construct, install, and test multimegawatt advanced wind-turbine systems, in an LeRC-directed project sponsored by the DOE. The turbines, costing $15-$20 million each, would be used at sites with annual mean wind speed of 23 kilometers (14 miles), to be selected by DOE, and would supply electricity to conventional local utility systems for use by the general public. (NASA Release 80-18)

February 8: NASA held a press briefing on the solar maximum mission slated for launch February 14. Dr. Thomas A. Mutch, associate administrator for space science, said that exploration of Earth's nearest star was significant both scientifically and technologically. Dr. Harold Glaser of NASA's solar terrestrial division noted that the Sun, dominant energy source for the Earth, was a variable star in that its energy output varied in periods running from 10 minutes to 11 years (the so-called solar cycle) as well as over periods of centuries.

The solar variations causes variations on Earth; for instance, the solar flares known to have a periodicity of 11 years. In short time periods, a flare is the most energetic manifestation of solar changes, with significant effects: Earth suffers communications problems along with atmospheric heating and other phenomena, and the trillion kilotons spewed into the solar system would affect almost all the planets. The focus of the Solar Maximum Mission (SMM) would be to understand more about solar flares in order to predict their occurrence. The magnetic field of the Sun had also been found to vary with a 22-year periodicity, strongly correlated with drought in the U.S. western plains.

During the 17th century, solar activity apparently ceased for about 80 years, a period called the Maunder Minimum which featured a "mini-Ice Age" documented in northern Europe. This seems to have happened more frequent-

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ly than previously realized. Space research during the last 20 years had produced these data, Glaser said, including evidence that the Sun might be changing sides, with a corresponding increase of luminosity or incident radiation. Also, the Sun appeared to oscillate rather like a fluid, probably because of interior activity whose nature was as yet unknown.

Joseph Purcell of GSFC, standing in for project manager Peter Burr who was ill, described the spacecraft and its planned retrieval by the Space Shuttle, and the modular design that would allow it to be serviced in orbit if necessary. The SMM would be the first NASA satellite designed for retrieval and first to include the tracking and data-relay satellite capability; at 5,000 pounds, it would also be the heaviest payload launched by a Delta. Purcell explained the 24-hour computer watch on the SMM, calling it an operation with "very intense man-machine relationships."

Kenneth J. Frost, also of GSFC as SMM project scientist, described the payload as essentially one experiment to determine the nature of solar flares, using seven instruments and a "very detailed scientific game plan." Investigators needed a 24-hour watch to evaluate the plan's progress and to react to targets of opportunity on the Sun. For instance, a flare on the Sun's west limb would be observed on Earth and by a series of spacecraft in orbit around the Earth, so that the quality and completeness of the observations would "far outstrip anything we've ever had before." The SMM spacecraft would have a productive lifetime of about two years, Frost said, and the scientific group at GSFC would consist of investigators prepared to spend that much time away from their home institutions. In response to a question, he pointed out that the broad range of the electromagnetic spectrum to be investigated by SMM could not penetrate Earth's atmosphere. (Text, Feb 8/80; NASA Release 80-16)

• The *Washington Star* quoted Defense Secretary Harold Brown's statement before the Senate Committee on Commerce, Science, and Transportation that NASA's Space Shuttle program was "critical" to defense planning. The committee was considering the FY81 budget requests of NASA and DOD. (*W Star,* Feb 8/80, A-5)

• The Naval Research Laboratory (NRL) reported that NASA's *Heao 1* had detected "surprisingly intense" X-ray emission from a pair of common Sun-like stars in the constellation Cepheus. The pair formed a tight binary revolving around each other with a period of only six hours, in a rotary motion like "the twin blades of an eggbeater." The gas in the intervening space would be stirred violently and the magnetic-field lines twisted, stretched, and torn in a furious turbulence, the resulting X-ray emission being "millions of times that expected from either star alone." The *Heao 1* discovery was recently confirmed by the large telescope aboard *Heao 2* (Einstein), and other stars of that sort would be checked for X-ray emissions; two other binaries had been detected as X-ray sources. (NRL Release 3-1-80F)

• LaRC reported award of a 3-year $4.6 million contract to Sperry Support Services for development, operation, and maintenance of flight simulators, including real-time digital programs for solving research problems and for aerodynamics and space flight. Sperry would design and operate flight simulators and would develop, integrate, and test electronic subsystems to use with existing data systems. (LaRC Release 80-9)

February 11: The *Washington Star* said that an Aeroflot jetliner carrying Soviet Olympic contenders had landed at Kennedy International Airport in New York February 10. This was the second time in two weeks that the airline had broken its agreement not to land in New York; union ground crews had refused to service Soviet planes as a protest of Soviet incursion into Afghanistan. New York airport officials had unloaded Aeroflot passengers' baggage two weeks previously after the State Department intervened; the plane had sat on the ground for two days during arguments about servicing it. The February 10 flight went on after a two-hour delay to Dulles airport in Virginia, where 122 of the 145 passengers boarded buses for Lake Placid. (*W Star,* Feb 11/80, A-1)

February 12: On the basis of photographs from *Mariner 9* and *Viking Orbiter 2,* Dr. Kevin D. Pang and a team of JPL scientists decided that the surface of the two small satellites of Mars (Deimos and Phobos) were like those of meteorites known as carbonaceous chondrites, strongly suggesting that the two originated elsewhere and were captured by the gravity of Mars in a close encounter with the planet, the *New York Times* reported. The surfaces differed superficially, Phobos marked by long grooves and Deimos with a covering of loose material, but reflected light identically. (*NY Times,* Feb 12/80, C-4)

• NASA announced that it would join the California council of the American Institute of Architects (AIA) and the Pacific Gas and Electric Company (PG&E) in building an Advanced Technology Display House to open in 1982 at Ames Research Center (ARC), to demonstrate new materials and technology from aerospace and energy research. The sponsors signed on February 4 this first-of-a-kind partnership agreement under which AIA would contribute innovative architectural expertise; PG&E would share its research on energy conservation; and NASA in association with the U.S. Department of Housing and Urban Development (HUD) would translate aerospace technology into the "down-to-earth challenge" of home building.

The design would include self-contained water and sewage-treatment systems and energy-saving lighting, plumbing, ventilation, electrical wiring, and appliances, with extensive use of solar energy, all managed and monitored by a centralized computer. Using advanced systems and materials instead of those now available to the building industry, the AIA would design the house to allow addition or deletion of components (office space, physical fitness areas) and to be dismantled for exhibition across the United States. Wider use of the innovations would lead to economies in mass production and put the new ideas within reach of average customers. (ARC anno Feb 12/80)

February 13: NASA announced that it would maintain an expendable launch-vehicle capability at the Eastern Space and Missile Center (ESMC) in Florida as a backup to the Space Shuttle during transition to Space Transportation System (STS) operation. It would use the standard Delta launch vehicle, capable of putting spacecraft weighing up to 1,100 kilograms (2,400 pounds) into orbit. NASA would charge commercial Delta users $22 million per launch at the outset. (NASA Release 80-22)

• NASA reported studies by Western Union and U.S. Telephone & Telegraph warning of a fivefold increase in satellite video and data traffic by the end of the century. By the year 2000, executive telecommunications would be a substitute for business travel; 90% of the messages would need real-time (instantaneous) service and only 10% (such as electronic mail delivery) would be non-real-time. The demand for telecommunications would saturate domestic communications satellite capacity in the 4-6 GHz (C-band) and 11-14 GHz (Ku-band) frequencies.

Having decided to resume advanced communications satellite research, NASA would work toward opening the frequency band at 20 -30 GHz for commercial use in the next two decades. This band had not yet been used in the United States. The 20-to 30-GHz (Ka-band) offered a far greater range than the C-or Ku-band; capacities of communications satellite systems using it would be 50 to 100 times greater than those working in C-band. (NASA Release 80-19)

• NASA announced that it had deferred an experiment to use zero gravity in studying cloud-physics phenomena, formerly scheduled as a Spacelab payload in 1982. Technical problems in transition from ground laboratory to space environment had caused delays and increased design and construction costs of the Atmospheric Cloud Physics Laboratory to the point of terminating the GE contact. NASA would use the equipment in its ground-based weather and climate research. (NASA Release 80-23)

• NASA said that it would launch seven sounding rockets February 15 and 16 from the San Marco platform off the coast of Kenya to study a total solar eclipse visible in that area but not in North America, recording changes in the electrical structure of Earth's middle atmosphere and temperature distribution in the solar corona during an eclipse. Two Astrobee D and three Super Arcas rockets would carry payloads from Pennsylvania State University, and two Black Brant rockets would carry payloads from the Los Alamos Scientific Laboratory in New Mexico. Piggyback on one of the Black Brants would be a Johns Hopkins University experiment to measure ultraviolet zodiacal light from the solar corona. Instrument packages carried to 330 kilometer

(205-mile) altitude would make measurements during parachute descent.

GSFC would manage the eclipse study with support from Wallops Flight Center (WFC) in rocketry, instrumentation, and range support. The mobile launch platform in the Indian Ocean was operated by the University of Rome's center for aerospace research. (NASA Release 80-24; WFC Release 80-1)

February 15: NASA launched at 10:57 a.m. February 14 the SMM observatory from Cape Canaveral on a Delta vehicle into a circular orbit 360 miles above the equator. The 5,200-pound spacecraft carried instruments to study solar flares [see February 8] over a period of 2 years; the 11-year cycle of solar activity was entering its most turbulent phase, with flares erupting on the Sun once or twice a day and superflares causing atmospheric disturbances on Earth once a month. The SMM launch cost the United States $99 million, including $20 million for the Delta. (*W Post,* Feb 15/80, A-7; NASA Release 80-16)

• NASA reported that a final test firing of the Shuttle solid-fuel booster motor February 13 in the Utah desert was successful, and the motor would be ready for flight as soon as test-data results were available. Tests of this motor had begun in July 1977 with static firing of the first of four prototypes; three more development tests followed, the last February 17, 1979.

A series of test firings of flight-type motors began June 13, 1979, to qualify them for manned flight; the test just concluded was the third and final firing of that series. Robert E. Lindstrom, manager of the Shuttle projects office of MSFC, said completion of the tests meant that the solid-fuel booster motors would perform successfully in flight. After propellant burnout, the boosters would separate and plunge into the ocean for retrieval and reuse.

Two of the solid-fuel boosters were already on the launcher at KSC awaiting integration with other components (external tank and the orbiter itself) in preparation for the first Shuttle flight later this year. The assembled motor, major component of the booster, was more than 35 meters (115 feet) long and 3.5 meters (12 feet) in diameter, largest rocket motor of its type developed for space flight and the first built for manned spacecraft; it would generate 3 million pounds of thrust. (MSFC Release 80-18; NASA Release 80-25)

• NASA reported a major milestone for a Shuttle main engine February 8, with completion of a second series of flight certification tests at the National Space Technology Laboratories (NSTL) near Bay St. Louis, Miss. In the two series of tests (mostly run for 520 seconds at 100% of rated power level), the engine accumulated more than 10,000 seconds of firing time, equivalent to that required for 19 Shuttle flights; in one test, the engine ran at 102% of rated power, and in another it ran for 823 seconds to simulate an aborted mission. The first series of tests last year began March 27 and ended June 27. (MSFC Release 80-19; NASA Release 80-26)

February 17: The General Accounting Office (GAO) warned that the United States was in danger of losing its space technology lead unless it invested more in the new area of space manufacturing. On Earth, gas bubbles rise in a liquid, heavy particles and dense metals settle at the bottom of a solution, and heated fluids swirl in random and unpredictable directions, all because of gravity. The weightlessness of space permits formation of composite materials and facilitates both separation and synthesis.

The *NY Times* reported a GAO statement that the United States should be spending two to three times the $20 million in NASA's current budget, just to maintain parity with other nations such as the Soviet Union, Japan, and the 11 European members of ESA. GAO said that industrialists believed being "first to market" with new products would give a firm the best chance of remaining competitive. GAO predicted that by the end of the century orbiting factories would be producing new or better metals and alloys, perfect crystals, composite materials, glass, semiconductors, and high-purity chemicals, medicines, and vaccines that cannot be made on Earth. If the United States is to exploit this new field, the GAO said, its government must work out a plan with private industry, and both must be prepared for financial risks. (*NY Times,* Feb 17/80, 59)

February 18: ESA announced the inauguration March 6 in Geneva of the Stella experiment using the *Ots* satellite to transmit scientific data at high speeds between high-energy physics laboratories. Participating in the ceremony would be Roy Gibson, ESA director general; J.B. Adams, executive director of the European Organization for Nuclear Research (CERN); L. van Hove, research director for CERN; and F. Braun, director general for the European communities commission on internal market and industrial affairs.

Some 1,600 scientists from ESA member states used CERN's accelerators and high-energy particle detectors for fundamental research into the structure of matter. Stella would transmit electronic data at speeds up to 1 megabit (1 million bits of data) per second from CERN to member-state laboratories at Hamburg, Germany; Saclay, France; Didcot, United Kingdom; Pisa, Italy; Dublin, Ireland; and Graz, Austria. The speed of transmission would be similar to the working speeds of computers in the participating laboratories, eliminating the delay of sending magnetic tapes through the mail. (ESA Info Bltn 6)

February 20: Eighteen years after he blasted away from a launch pad at Complex 14, Cape Canaveral Air Force Station, to become the first American to orbit the Earth, Sen. John Glenn (D-Ohio) returned to dedicate a marble memorial of his flight and those of Mercury astronauts Scott Carpenter, Walter Schirra, and Gordon Cooper, donated in 1978 by the American Monument Association but held back for dedication until gantries at the site were removed and sold for scrap.

The *Washington Star* said the site was now desolate, "surrounded by palmettos and visited only by an occasional alligator or rattlesnake." About 600 persons at the ceremony heard Glenn describe the new U.S. goal of routine and economical access to space with the Space Shuttle. (*W Star*, Feb 21/80, A-2; *Today*, Feb. 12/80, 10A; *NASA Actv*, May 80, 19)

• NASA reported that Dr. Cyril Ponnamperuma, director of the University of Maryland laboratory of chemical evolution, and his researchers had recently discovered amino acids (basic building blocks of life) in Antarctic meteorites presented by NASA. The Antarctic program began three years ago as a cooperative venture of NASA and the National Science Foundation (NSF) to collect meteorites under extremely clean conditions like those under which Apollo astronauts obtained lunar samples, so free of contamination that they could offer evidence of any organic history before they impacted Earth. The agency had given the team Antarctic meteorite and lunar surface samples, as well as data obtained by deep-space probes on atmospheres of other planets. The laboratory examined the lunar and meteor samples for evidence of organic material and tried to create molecules similar to those present in Earth and the planetary atmospheres before life began.

Using gas-chromatograph techniques to identify right-and left-handed molecules of amino acids (the direction in which a beam of polarized light sent through a solution of the material would turn), the team had obtained strong evidence of both right- and left-handed amino acids in the Antarctic meteorites. Since all Earth life forms contain only left-handed molecules, the preorganic matter in the meteorites had to be formed somewhere else. The meteorites used by the team were about 4.5 billion years old; the oldest Earth material identified so far was 3.7 billion years old, and some of it contained evidence of organic matter. "The processes we postulated as taking place on the earth before life began seem to have taken place somewhere else also," Ponnamperuma said. "What this implies is that all those events which led to life may be common in the universe, so what we said happened on the earth may be happening somewhere else." (NASA Release 80-21)

• The *Washington Star* reported on a campaign to raise $1 million for a Viking fund to collect and preserve data from Mars. The Viking landers "sitting on the red sands of Mars and sending back information" could keep doing so for the next 10 years, the story said, but NASA had decided that no life existed on Mars and stopped listening to the Viking transmissions. Among those supporting the fundraising campaign was Ben Bova, editor of *Omni* magazine, who said "the only people who have lost interest in space are here in Washington." NASA had not officially endorsed the effort, but "at least one spokesman" said the agency would be delighted to accept the contribution. (*W Star*, Feb 20/80, C-1)

February 21: Radio Corporation of America (RCA) said it would lease capacity on an American Telephone and Telegraph (AT&T) satellite to make up for its own satellite that disappeared after launch [see December 11, 1979]. Eleven cable television companies that were to use the lost satellite could now begin sending programs to cable systems as early as April 1. Loss of RCA Satcom 3 had threatened the cable television industry; twenty channels were in use on one RCA satellite, and eleven more had been scheduled for the lost satellite. Under the arrangement with AT&T, RCA would pay $70,000 a month for each channel which it would then lease at $40,000 a month; an 18-month lease would lose RCA about $5.9 million including expenses. (*W Star,* Feb 21/80, C-9)

February 22: NASA reported that the SMM launch February 14 was successful, the orbit close to prediction and no functional problems in spacecraft or experiment systems. The only anomaly during early orbits was inability to compute roll reference positions, a figure needed to conduct slew maneuvers. The cause was incorrect axis translation by ground processing of star-tracker output; the program was modified and all systems were now performing within specifications. (NASA MOR S-826-80-01 [postlaunch] Feb 22/80)

• FBIS reported launch of Japan's second communications satellite CS-B from Tanegashima Island at 5:35 p.m. local time. CS-B would replace Ayame (Iris), whose signal was lost when it collided with its apogee motor 12 seconds after ignition February 5, 1979. *Ayame 2* would reach stationary orbit over northern New Guinea by March 10. First stationary comsat designed to use millimeter-wave transmissions in communications experiments, *Ayame 2* was 1.4 meters long and 1.6 meters tall, weighed about 130 kilograms, and cost 6 billion yen; it would be Japan's fifth stationary satellite.

[FBIS reported February 25 that, 8 seconds after firing an apogee motor to put the spacecraft into a circular orbit, Japan's National Space Development Agency lost radio contact with *Ayame 2* also. With 30 billion yen spent to build and launch the two experimental comsats, the successive failures were "a shock to the agency and the Science and Technology Agency." Japan's tracking stations continued to send radio signals in an effort to restore contact, officials said, but the two failures would cast a shadow on future satellite-launching plans.] (FBIS, Tokyo *Kyodo* in English, Feb 22, 25/80)

• *Today* newspaper said NASA Associate Administrator John Yardley had "acknowledged for the first time" that NASA engineers were so concerned with the Shuttle tiles guarding against heat of reentry that they "virtually ignored whether the tiles would remain stuck to the spaceship." Yardley said at a briefing that tiles still headed the list of Shuttle problems; he said NASA was studying alternative heat protection systems using technology unavailable 10 years ago. He added that "NASA and Rockwell both have to take a share" of blame for not testing the insulating system sooner. NASA originally estimated the cost of each custom-built tile covering the Shuttle at $500 for fabrication and installation; Yardley said that the tiles would now cost three to four times that much. The actual price tag for the Shuttle was now about $8.7 billion; the cost projected in 1971 was $5.2 billion. (*Today*, Feb 22/80, 18-A)

February 25: The *Washington Star* reported that the Space Environment Services Center at Boulder, Colo., was predicting an 11-year peak in sunspots; solar outbursts in coming months could raise magnetic storms on Earth, foul up radio communications, and cause computers to go haywire. Gary Heckman, head of the center, said solar flares might have set off a civil-defense circuit in Canada that automatically put radio stations in an alert mode. The upcoming flare peak might be the second most active since the record of 1957. (*W Star*, Feb 25/80, A-9)

February 26: A United Press International (UPI) report from Moscow said the Soviet Union had unveiled its 350-passenger airbus with a timesaving baggage compartment where riders would load and unload their own luggage. The Ilyushin 86, 20 feet wide and 193 feet long, carried 70 more passengers than the A-300 French/German airbus; it had maximum range of 3,000 miles and a cruising speed of 600 mph. It had been test-flown to the Black Sea area and to Tashkent and would begin regular service June 1 to Sochi, a resort area; the new plane would eventually absorb a fifth of USSR domestic passenger service, officials said, especially on peak Black Sea routes. The prototype flew in 1976, and fulltime construction began in 1977.

The new baggage-handling feature had a short ladder by which boarding passengers could reach a lower compartment with bins numbered to match their seats. After putting their luggage in the proper bin, they would climb to the passenger sections on an upper deck. Officials said the system tested in a mockup could load or unload all 350 passengers within 20 to 25 minutes. (Western aviation experts said the Il-86 was a gas-guzzler, its four "fuel-inefficient" engines capable of generating only 28,000 pounds of thrust compared with 45,000 pounds for western widebody planes.) (UPI/*W Star*, Feb 280, C-11)

• The *Washington Star* reported that cable television operators awaiting a replacement for the lost RCA Satcom 3 had found that they would need big new dish receivers for signals from the Comstar satellite RCA planned to lease. (*W Star*, Feb 27/80, C-3)

February 28: ARC said that it would close the Pioneer project office effective February 29 after 16 years of sending spacecraft to various planets and to orbits around the Sun. The Space Missions Branch at ARC would handle the seven Pioneers still in interplanetary space: numbers 6 through 9 had formed a network of solar weather stations around the Sun, and Pioneer 10 and Pioneer Saturn was both headed out of the solar system after flights to Jupiter and Saturn. Pioneer Venus was in orbit about that planet photographing cloud circulation and sending back the first detailed maps of Venus's surface.

ARC director C.A. Syvertson in a staff memo said that [project manager] "Charles Hall and all who have participated in the program deserve our congratulations and a hearty well done." When NASA Headquarters recently presented a number of NASA medals and other recognition to Pioneer individuals and teams, Hall received NASA's distinguished service medal, its highest award, before his retirement after 30 years with the agency. (ARC Release 80-4)

• The International Telecommunications Satellite Organization (INTELSAT) reported that it had bookings for 260 hours of international satellite television when the winter Olympic games opened at Lake Placid, N.Y.; a tally after the games showed that 448 hours had been used, nearly double the original demand. Countries receiving direct broadcasts of the games included the United Kingdom, France, West Germany, Yugoslavia, Australia, Japan, Mexico, and Venezuela; these would have relayed many of the telecasts to a large number of other nations through Earth networks, INTELSAT said. (INTELSAT Release 80-02-I)

February 29: MSFC said that a second full-duration test of the Shuttle main-engine system February 28 was successful, and all objectives were met during the 555-second firing. For the first time, the three engines in the system were steered while being throttled back from 100% thrust, and the oxygen tank was allowed to run dry. (MSFC Release 80-27; NASA Release 80-31)

• NASA announced selection of General Electric and TRW Systems, Inc., to negotiate contracts for $500,000 six-month design studies of the gamma-ray observatory mission. One of the contractors would be chosen to build and operate the satellite under a follow-on contract after Congress approved the mission.

If approved, the observatory would carry five large gamma-ray instruments into space to observe gamma-ray sources and obtain fundamentally new information about stars, the galaxy, and the universe. It would be a Shuttle payload in the mid-1980s designed for retrieval after a two-year mission lifetime; GSFC would manage the project. (NASA Release 80-30)

During February: Dr. Richard T. Whitcomb, 59, the "legendary aerodynamicist" inventor of the area rule and the supercritical wing, retired February 29 after 37 years of service with NASA. Graduated in 1943 with honors in mechanical engineering from Worcester Polytechnic Institute, Whitcomb said an article in *Fortune* magazine impelled him to apply for a job at NACA's Langley Memorial Aeronautical Laboratory. His "brilliant career" there included three landmark ideas, all radical departures from conventional aerodynamic theory, all developed in Langley wind tunnels, and all successful.

His honors included the Collier Trophy for applying his "area rule" to design of supersonic aircraft, and the U.S. Air Force exceptional service medal (highest civilian award) in 1954; NACA's first distinguished service medal in 1956; NASA's medal for exceptional scientific achievement and the American Institute of Aeronautics and Astronautic's Sylvanus Albert Reed award, 1969; the National Medal of Science, highest honorary scientific award of the U.S. government, 1973; in 1974, the National Aeronautic Association's Wright Brothers memorial trophy, the AIAA aircraft design award, and a $25,000 cash award (largest ever given by NASA to an individual) for invention of the supercritical wing; in 1978, the National Business Aircraft Association award. (NASA Release 74-148, 80-38)

• NASA announced that Dr. William C. Schneider, associate administrator for space tracking and data systems, would retire from federal service February 29. He joined the Gemini program in 1963 after two years at International Telephone and Telegraph's (ITT) federal Laboratories as director of space systems, having also worked for the U.S. Navy and for NACA. He received NASA's exceptional service medal for his work as mission director for 7 of 10 Gemini missions. From July 1967 to December 1968 he directed Apollo missions beginning with *Apollo 4* and won NASA's distinguished service medal for the success of *Apollo 8,* first manned flight around the moon. He directed the Skylab program from December 1968 to July 1974, and with the three Skylab crews received the Collier Trophy in 1973. He would become a vice president of Computer Sciences Corporation. (NASA anno, Feb 22/80; NASA Release 80-27)

• LaRC announced that four of its top managers left NASA February 29. They were deputy director Oran W. Nicks; associate director Dr. John E. Duberg; Richard R. Heldenfels, director for structures; and James E. Stitt, director for electronics. The latter three, who began their federal service in the 1940s with NACA (Dr. Duberg in 1943, Heldenfels and Stitt in 1947), would retire. Nicks, who since 1970 had been deputy director at LaRC, began at NASA Headquarters 1960 working on unmanned programs; he would become executive director of the research foundation at Texas A&M University. (LaRC Release 80-14)

• The Air Force Systems Command (AFSC) *Newsreview* reported that Air Force Secretary Dr. Hans M. Mark proposed establishment of a consolidated space operations center near Peterson Air Force Base, Colorado, combining two major mission elements of the U.S. Air Force: satellite control and direction of future DOD Shuttle operations. The Colorado location, prime candidate out of 13 potential sites, would offer proximity to the North American Air Defense Command (NORAD) complex at Cheyenne Mountain; it would employ about 300 military, 100 U.S. Air Force civilian, and 1,400 contractor employees. (AFSC *Newsreview,* Feb/80, 1)

• FBIS reported the Il-18 airliner that carried a group of Soviet journalists and researchers to check the possibility of regular air service through Africa and the Middle East to the Antarctic, had returned safely to Moscow after establishing the flying time for the new route as 27 hours. Previously, the trip home by sea had taken 1 month. (FBIS, Moscow Wrld Svc, Feb 23/80)

March

March 3: NASA reported award of contracts to Martin Marietta and Aerojet worth $750,000 and $350,000, respectively, for a liquid-propellant boost module to increase the cargo-carrying capacity of the Shuttle's external tank. The goal would be to provide additional thrust by adapting portions of the Titan, still used by the U.S. Air Force as its heaviest intercontinental ballistic missile. The companies, which had been building the Titan and its engines for the U.S. Air Force, were considered the logical choice for adapting the booster to the Shuttle. The studies, managed by MSFC would be completed by the end of September 1980. (NASA Released 80-32; MSFC Released 80-28)

• LaRC, manager of the Scout program, announced that NASA had awarded Hampton Technical Center (a division of Kentron International, Inc., of Dallas) a $2.2 million contract modification calling for ten Algol 111A Scout rocket motors by March 31, 1981. Prime contractor for Scout was formerly Vought Corporation, also of Dallas; the modification was made with the same parent firm, Ling Temco Vought. Name changes and other corporate restructurings would streamline the work done for NASA, with estimated savings of about $1 million to be gained by contracting with a subsidiary already qualified to build and load the motors. To be qualified, a firm must have fired two or three launch vehicles, a process costing about $1 million. Scout, NASA's smallest vehicle, was a four-stage solid-propellant rocket that had launched payloads for NASA, DOD, and several foreign countries. (LaRC Release 80-15)

• FBIS carried a Reuters dispatch quoting diplomatic sources in Beijing that the People's Republic of China had launched a CCS-3 limited-range intercontinental ballistic missile (ICBM) February 9 from Jilin province in northeast China to an impact area in the far western Xinjiang region, a 2530-mile flight across a largely unpopulated, mainly desert region. The People's Republic had conducted at least six missile tests in 1979 over distances much shorter than the February 9 test. Other sources said the Chinese were working on a full-scale ICBM with a range that would bring the United States, western Europe, and all of the Soviet Union within striking distance. Test of such a missile would need an ocean-impact area such as the southern Indian Ocean, but no such firings had occurred. (FBIS, Reuters in English, Mar 3/80)

March 5: Newspapers reported a consent agreement in a suit by Ted Turner's Cable News Network (CNN) against RCA, for space on *Satcom 1* to replace that lost when Satcom 3 disappeared, whereby CNN would use a *Satcom 1* channel for six months and would drop a demand for $35 million in damages. RCA had said its clients could use transponders on the *Comstar D2* leased by AT&T from Comsat General; however, cable operators whose antennas received Satcom signals would need additional expensive ground receivers to get signals from Comstar. Turner's CNN clients around the United States could now continue to receive the 24-hour all-news service for six months without the additional expense. The lawsuit would continue in Atlanta's U.S. district court. (*W Star,* Mar 5/80, C-5;*W Post*, Mar 7/80, C-10)

March 6: Press reports said NASA faced a $760 million (14%) cut in its FY81 funding as President Carter announced a $20 billion cut in the entire federal budget. The *Washington Post* said Dr. Robert A. Frosch, NASA administrator, had protested the size of the cut to the Office of Management and Budget.

The White House had originally asked NASA to suggest reductions of $630 million. *Defense/Space Business Daily* said the cuts would eliminate two new NASA starts in FY81, the gamma-ray observatory and the national oceanic satellite system, as well as the Galileo mission to Jupiter. On March 5 the House subcommittee on space science and applications had unanimously passed NASA's $300 million FY80 supplemental request for Shuttle-development funds; subcommittee chairman Rep. Don Fuqua (D-Fla.) said NASA should share the FY81 cuts, but 18% was too high. (*D/SBD,* Mar 6/80, 25; *W Post*, Mar 7/80, A-2)

• ESA announced it would undertake a new scientific project called Hipparcos, an astrometric satellite to measure positions, proper motions, and parallaxes of celestial bodies and define the position and displacement velocity of about 100,000 stars. The data would help solve fundamental problems in astronomy. The 376-kilogram advanced-design satellite with a 2.5-year lifetime would be launched into a geostationary orbit by Ariane in mid-1986. (ESA Info Bltn 7)

March 7: Dryden Flight Research Center (DFRC) reported that test pilot John Manke had made test flights in the Gossamer Albatross, part of a joint DFRC-LaRC program using the humanpowered vehicle to collect data on large lightweight craft. Manke's first flights were human powered, as he pedaled a bicycle-like arrangement to turn the propeller; for later flights, under the direction of veteran Albatross pilot Bryan Allen who had flown it over the English Channel, he used small battery-powered samarium cobalt motors providing about 0.7 horsepower.

Manke reached an altitude of 15 to 20 feet, more than he " felt comfortable with," and reported that the Albatross was nothing like anything he had flown before, requiring concentration to keep it going straight. Short flights did not require an extra amount of legpower to keep it going, but longer flights would be "an exercise in exercise." (FRC *X-Press,* Mar 7/80, 3)

• *Aviation Week & Space Technology* magazine reported the launch March 3 of a DOD ocean surveillance system from Vandenberg Air Force Base on an Atlas F into a 1,115-kilometer by 1,053-kilometer (715 by 654 mile) orbit with 107.1-minute period, and 63.5° inclination. The report said that, on the basis of earlier tests, the system would use three spacecraft carried into orbit on a mother satellite and dispersed into parallel orbits with latitude as well as time/distance separation. (Earlier clusters developed by the NRL under code-name Whitecloud were launched April 30, 1976, and December 8, 1977, into orbits having parameters nearly identical to those of last week's launch.)

The feasibility of using multiple satellites to eavesdrop on and direction-find USSR ships and submarines was first demonstrated by three NRL spacecraft launched December 14, 1971, and dispersed into separate orbits. The 1976 and 1977 missions that preceded the March 3 launch incorporated a 107-minute orbital period to allow about 1,666 miles between successive cluster passes. From a 700-mile altitude the spacecraft could receive signals from surface vessels more than 2,000 miles away, offering overlapping coverage on successive passes. Similarity of displacement distances perpendicular to the orbital planes of the 1976 and 1977 clusters indicated the use of interferometry to pinpoint the location of Soviet vessels. Deployment of the active satellites by the carrier normally occurred over a period of days; late last week, NORAD was still logging the mission as a single spacecraft. (*AvWk,* Mar 10/80, 18)

—*Aviation Week & Space Technology* reported that the U.S. Court of Appeals had upheld a FCC authorization of January 1977 that allowed Satellite Business Systems (SBS) to own and operate a specialized all-digital domestic communications satellite system. AT&T, Western Union, AmSatCorp, and the U.S. Justice Department had appealed the FCC ruling. SBS had proceeded to develop the system, its first satellite scheduled for launch in October 1980. (*AvWk,* Mar 10/80, 22)

March 12: MSFC reported that a major reclamation effort had recovered thousands of dollars worth of critical or valuable materials from center laboratories. Used for electrical contracts, or for plating to protect against corrosion, were gold, silver, platinum, iridium, osmium, rhodium, and ruthenium; other substances not necessarily "precious" but consisting of strategic materials were aluminum oxide, beryllium, cadmium, cobalt, chromite, industrial diamond, ruby and sapphire bearings, and other rarities. DOD and the General Services Administration operated a government-wide program to conserve such materials, recover them where feasible, and transfer them to a defense stockpile.

Before recycling materials at the center, MSFC property managers had to decide whether recovery was possible or profitable: for instance, some center groups had been "banking" silver recovered from X-ray films and developing solution. The photo lab and documentation repository had contributed much because of the amounts of film used; the medical center also turned in silver recovered from X-ray film developing as well as scrap X-ray film. Materials from MSFC were sent to a federal "bank" in New Jersey for recovery and credit to NASA's account. Last year MSFC recovered and shipped to the bank 324 troy ounces of silver-bearing photoprocessing residue and 2,400 pounds of scrap film; assuming 90% recovery from the residue and 2%-by-weight recovery from scrap, MSFC's yield would be worth $30,000 at current prices. (MSFC Release 80-34)

• The National Aeronautic Association (NAA) announced that it would award the Collier Trophy, oldest U.S. aviation award, to Dr. Paul MacCready for his Gossamer Condor (first vehicle to make controlled sustained humanpowered flight) and Gossamer Albatross (first humanpowered aircraft to fly the English Channel). The NAA said the Albatross flight might result in more practical applications than Blériot's first engine-powered crossing in 1909. (NAA Release Mar 12/80)

• ESA announced that its member nations participating in the Spacelab program had voted to fund it under a new scale that would ensure completion of the project by providing 120 to 140% of previously agreed amounts. West Germany would contribute 64.4%; France, 12.07%; the United Kingdom, 7.6%, and seven other countries, the remainder. (ESA Info Bltn 8)

March 13: INTELSAT said that it would reduce by 20% its charges for communications satellite capacity leased to nations for domestic use. The board of governors decided to charge $800,000 (U.S.) per year per transponder; the previous fee had been $1 million. Fifteen nations were currently leasing capacity on INTELSAT spacecraft for their own domestic use. (INTELSAT Release 80-03-I)

March 14: MSFC reported successful completion March 13 of the first full-power test (10% of rated power level) of the Space Shuttle main engine. The test consisted of a 125-second run on a single engine, 10 seconds at 109%; a total of 26 seconds ran above normal rated power. This major step toward certification of the engine for full-power abort capability envisioned possible malfunction of a single engine, requiring thrust in excess of rated power from the other two engines to ensure achievement of orbit or return for safe landing. Rockwell International, prime Shuttle contractor, conducted the tests at NSTL in Mississippi. (MSFC Release 80-36; NASA Release 80-36)

• NASA announced the first use of a major new flight-simulation facility for Shuttle support. The vertical-motion simulator at ARC would start next week evaluating the effect of an adaptive gain device to be attached to orbiter controls because of oscillation experienced during approach and landing tests conducted at DFRC in 1977. (NASA Release 80-34)

March 18: NASA reported that it and NSF had found a promising new meteorite source in the Antarctic, two fields known as Recking Peak and Elephant moraines, three or four times as large as the Allen Hills area covered by meteorite hunters during the past four years—also "more promising. . .and more dangerous," said curator John Annexstad, one of the discoverers.

The finds had been handled like the lunar samples brought to Earth by Apollo astronauts; the unusual preservation aspects of the ice shelf kept the meteorites as they had been when entering Earth atmosphere hundreds of thousands of years ago, providing evidence of organic history predating their arrival on Earth. The search for meteorites on the ice shelf had begun with the Japanese, who found large amounts in the Yamato mountains of Queen Maud Land. Dr. William Cassady, University of Pittsburgh, theorized a transport system explaining the Antarctic icefield concentrations, and several seasons of hunting tended to confirm the theory. The total of Antarctic meteorites found topped 1,600, many of them rare or unique types. (NASA Release 80-28)

• The *Washington Post* reported that Dr. Robert A. Frosch had approved a NASA regulation covering the situation "when a barroom brawl breaks out in space." The rule would permit a Shuttle commander to "use any reasonable and necessary means, including physical force," to maintain order on board. The police power would include authority to arrest a person in space and charge him or her with a crime punishable by a $5,000 fine, a year in prison, or both.

Eugene Cernan, veteran of two trips to the Moon and one in Earth orbit, commented that "I never felt the need for a written regulation or the need for brute force to get things done." NASA's lawyers said that times had changed: the Shuttle would carry seven people compared to the three on Apollo and two on Gemini; up to four could be civilians, not professional astronauts, and up to three of them could be foreigners unfamiliar with NASA procedures.

NASA General Counsel Neil Hosenball said NASA "had to establish a chain of command with all those people on board." Legal precedents were two assault cases where people were out of touch with the rest of the world: one occurred on a plane flying from Puerto Rico to New York, the other on an ice floe carrying civilian scientists in the Arctic. In 1956 two Puerto Ricans on their way to New York were toasting each other in rum while the plane was over the Atlantic; a fist fight ensued that drew most of the passengers to the rear of the plane to watch. The plane became tail-heavy the pilot interfered; and was bitten in the shoulder. A New York court released the accused, ruling that it was without jurisdiction over a plane in flight above the ocean. When one of a team of technicians doing research on an ice island off Alaska attacked three others before one of them killed him, a court of appeals in Alaska ruled that it had no jurisdiction in a crime committed on an island floating through the Arctic Ocean. (*W Post,* Mar 18/80, A-8; *Nature,* Mar 27/80, 296)

March 20: MSFC reported successful firing of three Space Shuttle main engines mounted in a test article for 535 seconds in the eighth test of the main propulsion system. A similar firing for 555 seconds occurred 3 weeks ago. In the latest test, engineers for the first time gimbaled the engines while including a "pogo" effect (a phenomenon of cyclic pressures in the propellant system that had occurred in earlier launch vehicles) to demonstrate the engine accumulator's ability to prevent pogo during flight. Another successful first was the simulation of failure in thrust-vector control to see whether redundant systems would perform properly. The test had been planned for early morning so that engineers could observe ice and frost conditions on the external tank when it was filled with supercold propellants during nighttime hours, in the absence of heat from the Sun. Rockwell International's space systems group conducted the main propulsion-system testing for MSFC at NSTL. (MSFC Release 80-41)

• JSC described a simulated Shuttle mission ending in a return-to-launch-site abort, as one of a series run in the Shuttle avionics integration laboratory (SAIL) in preparation for launch later this year. The SAIL resembled a full-size orbiter stripped of its skin, with wires and connectors bared, configured with the same flight-qualifiable hardware and electrical systems being used on the real orbiter at KSC. SAIL employees would run test sequences on a 24-hour basis to check out the complex Shuttle avionics system; a typical test would begin with a nominal phase (all systems operating normally), then engineers would inject failures to see if the flight system could cope. The Shuttle dynamic simulator would feed equations for aerodynamics, environment, and motion of the orbiter, solid-fuel rocket booster, and external tank into the test system. More than 300 mock missions would fly in the JSC lab before the projected November launch. (JSC Release 80-016)

• JSC reported that the third group of 20 astronaut applicants from the 3,122 received in the fall of 1979 would report March 24 for interviews and physical exams. This group included 9 pilot and 11 mission-specialist applicants; 5 of them were women. (JSC Release 80-017)

• NASA noted the 20th anniversary of the first research of the X-15 rocket plane that opened up the realm of hypersonic flight and contributed significantly to the U.S. space program. The X-15 made 199 flights in a joint NASA-U.S. Air Force-Navy research program between 1960 and 1968, during which it set the standing records for altitude and speed of winged aircraft: altitude of 1,796 kilometers (354,200 feet, more than 67 miles), and on another flight 7,274 kilometers per hour (4,520 miles per hour), or 6.7 times the speed of sound. X-15 pilots included Scott Crossfield, the first; astronaut Joe Engle; and Neil Armstrong, first man on the Moon.

In 1954, at the beginning of the X-15 program, hypersonic flight had many unknowns: effects of weightlessness, high heat rates, steep reentry angles, attitude control in space—questions that only actual flight could answer. The program would also explore capabilities and limitations of a human pilot in an aerospace vehicle; analysis of the first 44 flights showed that 13 would have failed without a human pilot. Positive result of the program was the finding that human capabilities of sensing, judging, coping with the unexpected, and using a variety of acquired skills remained undiminished in all key problems of aerospace flight. A significant X-15 contribution to the space program was to demonstrate that simulators could be used for crew training: no X-15s had two seats, so the pilots had to train in simulators. Success of this method led to all-out use of simulators for the space program. Total cost of the program, including construction of three X-15 aircraft, was about $300 million. (NASA Release 80-37; *NASA Actv,* May 80, 8)

March 24: The White House issued a statement on President Carter's presenting the Goddard Trophy of the National Space Club to NASA's Voyager team, for the "outstanding achievement in advanced spaceflight programs contributing to American leadership in space." NASA Administrator Dr. Robert A. Frosch would accept the trophy on behalf of the Voyager team for its successful planetary mission to Jupiter. The award was established in 1958 to honor Dr. Robert Goddard (1882-1945), considered the father of modern rocketry; receipts in previous years included Wernher von Braun, John Glenn, the *Apollo 11* crew, the Skylab astronauts, and the Viking project team. (WH Anno, Mar 24/80)

• *Defense Daily* reported that DOD's plans to let civilian aircraft and ships use its NavStar global-positioning systems to obtain navigation signals with 200-meter accuracy had met with difficulty. Tests showed that the "coarse" signal, considered insufficiently accurate to be militarily useful, was much more accurate than DOD thought. DOD was studying techniques to deny use of the "precise" NavStar signal to others and to degrade coarse-signal accuracy that "could provide improved capabilities to an adversary." (*D/SBD,* Mar 24/80, 119)

• *Aviation Week & Space Technology* reported that NASA scientists and engineers were "concerned that political maneuvering, as opposed to thoughtful planning, was playing too strong a part" in FY81 budget cuts affecting NASA science and applications programs.

Delay in bringing NASA's program before a House appropriations subcommittee scheduled to meet March 25 could force the agency off the hearing schedule for weeks, further endangering approval of the $300 million Space Shuttle supplemental for FY80. NASA and congressional observers feared administration efforts to delay announcement of federal program cuts until after primary elections set for the coming week. (*AvWk,* Mar 24/80, 21)

• FBIS carried a Tass report that *Soyuz T* separated from *Salyut 6,* which was continuing to fly "in the automatic regime" after completing a joint program. More trials of new Soyuz systems -- power unit, orientation and position-control systems, and computer complex—would proceed during further flight of that spacecraft. Tass reported later that *Soyuz T* made a soft landing March 26 to end a 100-day flight. (FBIS, Tass in English, Mar 24, 26/80)

March 27: The *Washington Post* reported that the House Armed Services Committee had voted $50 million to expand production of Fairchild Industries, A-10 plane from a one-seat to a two-seat configuration. The aircraft was originally designed to accommodate two cockpits. Fairchild said DOD would save $10.5 million a year in fuel costs because it would not need a second plane to follow the first in training flights. Besides the added seat, the new model had the capability of flying in bad whether and at night. The company tested the two-seater for five months in 1979 and turned over the prototype to Eglin Air Force Base for testing; the U.S. Air Force had completed its tests and was assessing results. (*W Post,* Mar 27/80, B-1)

March 28: NRL announced that one of its scientists, James C. Ritter, had received a patent on a radioisotope photoelectric generator to produce energy for spacecraft on missions to distant planets that would last for years without dependence on thermal heat or solar radiation. The generator, built like a storage battery, used low-energy photons from a radioactive source interacting with high atomic number material to eject photoelectrons. (NRL Release 80-3-80C)

March 31: Aviation Week & Space Technology said that cuts in NASA's FY81 budget would delay the international solar polar mission to 1985, although $135 million in contracts had already been awarded in the United States and Europe. Delay would force "major restructuring of the contracts"—$80 million to TRW for the U.S. spacecraft and $55.8 million to Dornier as prime contractor for the European spacecraft—and would give ESA additional problems with its budget, although NASA expressed hope last week that ESA would remain a part of the project. A split mission with the U.S. and European spacecraft on separate launches would increase costs substantially.

Aviation Week & Space Technology said that NASA was "unable to discuss this situation before Congress last week" because of an administration embargo on new budget projections. Although NASA could testify on the Space Shuttle need for a $300 million FY80 supplemental appropriation, the embargo had forced the House appropriations subcommittee to cancel two days of NASA hearings on FY81 space science and applications. NASA Administrator Robert A. Frosch said that, unless the supplement was passed, contractors would lay off up to 20,000 skilled workers, and the overall cost of the Shuttle program could increase by $600 to $900 million. The combined impact on NASA and DOD could go as high as $1.1 billion, according to subcommittee members. (*AvWk,* Mar 31/80, 27)

• *Aviation Week & Space Technology* reported that Southern Pacific Communications Company (SPC) had applied to the FCC for authority to build a domestic communications satellite system starting with two satellites in orbit and a third maintained as a spare. Capacity of the system would exceed that of any other domestic system now in orbit or in construction; each proposed satellite would have twice the capacity of the largest communications satellite now in domestic service (AT&T's Comsat or RCA's Satcom) and a voice or digital-data capacity 60% higher than Western Union's Westar.

SPC predicted that the demand for transponders would triple between 1980 and 1985 and said that no existing or planned system would be adequate to provide SPC with the capacity it would need by mid-decade. It had petitioned earlier to deny requests of RCA for orbit slots at 132°W and 83°W, of Western Union for 83°W, and Hughes for 79°W and 75°W. Given authority to orbits its satellites at 132° and 83°W, with assignment of a third slot at 79°W, the company said it would provide service to all 50 states, Puerto Rico, and the Virgin Islands. It would also build a control center in Maryland and launch its communications satellite in 1982-1983. (*AvWk,* Mar 31/80)

April

April 1: MSFC reported the first sustained operation of the Space Shuttle main engine at full power level, 109% of rated power for 6 minutes, in static firing tests March 31 at NSTL. The engine ran for 10 minutes, 10 seconds, reaching the objectives attempted in an aborted run the previous week. (MSFC Release 80-47; NASA Release 80-42)

• NASA reported that LaRC would manage a nine-month $900,000 design study of alternative thermal protection for the Shuttle orbiter, aimed at reducing costs and determining whether the present system was the best now available. The ceramic covering originally chosen in the early 1970s was the best then available; no study of alternative systems had taken place since. The study would center on technological advances in reusable surface-insulating materials such as metallic or reinforced carbons; coping with various loading conditions as well as handling, inspection, and maintenance; and deficiencies in present technology needing further research. (NASA Release 80-40)

• JSC reported that the Gossamer Albatross, a human powered aircraft that crossed the English Channel last June, would appear on display at JSC's Building 9A during April as part of a nationwide tour. NASA had just completed a month of tests on a sister ship at DFRC to study its unique aerodynamic traits, especially its low-speed flight at low Reynolds numbers. The test flights used various power sources (motor power, cycle power, and towing) to demonstrate the craft's maneuverability and to define performance under varying conditions. (JSC Release 80-020)

• MSFC announced the award to BDM Corporation, McLean, Va., of a $699,864 contract for engineering support of a Tennessee Valley Authority (TVA) coal-gasification plant, first large-scale commercial operation of this type in the United States. Besides helping to ensure efficient operation, MSFC would work with TVA to define advanced technology that could be applied in areas where NASA had some expertise, such as materials, combustion dynamics, instrumentation, and control. (MSFC Release 80-49)

April 4: ARC said that it would test for the first time the ability of males aged 55 to 65 to withstand the physiological stress of weightlessness. Previous studies had tested males and females aged 35 to 45 and 45 to 55. Women aged 55 to 65 would be tested later in 1980 to complete the baseline data for use in establishing medical criteria for space flight.

For the first briefing early in February, 46 volunteers reported and 20 were chosen for orientation March 24. The preliminary orientation and testing would give researchers a chance to see how the subjects performed and allowed the subjects to decide whether they wanted to participate in the entire test. Two sets of four subjects would be selected: four would begin 9 days of controlled observation April 10 at ARC's human research facility, followed by 10 days of bed rest and 5 days of recovery and tests of the cardiovascular system. Another group of four would begin the same series April 13. Dr. Harold Sandler, ARC project scientist, would supervise the tests. (ARC Release 80-7; NASA Release 80-43)

April 6: NOAA reported that it would submit to OMB by midyear a transition plan for NOAA to assume responsibility for operating a Landsat-type system to be launched in the late 1980s. Based on technology derived from NASA's experimental Landsat program, the system would provide essential data from space for use in food production, mineral exploration, Earth resources inventory, management of rangeland, forests, and water resources, and environmental protection.

NOAA had operated meteorological satellites for 14 years, developing the ability to process, disseminate, and archive "enormous qualities" of satellite-generated data for users who need it for decision making. NOAA would also have to determine not only the data requirements of various sectors of society but also how quickly the information was needed and in what format. NOAA would hold a series of regional meetings with users of satellite data to develop a system meeting their needs. (NOAA Release 80-48)

April 7 NASA reported a further development in its ongoing work with the St. Regis Paper Company in New York: an arrangement under which the initiating company would share the cost of satellite data gathering, but the technology developed would be available to all other timber companies. In 1977 St. Regis had begun a test program with NASA to see if Landsat data could improve the company's data base on forest lands; it wanted to use the information to plan timber harvesting, leasing and buying new timber lands, and monitoring more than 2.3 million acres across the southern United States [see *A&A77,* Oct 25]. The success of the project led to the authorization by St. Regis Southern Timberland Division in Florida of more than $300,000 new capital investment for an information system using Landsat data to support its general operations.

St. Regis was the first private company to participate in NASA's test program on resource-observation applications. The program began a unique relationship between NASA and the private sector, because St. Regis (not NASA) initiated the project and the company shared in the cost. NASA said that the entire forest industry would gain by the venture because technology from the St. Regis experiment would be in the public domain, available to other firms. NASA and St. Regis planned to conduct a symposium in 1981 to demonstrate Landsat data interpretation to timber industry management. The program was managed by JSC and Purdue University's Laboratory for Applications of Remote Sensing, as well as by St. Regis. (NASA Release 80-44)

• INTELSAT announced that its "assembly of parties" in Florida last week had agreed to technical and economic coordination of the proposed Arabsat communications satellite system, as Arabsat would lack significant economic impact on, and would be technically compatible with, the INTELSAT system. It would be the third regional system coordinated with INTELSAT; others were the European and Indonesian systems. (INTELSAT Release 80-06-I)

April 9: The Soviet Union launched *Soyuz 35* [see *During April;* Appendix A].

• *Aerospace Daily* carried a chart showing Carter administration cuts in federal R&D funding for FY80 and FY81. The DOD would absorb 21% of all cuts but would retain 46.6% of the remaining federal R&D funds. NASA would take 20.8% of the cuts and get 15.4% of the revised total. The cuts would have a bigger impact at NASA (3.9% of the agency's budget) than at DOD (1.3%), the report pointed out. (*A/D,* Apr 9/80, 222)

• INTELSAT announced that it had awarded Ohio State University a $150,000 contract for a rain measurement study that might improve satellite transmission quality in regions with heavy rain. Satellite signals above the 10-GHz frequency would be weakened when sent through rain; the study would help INTELSAT determine how much extra power a satellite would need to compensate for rain effects. Having two stations a few miles apart in heavy-rainfall areas would permit use of the station with better weather during stormy times. The study would send radar signals into rainclouds and measure the return signal to find the rain's effect on signal strength. (INTELSAT Release 80-07-I)

April 14: NASA reported that it was studying options for restructuring the Landsat D project because of persistent engineering and management problems in manufacturing the spacecraft instruments and ground systems. Fourth and most advanced of NASA's experimental Earth-resources monitoring spacecraft, Landsat D was designed to carry an advanced scanner called a thematic mapper, to provide Earth images in more spectral bands and with twice the resolution (30 meters) of earlier Landsats. Hughes Aircraft problems with the mapper resulted in increased cost estimates and delivery delays. Mission-system contractor General Electric was also having problems and had projected schedule delays that would increase costs of both the flight system and the ground system it was building for Landsat D. Both sets of problems would effect Landsat D's launch schedule, increasing the risk of a gap in data for present users. *Landsat 3,* launched in March 1978, was still operating but had had problems with its sensor, a multispectral scanner that collected data for conversion to images of Earth's natural resources.

NASA was considering three possibilities: launch Landsat D as soon as possible with a thematic mapper and a multispectral scanner like that carried on *Landsat 3;* launch Landsat D as soon as possible with only a multispectral scanner, following as soon as possible with another Landsat carrying the thematic mapper and a multispectral scanner; or launch Landsat D with Landsat D Prime (the backup) each carrying only a multispectral scanner. The decision weighing budget constraints against providing an ongoing Landsat data capability should take weeks, NASA said, including consultations with NOAA, which President Carter had designated to manage a follow-on remote-sensing satellite system. (NASA Release 80-46)

• JSC announced the award of a $63,640,000 cost-plus-fixed-fee contract to Canadian Commercial Corporation, Hull, Quebec, for production of three remote-manipulator systems for the Shuttle. The system, a 50-foot jointed arm, would be operable from inside the crew compartment to deploy or retrieve payloads in space. Under a 1975 agreement between NASA and Canada's National Research Council, Canada would develop the first flight unit of the remote manipulator and provide it free to NASA; NASA would buy additional systems from Canada as necessary. (JSC Release 80-023; NASA Release 80-47)

April 15: NASA reported successful testing April 14 of a Space Shuttle main engine at 109% of rated power for six minutes, in the second such test in two weeks conducted by Rockwell International at NSTL. The 10-minute, 10-second test met all objectives; NASA said that it planned at least one more firing in this series on this engine, which had accumulated 183 minutes of firing time in two series of preliminary flight-certification tests. (NASA Release 80-49; MSFC Release 80-55)

• MSFC said several companies had proposed definition studies to demonstrate performance of a large space antenna in low Earth orbit. Wide use of such a system could revolutionize satellite communications and radar and radiometry. Large space antennas might solve problems preventing expansion of satellite communications, Earth-resources survey, weather research, and other services. Dozens of small satellites, each with its own antennas, were now providing such services, but their growing number had crowded the transmission frequencies and filled up the orbital slots. The MSFC study would define the structure of a large antenna as well as packaging, transportation, and orbital deployment. (MSFC Release 80-54; NASA Release 80-48)

• INTELSAT announced that Niger on April 14 had become the 103rd nation to join the organization. Niger was already linked to the INTELSAT system through a ground station at Niamey that operated with an Intelsat IV-A satellite over the Indian Ocean. (INTELSAT Release 80-08-I)

April 16: NASA reported shutdown of a planned 10-minute test of the Shuttle main-engine cluster after about six seconds; probable cause was overheating in a high-pressure fuel turbopump of engine no. 2 of the three-engine cluster. Test stand and engines were apparently undamaged. Had all gone well, each engine would have shut down at a different time: engine no. 1 was scheduled to fire for 8 minutes (480 seconds), no. 2 (which shut down after 4.71 seconds) for 565 seconds, and no. 3 for 591 seconds. Evaluation of test data was under way at NSTL to find the cause of the overheating. (NASA Release 80-50)

April 17: The *Washington Post* reported that a U.S. Air Force estimate of the cost of building a West Coast launch pad for the Shuttle was $82 million short. Less than 3 years ago, the estimate was $118 million for a Vandenberg Air Force Base pad to launch polar-orbiting (as opposed to equatorial-orbiting) satellites. Military satellites used a polar orbit to cover the globe as it rotates; spacecraft could not use the Florida facility for launches into polar orbit because of the danger of coming down on land in case of a mishap. First phase of the Vandenberg program (excavation of the area where the launch pad would be built) was complete, the U.S. Air Force said, but bids for the second phase ranged from $103.9 to $112 million instead of the $79.6 million U.S. Air Force had estimated. Bidders said inflation caused the higher bids, especially the price of assembled electrical equipment and copper cable. U.S. Air Force could ask permission of Congress to reprogram funds from other construction projects to the Vandenberg construction. (*W Post,* Apr 17/80, A-14)

April 18: LaRC said that NASA had awarded three major U.S. manufacturers contracts for 14.5-month studies of advanced supersonic transport aircraft. Boeing Company, Lockheed California, and McDonnell Douglas, each received a $1.15 million contract to work in the same discipline, but each on its own concept. Boeing's was a 270-passenger delta-wing, cruise speed Mach 2.4; Douglas's was an arrow-wing carrying 225-500 passengers, cruise speed Mach 2.2; Lockheed's was an arrow-wing carrying 290 passengers, cruise speed Mach 2.5.

Each firm would broaden its research in aerodynamics, lightweight titanium and composite-material structures, and variable-cycle engines for subsonic and supersonic operation. Past studies by these contractors on reducing fuel consumption and noise and on economic considerations needed updating. LaRC would manage the work at the contractors' facilities. (LaRC Release 80-29; NASA Release 80-51)

• WFC awarded a $1.239 million fixed-price noncompetitive contract to Automation Industries, Inc., a Vitro subsidiary, for a mobile C-band instrumentation radar system to replace an existing MPS-19 radar, updating WFC's tracking capabilities. (WFC Release 80-3)

• LaRC said that it would close the Environmental-Quality Projects Office (EQPO) set up in 1972 to lead NASA's programs in that area and would turn over future work to the Office of Space and Terrestrial Applications at NASA Headquarters. LaRC was chosen for its experience in remote-sensing research and in developing advanced instrumentation. Other centers worked on particular problems: JSC, Earth-resources study; GSFC, meteorological research; and ARC, aircraft flight problems. EQPO head John Mugler said LaRC's leadership had helped that center build a growing atmosphere and water-quality program. (LaRC Release 80-28)

April 19: The *New York Times* and *Aerospace Daily* said the Soviet Union tested a "killer satellite" in space, ending a two-year gap in testing antisatellite weapons. (A killer satellite is an orbiting vehicle designed to wreck other satellites by hitting them in direct collision or exploding nearby, or by directing a force such as a laser beam against them.) *Cosmos 1174,* launched from Tyuratam April 18, apparently neared its target (*Cosmos 1171,* launched from Plesetsk April 3) on its first orbit and exploded. Sources said the test was a failure.

The Soviet Union first tested an antisatellite weapon (ASAT) in 1963 and apparently was successful in destroying targets at altitudes up to 150 miles. The Soviet tests aroused concern because of U.S. dependence on satellites for a number of military uses: reconnaissance, communications, and early warning of attack. Though many U.S. satellites orbit 20,000 miles or more from Earth's surface, many systems for reconnaissance and electronic intelligence might be vulnerable. In 1978 Defense Secretary Harold Brown announced that the Soviet Union had an operational ASAT capability; after launching a killer satellite in May of that year, it had suspended tests when talks began on controlling such weapons. U.S. sources said Moscow stopped the tests as proof of its interest in a treaty to limit strategic bombers and missiles. A treaty was signed, but President Carter asked the U.S. Senate earlier this year to hold off action because of Soviet intervention in Afghanistan. Talks on limiting ASATs was also suspended.

A U.S. antisatellite system in preparation but not expected before 1982— the Vought miniature homing craft carrying a heat-seeking guidance unit—was a small rocket for launch from high-altitude aircraft. The DOD was also working on a laser-powered system for possible deployment in the 1990s. With talks on limiting ASATs now suspended, and the outlook for arms control increasingly bleak, officials said the Soviet Union might have decided to revive its space weapons program. Any agreement in the near future was said to be unlikely. (*NY Times,* Apr 19/80, 28; *A/D,* Apr 21/80, 280)

April 21: NASA reported "highly successful" completion of a third static test on a Space Shuttle main engine at NSTL April 19, last of a series simulating power levels necessary to abort at full power in a Shuttle launch. Previous tests were on March 31 and April 14. The engine used (2004) was fired for

10 minutes, 10 seconds with 6 minutes at the 109% power level; this engine had a total firing time of 12,911 seconds (3.58 hours), equivalent to about 25 Shuttle flights. It would now undergo preliminary flight certification tests, 13 static firings at 102% of rated power level. (NASA Release 80-55; MSFC Release 80-58)

April 22: Aerospace Daily reported that malfunction of a portable life-support system caused a flash fire April 18 at JSC in which Robert Mayfield (employed by the contractor, Hamilton Standard Division, United Technologies) was hospitalized with second-degree burns. The system included two tanks of oxygen pressurized at 3,000 pounds per square inch. The fire started during a performance test when a regulator was switched to the extravehicular activity mode. Extensive damage occurred to a test spacesuit and the life-support system as well as the cleanroom at JSC's crew systems laboratory. Mayfield was reported in stable condition April 20. JSC had appointed a board to investigate the accident. (*A/D,* Apr 22/80, 289)

—*Aerospace Daily* reported an Aerospace Corporation study for the U.S. Air Force on the risk that a large active satellite might collide with debris from inactive satellites or launchers. Probability of collision for a large satellite on a 1,000-day mission in low orbit (500 to 1,500 kilometers up) was high because of the great concentration of debris at those altitudes. As the objects were moving in different directions, velocity for any satellite would be at a maximum. Collision in synchronous orbit was less likely to the extent that the objects were all moving in the same direction; however, debris in those orbits tended to collect at certain points because of Earth's gravity. (*A/D,* Apr 22/80, 294)

• The *Washington Star* said that the FCC would call for restructuring of ComSatCorp to differentiate between its regulated and its competitive activities. ComSatCorp, now sole U.S. representative in two global satellite communications systems, would have to put all its competitive operations, including research and development, into a separate subsidiary.

Restructuring would answer complaints that ComSatCorp, a congressional creation, could use its unique monopoly status in global communications systems to is advantage in highly competitive ventures it is considering. With two other major companies, it was starting a long-distance telephone system to compete with AT&T; it also had considered a satellite-to-home subscription television service to compete with the three major television networks [see April 8].

ComSatCorp already had a subsidiary, Comsat General, that handled its competitive activities; the FCC said that a sharper separation was necessary between the two: Comsat Laboratories and other research and development, for instance, should be put into the subsidiary to avoid the possibility of cross subsidies. A newly purchased environmental monitoring firm, Environmental Research & Technologies Inc., would have to be in the subsidiary, FCC said.

The parent company would include only those activities relating to INTELSAT and INMARSAT (International Maritime Satellite Organization), international systems in which ComSatCorp acts as U.S. representative. (*W Star*, Apr 22/80, C-6; *W Post*, Apr 23/80, B-1; ComSatCorp Releases 80-22, 80-23, 80-24, 80-25)

April 23: NASA announced award of a $70,072 million contract to McDonnell Douglas for Delta expendable launch vehicle services. The company would continue for 2 years the launch services work it had done for the past 18 years, including mission-peculiar vehicle changes, checkout, and launch. KSC would supervise the work at ESMC and Vandenberg Air Force Base for GSFC, which had overall Delta management responsibility. (NASA Release 80-53)

April 24: The Department of Commerce (DOC) reported that more than 700 representatives of business firms, trade associations, educational institutions, and state and local government agencies had responded to NOAA's request for assistance in developing a national civil operational land remote-sensing satellite system.

At March meetings in Seattle, Chicago, Tallahassee, Washington, D.C., and Albuquerque, NOAA satellite managers received many suggestions for using such a system in food production, mineral exploration, land-use planning, resource assessment and management, and environmental protection. Wilbur H. Eskite, Jr., of NOAA's task force, who chaired the meetings, said that interest in an operational system offering a continuity of data within specific timeframes was "larger than we had believed" before the meetings [see April 6].

Questions raised at the meetings that would require policy decisions included what instruments to carry into orbit, their capabilities, how quickly and in what form users should receive the data, and whether education and government agencies should pay the same fees for data as profit-making companies. The White House made NOAA responsible last November for moving to an operational program of satellite remote sensing. (NOAA Release 80-55)

April 25: NASA announced selection of 26 scientific investigations for possible inclusion on upper-atmosphere research missions in the late 1980s. Congress had not approved the program, but early solicitation of participants and experiments would allow prompt start when approved. U.S. researchers had suggested 23 of the investigations, the United Kingdom, 2, and France, 1. The chosen ideas, selected from 75 proposals, included 16 experimental and 10 theoretical investigations. U.S. investigators were from 8 universities, 6 government laboratories, and two private organizations. Cost to the United States of the initial study phase would be about $5 million over two years. (NASA Release 80-56)

• The last of six science workshops sponsored by NASA's exobiology program on the origin of life was at Rockefeller University April 25. An extensive report on the series would be available before the end of 1980. A press conference with workshop cochairman Professors Philip Morrison (MIT) and Melvin Calvin (UCB) and workshop host Dr. Joshua Lederberg, president of Rockefeller University, was followed by a public symposium with lectures and presentation of findings by Lederberg. (*NASA Actv Rpt,* May 5/80, 2)

April 29: NASA reported that France and West Germany signed an intergovernmental agreement today for joint development of a direct-broadcast television satellite to be launched on Ariane late in 1983. The two nations would split the cost of the initial three-satellite system, estimated at $250-$300 million. The sponsors said major return on the investment would come from sales of 15 to 20 such television satellite systems over the next 10 years to third parties such as Scandinavia's Nordsat, Radio Luxembourg's Luxsat, and People's Republic of China. ESA would continue definition work on LSat, a parallel television-satellite effort without French and German participation. (*NASA Actv Rpt,* May 1/80)

• *Aerospace Daily* reported that the Soviet Union today launched *Cosmos 1176,* possibly the first nuclear-powered ocean-surveillance satellite since radioactive fragments of *Cosmos 954* crashed into Canada in January 1978. Orbit parameters were 265-kilometer apogee, 260-kilometer perigee, 89.6-minute period, and 65° inclination. Until the 1978 incident, the Soviet Union had routinely used radar-carrying satellites powered by nuclear sources traveling in pairs in similar orbits to detect ships; at end of mission, the nuclear source would be propelled into higher orbit to decay in outer space, but *Cosmos 954* had malfunctioned. (*A/D,* Apr 30/80, 338)

April 30: The *Washington Post* reported that AT&T would launch and operate its own satellites for use with its domestic satellite communications system. The firm filed with the FCC a plan to launch three satellites—one each in 1983, 1984, and 1986—to replace three Comsat satellites it had been leasing from Comsat General Corporation (a subsidiary of ComSatCorp). It would use its satellites to provide long-distance telephone service and specialized business services for 10 years in the continental United States, Alaska, Hawaii, Puerto Rico, and the U.S. Virgin Islands. Each satellite would be able to handle up to 21,600 simultaneous telephone conversations. (*W Post,* Apr 30/80, B-4)

During April: NASA announced appointment of Robert E. Smylie, deputy director of GSFC since December 1976 and acting director from June 1979 to February 1980, as Headquarters associate administrator for space tracking and data systems. He had joined NASA in 1962 at JSC, where he worked in various positions until assigned to Headquarters in 1973 as deputy associate administrator for aeronautics and space technology. He was previously employed by Douglas Aircraft Company. (NASA anno Apr 2/80; NASA Release 80-41)

• The AFSC *Newsreview* reported on tests in Arnold Engineering Development Center wind tunnels of insulating materials for NASA to use on the Shuttle's external tanks. One or more of these materials would cover the tanks carrying cryogenic propellants for the orbiter's main engines, to protect against liquid-hydrogen temperatures of -420°F and liquid-oxygen temperatures of -295°F, and to prevent ice buildup on the tanks before launch.

Although insulation would minimize the icing problem, NASA's concern was that at launch chunks of material might break off where it protected attachment brackets. Lumps the size of a sugar cube could damage the thousands of fragile heat-shield tiles designed to protect the orbiter from overheating. Tests showed that the material would not fragment if streamlined shapes were used ahead of the brackets. (AFSC *Newsreview,* Apr 80, 7)

• The *Washington Star* reported that the American Newspaper Publishers Association (ANPA) approved a proposed system of satellite communications between wire services and newspapers. A joint task force representing ANPA, UPI, and Associated Press (AP) conducted a two-year study of economic, technical, legal, and regulatory aspects of such a system. (*W Star,* Apr 22/80, C-6)

• The NAA newsletter paid tribute to former Senator A.S. Mike Monroney (D-Okla.), who died February 13 at the age of 77. Known as "Mr. Aviation" during his 30-year tenure in Congress, he was president of NAA 1970-1972. Longtime chairman of the Senate subcommittee on aviation, he introduced the 1955 Federal Airport Act promoting civil aviation, which led to establishment of the FAA. He received in 1961 the Wright Brothers memorial trophy for service to aviation, and the first Collier award for distinguished congressional service. (NAA newsletter Mar-Apr 80, 4)

• The British Interplanetary Society's *Spaceflight* announced that Skylark 12, a rocket launched from Natal, Brazil, by British Aerospace, reached a record altitude of 834 kilometers (*SF,* Apr 4/80, 177)

Spaceflight reported a discovery by USSR scientists that the lunar regolith (the dust covering the Moon's surface) contained nonoxidized iron. Lunar samples proved to be corrosion resistant when exposed to terrestrial atmosphere. The finding, registered at the USSR Committee for Inventions and Discoveries, was confirmed at other USSR and U.S. laboratories. This unusual form of element resulted from the action of the solar wind on the Moon's surface, said Dr. Valery Barsukov, director of the Institute of Geochemistry. Particles from the solar wind "seize the oxygen of the lunar matter and carry it away into space," leaving pure metal on the lunar surface.

The iron had not oxidized during the eight years since the *Luna 16* expedition. (*SF*, Apr 4/80, 164)

• The Soviet Union launched *Soyuz 35* at 1638 hours Moscow time April 9 from the Baykonur site into an orbit with 346-kilometer apogee, 336-kilometer perigee, 91.3-minute period, and 51.6° inclination. Headed for a linkup with the obiting station *Salyut 6* were two cosmonauts, engineer Valery Ryumin, 40, who spent 175 days there last year, and rookie Lt. Col. Leonid Popov, 34, a former jet fighter pilot.

The cargo carrier *Progress 8* launched March 27 had automatically docked March 29 with *Salyut 6*, which used the Progress engine to adjust its orbit. The supply ship was still docked to Salyut, waiting for the new arrivals to unload it, *Salyut 6*, launched September 29, 1977, had been in orbit for more than 30 months; when the *Soyuz 35* crew docked with it at 6:16 p.m. Moscow time April 10, Ryumin said in a telecast "Look, the station is absolutely in the same condition as we left it." Tass said the crew would clean, repair, and restock the station and resume research on medical and biological effects of long-term spaceflight. The Soviet television program said that Ryumin was a last-minute choice for this flight, apparently taken from a backup crew to replace an unidentified flight engineer who "had trouble during his physical exercises."

First task was to turn on station systems: lights, air and water regeneration, communications, and control desk, all of which had been off for seven months while *Salyut 6* was unmanned. The crew began April 11 to unload *Progress 8* and activate systems and instruments including plant-life installations Oaziz, Vazon, and Malakhit, the latter an orchid-growing greenhouse the crew had brought with them on *Soyuz 35*. Ground control said that observing growth of the orchids would encourage "good spirits" in the crew.

By April 15 the crew had dismantled and replaced apparatus that had worn out, putting the used equipment into the freight compartment of *Progress 8*. They had installed new storage batteries and replaced solar batteries in the attitude-control system and parts in the water-regeneration system. They had also prepared to refuel the propulsion unit. At the end of their first week, Dr. Anatoly Yegorov said that the cosmonauts were adapting "more quickly than expected" and were working ahead of schedule, "the most convincing proof of their physical wellbeing."

[Nature magazine reported speculation that Ryumin's return flight meant the Soviet Union might be preparing for a manned mission to Mars. "Classical" Soviet projects for space exploration, following the lead of Tsiolkovsky, assumed the establishment of a permanent orbital station staffed by "several tens" of male and female crew and scientists for several months at a time; lunar and planetary exploration, for this century at least, would be left to automatic vehicles. However, Soviet experts had shown considerable interest in biological effects of long-term spaceflight; they had found "no significant organic changes" that might limit the duration of future flights. Sending

Ryumin aloft again after his record 175-day flight (which *Nature* called "serendipitous") should have especially interesting results. *Nature* quoted a Tass report that Ryumin was included at the last minute when "Flight Engineer Lebedev" hurt his leg.]

By April 22 the crew had almost finished unloading the freighter and had refueled the joint propulsion plant, preparatory to filling the station with oxidizer. Dr. Konstantin Feoktistov said that the most productive period of cosmonauts in space would begin one month to six weeks after a mission started; the *Soyuz 35* crew had been doing repair and fault-prevention work so far, but had also begun to resume experiments. They used *Progress 8*'s propulsion unit for another orbit adjustment April 24. On April 25 they separated the freighter from the Salyut-Soyuz complex; on April 26 they ignited the propulsion unit at 9:54 Moscow time to put it into a descent trajectory over the Pacific Ocean, where it "ceased to exist." On April 27 the Soviet Union launched *Progress 9* at 9:24 p.m. Moscow time; it docked with the Soyuz-Salyut complex at 11:09 a.m. April 29, bringing more apparatus and equipment, materials for the life-support systems, additional fuel, and mail for the cosmonauts. As usual, the report ended with the statement that the cosmonauts were "feeling fine." (Tass in English, Apr 3-29/80; Moscow Dom Svc in Russian, Apr 3-29/80; *W Post,* Apr 10/80, A-18; *W Star,* Apr 10/80, A-15; Apr 12/80, A-10; *NY Times,* Apr 11/80, D-15; *Nature,* Apr 17/80, 585)

May

May 1: Changes made during the past year to the three main engines designated for the first flight of Space Shuttle orbiter Columbia had led NASA to set up further tests, the agency announced. Modifications included high-pressure turbopumps, valves, and nozzles. Acceptance-tested between April and July 1979, the engines would be shipped from KSC to NSTL in Mississippi for reacceptance firing and return to KSC. The two- to three-month testing would not affect the timing of the first flight, now scheduled for a date between November 1980 and March 1981. About 6 weeks before the planned launch, the engines would be fired again for 20 seconds on the launch pad. (NASA Release 80-60; JSC Release 80-030)

• JSC reported signing a noncompetitive $12.931 million contract with the Charles Stark Draper Laboratory for development of Shuttle avionics software. Draper would perform most of the work under the 21-month contract at Cambridge, Mass. (JSC Release 80-029)

May 2: Further press comment on the USSR launch April 29 of *Cosmos 1176* included a *Washington Post* speculation that the United States might deplore the nuclear-powered vehicle for more reasons than its deterrent effect on United Nations negotiations.

Recalling the aborted attempt April 24-25 to rescue U.S. hostages in the Tehran embassy, the *Washington Post* noted that the *Cosmos 1176* launch came only four days later. Just before it began the rescue attempt, the U.S. aircraft carrier Nimitz "sped away from a Soviet spy ship that had been trailing it, and apparently was able to launch the rescue helicopters on their secret mission without notice." Satellites spying with radar needed nuclear sources for the necessary power; solar cells, e.g., could not produce enough electricity. The new satellite "passing daily over the Indian Ocean and Middle East. . . may well be meant to keep the Kremlin from being surprised again by providing radar surveillance of the U.S. fleet," the *Washington Post* said.

The *Washington Star* cited the January 1978 breakup of *Cosmos 954* that scattered radioactive debris across a remote region of Canada; one expert suggested that the Soviet Union might have solved the problem causing the Canada crash or might have developed a new nonnuclear power source for the new satellite's radar. However, U.S. officials were "virtually certain" that the new satellite was, like those in the *Cosmos 954* series, powered by radioactive thermal generators creating heat that turned turbines to produce electricity. The United States had already detected radar emissions from *Cosmos 1176,* indicating that it was looking for U.S. and other ships. Its radar was 90% able to detect objects the size of aircraft carriers, 50% cruisers, and 30% frigates. Soviet leader Leonid Brezhnev had revealed that such satellites carried about 1001 pounds of uranium; after about 75 days, they were supposed to be rocketed to 500-mile-altitude orbits where they would remain for about 100 years, or until the materials were no longer dangerous. (*W Post,* May 2/80, A-6; *W Star,* May 2/80, A-1)

May 4: The U.S. Coast Guard signed an agreement with NASA April 29 for work leading to an operational lighter-than-air machine that might constitute a fleet of blimps by the early 1990s, according to the *New York Times.* Coordinating the two agencies' research would reduce costs: NASA scientists had been studying use of lighter-than-air craft to lift heavy equipment and would now work on developing stronger synthetics and better adhesives for the blimp bag, more sophisticated electronics, and more automated procedures for ground handling to do away with the need for large ground crews.

Lt. Cdr. Kenneth Williams, chief of the Coast Guard technology branch, said that they sought a vehicle for use in "search and rescue, law enforcement, and other patrol functions." The Navy had abandoned its airship program in the early 1960s because fuel was cheap; it "costs a heck of a lot more today," Williams said, and a Coast Guard-Navy study had found fuel-efficient airships operationally and technically feasible for maritime patrol work in combination with cutters and conventional aircraft. (*NY Times,* May 4/80, 56)

May 6: NASA announced that a JPL scientist, Dr. Stephen P. Synnott of the Voyager optical navigation team, had discovered a 15th moon of Jupiter from *Voyager 1* photos taken in March 1979. Checking March photos to confirm the discovery of another satellite (1979 J1) in October 1979 photos taken by *Voyager 2,* Synnott detected an unexplained shadow on the planet that, once recognized, was evident on seven earlier images. The new satellite, labeled 1979 J2, had a 16-hour orbit around Jupiter between moons Amalthea and Io; 1979 J1 had a 7-hour orbit. (NASA Release 80-61; JPL Release 930)

• INTELSAT announced that Honduras had become its 104th member. In a ceremony at the U.S. State Department Roberto Nunez Montes, general manager of HONDUTEL (Empresa Hondurena de Telecomunicaciones) signed the operating agreement. Honduras already was a user of the INTELSAT system through ground stations in neighboring countries. (INTELSAT Release 80-09-I)

May 7: NASA announced selection of two firms, McDonnell Douglas and TRW, to receive parallel $1 million one-year contracts for design-definition studies of 25-kilowatt power systems for the STS. The power systems, using solar energy to support large payloads left in orbit, would be placed in a fixed orbit by the Space Shuttle to provide electric power, heat rejection, attitude control, communications, and data handling for a variety of payloads freeing the Shuttle from extended time in orbit and reducing payload cost per day in orbit. MSFC would manage the study contracts and any follow-on development flight system. (NASA Release 80-63)

May 8: NASA announced that it and the ESA had selected 37 scientific experiments for the first flight of Spacelab, scheduled for launch on the Space Shuttle late in 1982. The experiments were in five categories: atmospheric physics and Earth observation; space plasma physics; material sciences and technology; astronomy and solar physics; and life science. NASA would sponsor 13 of the 37; ESA (a consortium of 11 nations), the others.

Deferred for assignment to later flights were three NASA experiments and a major ESA facility; the factor preventing selection of all the experiments was mass. Each agency would be allowed to fly 1,392 kilograms (3,062 pounds) of equipment on the mission. Unlike Skylab, Spacelab would not be left unattended in space; it would remain in the Shuttle and be returned to Earth for use in another mission. (NASA Release 80-62; MSFC Release 80-66; ESA Info 9)

May 9: JSC announced NASA selection of two California aerospace firms to negotiate contracts for production of solar cells as a supplemental power source for the Space Shuttle orbiter. Applied Solar Energy Corporation and Spectrolab would each receive a $300,000 contract to develop a large-area low-cost solar cell for NASA's proposed power-extension package, to be produced at the rate of 144,000 space-qualified solar cells per year, reducing the cost to $30 per watt. (Solar cells now cost from $80 to $120 per watt.) The power-extension item would be a 2,000-pound package folded into the orbiter cargo bay; in orbit, the item would be moved out by a remote mechanical arm, the 177-foot wings unfolding to supply the Shuttle with 26 kilowatts of electric power. (JSC Release 80-032)

• The Naval Research Laboratory (NRL) reported that a team of its scientists was working on a solar-ultraviolet (UV) spectral irradiance monitor (SUSIM) for use on the Space Shuttle to study long-term variations in solar flux for more accurate monitoring of UV radiation from the solar chromosphere and corona. Solar radiation in the wavelengths under study control many photochemical processes in Earth's atmosphere at altitudes below 100 kilometers; variations in the radiation may alter the composition of the lower atmosphere, affecting the lifetime of pollutants and ion density in the D region. The Navy also considered the D region of the atmosphere important because of its direct effect on communications systems.

The principal investigator, Dr. Guenter E. Brueckner, said that measurements by conventional methods in the 120- to 400-nanometer wavelength range were not accurate enough for scientists to define values for solar-flux variations over time. The monitor would travel as a solar sensor on an early orbiter flight; the spacecraft pilot would use its real-time data to point directly at the Sun in order to monitor the entire solar disk and measure variation of its intensity with solar activity. Brueckner's team consisted of three scientists—Michael E. VanHoosier, Dr. Dianne K. Prinz, and Dr. John-David F. Bartoe—developing and testing the SUSIM for Shuttle flight. Both Prinz and Bartoe had passed mental and physical tests for astronaut-scientists and had been chosen to make a Shuttle flight; one of them might obtain firsthand data on solar activity by actually using monitor on a Shuttle flight. (NRL Release 20-5-80C)

May 12: NASA reported that the National Archives had formally accepted its records of the 1967 Apollo 204 spacecraft fire, to be retained permanently for use by scholars studying the space program in general and the failure and subsequent redesign of the spacecraft. (*NASA Actv Rpt* May 12/80)

• JSC reported that parts of the remote-manipulator system (the robot crane that would handle inflight transfer of Space Shuttle cargo) were being tested in its Shuttle avionics integration laboratory. The system would be used on the Shuttle beginning with the second flight to place or retrieve satellites in space, to assemble structures or components, or if necessary to rescue crews by transferring them to another vehicle.

The manipulator was a 50-foot arm with movable joints at the shoulder, elbow, and wrist; associated motors, gears,and sensors; and an end-effector serving as an ingenious hand. The test parts were a display and control panel, rotational and translational hand controllers, and an interface unit for manipulator control belonging to the electrical subsystem. The arm and its movement would be simulated by computers in the lab.

In the tests, engineers and technicians from NASA and the contractor Space Aerospace, astronauts, and representatives of the Canadian Research Council would try to duplicate events to be encountered while operating the space crane in orbit. Astronauts Drs. Sally Ride, Judy Resnick, Norm Thagard, and Story Musgrave would controls arm movement by using the hand controllers in a mockup of the orbiter's aft station. System operators would watch a computer-generated television scene duplicating the view the crew would have out of the cockpit aft window.

The difficulty would come in operating the arm with the dynamics induced by arm movement: in the weightlessness of space, once a mass (the arm and its load) were moved, it would keep going until stopped by an equal and opposite force. When a command moved the arm, the control system had to be ready to command a counteracting move. Also, the orbiter would move in response to the arm, and vice versa. Interaction between arm and orbiter controls must be explored before flight; the simulations in this investigation were among the most sophisticated ever attempted at JSC. (JSC Release 80-034)

• In the first transcontinental balloon trip, a father-son team landed the 75-foot-tall helium-filled Kitty Hawk on Canada's Gaspe peninsula at 7:27

EDT after a May 8 liftoff in San Francisco, Calif. Maxie Anderson, 48, and his son Kris, 23, of Albuquerque, N.M., had planned to land in Kitty Hawk, N.C., but were blown by brisk winds toward Maine and Canada. They had met with bad weather beginning with strong winds, rain, and snowstorms over Wyoming. Despite their failure to land at Kitty Hawk, the team set distance records: a previous balloon record was set last year by a 2,002-mile flight that ended in a snowstorm in Ohio. The Andersons on May 11 had gone 2,417 miles.

In August 1978 Maxie Anderson and two companions had crossed the Atlantic in 137 hours in the balloon Double Eagle II from Presque Isle, Maine, to Paris. The *Washington Star* said in a May 21 editorial: "Mr. Anderson says he has no plans for further record-breaking trips, but refuse to believe it. There's the Pacific Ocean just waiting to yield to helium and human dexterity." During a visit to North Carolina the week after the flight, Anderson was inducted into the Man Will Never Fly society, a group with the motto "Birds Fly; Men Drink." The society's Dr. Ed North said it had awarded Anderson and his son memberships without knowing whether they were drinkers. "They missed their landing site by over a thousand miles," North said, "so I just assumed that they were." (*W Star,* May 12/80, A-1; May 20/80, A-2; May 21/80, A-12)

May 13: NASA declared the mission of *Heao 3* successful in its prelaunch objectives. Launched September 29, 1979, the satellite had in its first six months of operation made a full gamma-ray sky survey and detected a wide range of cosmic-ray elements. Dr. Thomas A. Mutch, associate administrator for space science, said *Heao 3* should "continue to provide excellent scientific data." (NASA MOR S-382-79-03 [postlaunch] May 13/80)

• NASA announced plans to launch NOAA-B on or about May 21 from WTR on an Atlas F. A third-generation environmental-monitoring spacecraft operated by NOAA for the National Operational Environmental Satellite System (NOESS), NOAA-B would join NOAA-A (*Noaa 6*) in acquiring quantitative data as input for GARP (the Global Atmospheric Research Program). Known as the "TIROS twins," the NOAA satellites would be the only civilian operational spacecraft whose orbits cover the polar regions. (NASA MOR E-615-80-02 [prelaunch] May 13/80; DOC Release NOAA 80-67)

• NASA reported that it would negotiate with the National Science Teachers Association (NSTA) to run the student involvement project, a nationwide yearly competition among secondary-school students for scientific and engineering experiments to fly on the Shuttle on a space-available basis. The NSTA would manage the competition to the point of selecting 10 finalists from 20 semifinalists in each of 10 regions; NASA would decide whether to fly a particular experiment.

Dr. Robert A. Frosch, NASA administrator, noting "The vitality of NASA depends heavily on an infusion of fresh ideas," said the student connection would be important to the agency program. NASA held a similar competition before the Skylab mission in 1973; it was also considering a program to involve college students. (NASA Release 80-65)

• MSFC announced that the second round of acceptance tests declared necessary for Columbia's main engines because of modifications on them since acceptance [see May 1] would consist of a single 520-second static firing of each engine. No. 2007 was mounted in test stand A-2 for firing late in May; no. 2006 would be tested on stand A-1 in mid-June; and no. 2005, on stand A-2 in late June. (MSFC Release 80-67; JSC Release 80-036; NASA Release 80-68)

• JSC said that it had selected Barrios and Associates for negotiations leading to award of a cost-plus-award-fee contract for flight-design support services to operational flights of the Shuttle. Cost of the first two years of a planned five-year program (June 80 through May 82) would be $1.9 million. (JSC Release 80-035)

• The *Washington Post* said that Pratt & Whitney division, United Technologies, had signed a pact with Rolls Royce of England to jointly develop and produce engines for AV-8B aircraft. The company said that the Pegasus engine could be worth up to $1.5 billion, $350 million of it for Pratt & Whitney. (*W Post,* May 13/80, D8)

• ESA reported that representatives from Canada, France, India, Japan, and the United States, as well as ESA, met in Ottawa May 8-9 to discuss international cooperation in remote-sensing satellite systems. ESA would host a follow-up meeting in 1981. A series of regional meetings with nations planning to use remote-sensing data would bring the needs of user states to the attention of satellite operators and would help in preparing for a 1982 United Nations conference on exploration and peaceful uses of outer space. (ESA Info 11)

May 15: NASA reported that astronomers using data from the international UV explorer were continuing to study the halo discovered around the Milky Way in early observations by the satellite. The halo material was found to be hot (about 100,000°), to extend 50,000 light-years from the galaxy, and to contain oxygen, sulfur, iron, silicon, and carbon. *Iue* launched January 26, 1978, was a joint mission of the United States, the United Kingdom, and ESA.

For most of history, visible light was the only medium for studying celestial objects, but many types of electromagnetic radiation were now available for observation: radio waves, infrared, X-ray, gamma rays, and ultraviolet rays. Earth's atmosphere blocked most of these types of energy, which must be studied through spacecraft above the atmosphere. *Iue,* in a synchronous orbit keeping it in continuous touch with either the United States or the European ground station, could be used by astronomers located either at GSFC or the Villafranca station in Spain (Vilspa) much like a ground-based telescope but observing in the ultraviolet instead of visible-light spectrum. A scientific colloquium at GSFC during May heard 92 papers on *Iue,* findings; Prof. Robert Wilson, University College London, said "there is hardly an area of modern astronomy that hasn't been affected." Scientists from 25 countries were participating, and 478 astronomers had been assigned observing time on the satellite. (NASA Release 80-67)

• NASA might decide to remove and strengthen every heat-protection tile on Columbia not already removed and treated, *Today* newspaper reported. As many as 10,000 tiles could be affected, delaying Shuttle launch by months.

Recent tests had shown weaknesses in tile faces that were glued to the Shuttle surface; NASA had removed thousands for "densification," painting the bonding surfaces to increase their sticking power. NASA was now testing 16,000 of the 30,922 tiles at points of greatest stress to see if they needed to be densified. Tiles failing the test had been removed and densified; those passing were left intact. However, NASA was now thinking of doing all the tiles as a safety measure. Installation was about 80% complete, but a decision to densify all would leave only a few thousand tiles on the ship.

Officials would not give an exact count of the number of tiles already densified; technicians gluing the tiles in the processing facility at KSC had been averaging about 700 a week. JSC structural design chief Tom Moser said that he could not predict whether all the tiles would be densified or how long it would take. (*Today,* May 15/80, 1A)

May 16: Aviation leaders from across the United States attended a banquet at the Washington Hilton, Washington, D.C., to honor Dr. Paul B. MacCready, designer of the Gossamer Condor and Gossamer Albatross, who won the Robert J. Collier trophy for the first human powered flight across the 22-mile-wide English Channel. Master of ceremonies was NBC news correspondent Peter Hackes, a fellow enthusiast of sail planing. The audience saw the film of the Channel flight and applauded the touchdown of the Albatross on the beach at Cap Gris Nez, France. MacCready accepted the trophy for himself and for the "engine" of the Albatross, cyclist Bryan Allen, who was unable to attend.

MacCready reported that NASA was negotiating to use his backup aircraft Gossamer Albatross II in tests aimed at design and operation of a remotely powered vehicle at 100,000 feet altitude. The Albatross's extremely light weight "exaggerates the apparent mass effects in stability and control, and also the effect of turbulence on wing efficiency." "These are areas heretofore unexamined and deal with phenomena never before encountered," he added. (NAA newsletter May/June 80; NAA Release May 19/80)

May 18: The People's Republic of China launched a long-range missile May 18 capable of delivering a nuclear warhead as far as Moscow or the west coast of the United States, Xinhua press agency announced. Australian navy ships reported the rocket's splashdown in the ocean about 750 miles northwest of Fiji. Diplomatic sources in Beijing said the rocket may have been fired from a complex about 1,000 miles west of there, or from the Lop Nor nuclear-arms test area in northwest China. If so, the rocket made a flight of 5,000 miles or more. (*W Star,* May 19/80, A-6; FBIS, Xinhua in English, May 23/80; Hong Kong AFP in English, May 18/80; Moscow World Svc in English; Tass in English, May 16-25/80)

May 19: AP said that NASA and DOE had awarded Boeing Aerospace a $296,000 contract to study disposal of nuclear waste (long-lived radionuclides radioactive for thousands of years) in space: whether to launch the "nuclear trash" on an unmanned rocket, or by a manned Shuttle whose crew would eject it in orbit and propel it further out; where in space to put it; how to protect it during launch and in space; and how to retrieve it in case of an abort at liftoff. (NASA Release 80-69; MSFC Release 80-69; AP in *W Post,* May 21/80, A-5)

• NASA announced that it had renewed a cost-plus-management-fee contract with the Universities Space Research Association for management and operation of the Lunar and Planetary Institute. The fee through March 31, 1982, would be $4,292,700. Work would be done at the institute, adjoining JSC in Houston.

The institute, a focal point for the lunar and planetary science community to pursue solid-body geosciences such as mineralogy, petrology, and geochemistry, was created in October 1968 in response to NASA's quest for a university consortium to work with. The association was incorporated the following March as a means for universities and other research organizations to work with each other and with NASA in space research. (NASA Release 80-73)

May 20: ESA reported that European and U.S. astronauts scheduled to fly with the first Spacelab on the ninth Shuttle flight would attend a training session May 27-30 on using an infrared-grill spectrometer to check the composition of the stratosphere to monitor the effect of human activity on its evolution.

Besides a commander and copilot of the Shuttle, the Spacelab crew would include two payload specialists (one each from ESA and the United States) and two mission specialists in charge of the interface between the Shuttle and Spacelab. Two of the five payload specialists attending the training session would be selected six months before flight: physicist Ulf Merbold of West Germany; astronomer Claude Nicollier of Switzerland; physicist Wubbo Ockels of the Netherlands; physicist Michael Lampton, University of California at Berkeley; and biomedical engineer Byron Lichtenberg, Massachusetts

Institute of Technology. NASA mission specialists attending the training session would be atmospheric physicist Owen Garriott and astronomer Robert Parker. (ESA Info 13)

May 21: Jack Anderson wrote in the *Washington Post* that the controversial B-1 bomber, "like the wondrous Phoenix of Egyptian mythology, seems about to rise from the ashes" 3 years after the President "shot it down in flames": the House Armed Services Committee had voted $600 million for B-1 research and procurement.

The committee had asked Rockwell International, "which still hopes to build the big bird," to prepare a brochure comparing the B-1 with the FB-111 preferred by the U.S. Air Force to carry cruise missiles. The *Post* said an internal Air Force report prepared for Rep. Robert Carr (D-Mich.) indicated that Rockwell had "drastically" oversold B-1 capabilities. The brochure "grossly understated the range of the FB-111" by almost 900 nautical miles, comparing it on a low-level mission with a B-1 flying at a higher, fuel-saving altitude, the U.S. Air Force noted. Rockwell also "fudged on the delivery dates it promised in the brochure" by three to four months in one case, almost a year in another. The U.S. Air Force report said that there were "many other areas that are inaccurate." (*W Post,* May 21/80, B-16)

• NASA reported that a team using Voyager data found that Saturn's period of rotation (the length of a day on that planet) was 24 minutes longer than was thought earlier. Astronomers using Earth-based observations had calculated the length of a Saturn day as 10 hours, 15 minutes but admitted that their figures lacked accuracy. The inaccuracy of the earlier measurements arose from Saturn's lack of a solid surface; viewers could see only the cloud tops of the planet, with no sharply defined features to permit accurate determination of rotation.

The two Voyager spacecraft had recorded bursts of radio noise from Saturn and other sources in the sky during January 1980. By isolating Saturn signals from those recorded from the Sun, Jupiter, and other sources, the Voyager planetary radioastronomy team found that Saturn's originated at the planet's north pole and were precisely controlled by its rotating magnetic field. (NASA Release 80-72)

May 22: NASA announced a change of date to April 1982 for completing orbital flight tests of the Shuttle. "Several factors" such as continuing engineering assessment and improvement of the thermal-protection system led to the decision. First operational flight of Columbia, now slipped from March to September 1982, would carry the tracking and data-relay satellite TDRS-A into a geosynchronous orbit. Other schedule adjustments would be discussed with users at KSC May 29-30. Changes in the manifests had been coordinated with DOD, NASA said; it would make use of Deltas during the transition to full Shuttle operations. Others set to use the Delta included Telesat of Canada, Hughes Aircraft, and Indonesia. (NASA Release 80-74; JSC Release 80-037)

May 23: The *Washington Post* reported that Summa Corporation, holding company for the late billionaire Howard Hughes's estate, would "immediately" disassemble the Spruce Goose, Hughes's 140-ton flying boat, since a last-minute public appeal for $750,000 to preserve it had failed. The Port of Long Beach, Calif., had wanted the 220-foot boat, 80-feet high with a 320-foot wingspan, to display with another transportation mammoth, the ocean liner Queen Mary. Designed to be a World War II troop carrier, the eight-engine Spruce Goose (actually made mostly of birch) had flown only once in 1947. Parts of it would go to nine museums, including the Smithsonian. (*W Post*, May 23/80, F3)

• ESA reported that the Ariane L02 launched from Guyana at 14:29 GMT had fallen into the sea. Liftoff was normal, but 7 seconds later, telemetry showed pressure fluctuations in a first-stage motor that caused the other motors to fail. The launcher self-destructed at 108 seconds. Teams evaluating the telemetry data later reported events during launch in detail; further study would be needed to find the cause of the malfunction. (ESA Release May 23, Info 15)

• LaRC said that NASA had sent an airborne-particle measurement team from WFC as far west as Missouri May 21-22 to measure dust layers resulting from the eruption of Mt. St. Helens, which had caused dense concentrations of particles in five distinct clouds in the stratosphere over the United States and Canada. The leading edge of the volcano plume (a tropospheric cloud containing the largest amount of particles) had already passed over the United States and was out to sea.

NASA had detected concentrations of from 200 to 800 particles per cubic centimeter (typical readings were only half a particle per cubic centimeter) May 21 and 22 in a stratospheric dust layer over Pennsylvania, Ohio, Illinois, and Indiana at an altitude of 13-14 kilometers (43,000-46,000 feet). Four other stratospheric dust clouds had been detected over eastern Canada, the Ohio Valley, the Great Plains, and the far west, with particle concentrations far above normal. Besides airplane and high-altitude balloon observations the week of May 19-23, scientists were waiting for a NASA satellite carrying the SAGE (stratospheric aerosol and gas experiment) to come to a point in its orbit over the United States and Canada where it could provide more detailed measurements of atmospheric profile in latitudes from 55° to 30°N before it went out of range May 28. (LaRC Release 80-42)

May 26: The Soviet Union launched *Soyuz 36* May 26 at 9:21 p.m. Moscow time (2:21 p.m. EDT) carrying a Russian commander (Valery Kubasov, 45, veteran of three space missions) and Hungarian engineer (Bertalan Farkas, 30) to the orbiting *Salyut 6* station already occupied by Leonid Popov and Valery Ryumin. (*W Star,* May 27/80, A-8)

May 27: LaRC announced that NASA had selected Rockwell International to study alternate thermal-protection systems for the Shuttle orbiter [see April 1]. The nine-month study beginning in late June would cost about $900,000. Boeing Aerospace also bid on the study. (LaRC Release 80-43; NASA Release 80-77)

May 28: The *Wall Street Journal* said that the Ariane rocket failure in its second test flight was a blow to western European development of a competitor for the U.S. Shuttle. ESA experts had not solved the mysterious engine shutdown that dropped the Ariane into the ocean after launch from Guyana [see May 23]. The difficulty seemed to be with the Ariane feature they valued most, the first-stage engine that had been fired 200 times on the ground and had worked flawlessly during test flights. The same engine had been highly reliable in the French rocket Diamant, now being phased out after years of successful use.

ESA and France (which paid 64% of Ariane expenses and had done much of the development) hoped to put Ariane into service in mid-1981, ahead of the Shuttle, which was able to orbit six times the weight of an Ariane payload and return to Earth for reuse. Shuttle problems had put NASA behind, but the *Wall Street Journal* said prolonged delay in Ariane development would have "serious consequences" for ESA. The Europeans had bid vigorously for launching assignments for Ariane because it would be available earlier as well as less expensive, but engine problems could undermine the claim. (*WSJ,* May 28/80,20)

• NASA reported that scientists were beginning to identify major features on the surface of cloud-shrouded Venus on the basis of data returned by Pioneer and had met with the working group on planetary nomenclature of the International Astronomical Union (IAU) on a policy of naming the major features for goddesses from various cultures, with minor features named for other mythical females and smaller features for famous women no longer alive. The *Washington Post* said that women's groups such as the National Organization for Women (NOW) had immediately protested "a typically male response" of naming planetary features for myths instead of real women. Dr. Harold Masursky said the IAU at its Budapest meeting next week would consider names for Venus sites, most of the 30 submitted being those of actual women. (NASA Release 80-70; ARC Release 80-47; *W Post,* May 29/80, A-2)

May 29: NASA launched NOAA-B from the Western Space and Missile Center (WSMC) into an elliptical orbit of 1,453-kilometer apogee, 273-kilometer perigee, 72.9° inclination, and 90.4 minute period, instead of the planned circular orbit at 470-540-kilometer altitude. Malfunction of the

Atlas F launch vehicle put the $15 million payload where it could not carry out its planned mission, and NASA expected it to remain in orbit only about six months. Attempts by NASA and NOAA to correct the orbit were unsuccessful. A replacement called NOAA-C would be sent up in about five months. (*NY Times*, May 30/80, B-6; *W Star*, May 30/80, A-7; *W Post*, May 30/80, A-9; NASA Release 80-82; *NASA Dly Actv Rpt*, June 2/80)

• NASA announced selection of Ford Aerospace to negotiate a contract for overall system-design engineering on preliminary operations requirements and test-support system for the Space Telescope. Work under the $9.2 million contract should be done by December 1983, to support the space-telescope mission. Ford Aerospace would run the system for six months before turning it over to NASA.

The system located at GSFC would control telescope attitude, point it, and monitor the on-board systems 24 hours a day, 7 days per week. Besides engineering design, hardware and software, and support for facility construction, the contract covered design of the project operations-control center plus required software and hardware. Ford Aerospace would provide testing, integration, installation, maintenance, documentation, training, and operating services for the system, including launch on the Space Shuttle. (NASA Release 80-80)

• KSC reported on steps taken by NASA to ensure survival of an endangered species, the manatee or sea cow, whose entire U.S. population estimated at about 1,000 lived in Florida waters. Brevard County, site of KSC, had the highest incidence of manatee deaths in the state. KSC included the site of the Merritt Island National Wildlife Refuge containing hundreds of species of plants, birds, mammals, and reptiles; 12 of the latter were endangered, more than in any other single site in the 48 states. About 20% of the nation's manatees spent part of the year on the Space Center, and KSC activities had been arranged for minimum interference with the indigenous wildlife.

Aerial surveys over KSC furnished information about group migratory habits, feeding grounds, and times for scheduling work in areas when the manatees would be elsewhere. Space technology provided tracking devices to monitor the routes traveled by individual animals. Ships that recovered spent Shuttle boosters docked in the Banana River, a prime manatee feeding ground. NASA had fitted its ships with a propulsion unit to maneuver them without use of large propellers found to be highly dangerous to the slow-moving and air-breathing manatee; the unit proved to be better at retrieving booster parachutes without tangling the lines. (KSC Release 95-80)

• NASA said MSFC's Spacelab program office had ordered a second Spacelab instrument-pointing system from ESA and Dornier Systems of West Germany for delivery by the end of 1983. The major Spacelab subsystem was valued at about $20 million. The number of experiments currently planned for Spacelab that needed highly accurate pointing required NASA to buy a second unit to supplement the one NASA would receive as basic Spacelab equipment provided by ESA. Earlier this year ESA had signed a contract with NASA for a second Spacelab unit; each basic unit would now have its own pointing system.

Mounted on a Spacelab pallet in the Shuttle cargo bay, the instrument-pointing system (IPS) gimbaled in three directions offered highly accurate pointing to scientific instruments weighing from 200 to 2,000 kilograms, belonging to disciplines such as astronomy, solar physics, high-energy astrophysics, or Earth observation, and needing more stability than the Shuttle provided. It could lock on and track targets such as stars, solar flares, or specific items of interest on the Earth's surface without being affected by slight changes in Shuttle attitude. (NASA Release 80-79; MSFC Release 80-75; ESA Info 14)

May 30: Newspapers reported NASA's selection of 19 astronaut candidates for Space Shuttle training, the second group of pilots and scientists specifically picked for that purpose. Those chosen in the 1978 group of 35, including the first women and blacks among civilian astronauts, received astronaut wings at JSC in August 1979. In the new group was Dr. William F. Fisher, husband of Dr. Anna Fisher, who was selected two years ago; the Seabrook, Tex., physicians were the first married couple chosen by the United States. The 8 new pilot candidates (one black) and 11 mission specialists (two women and one Hispanic) would, if successful, join the 62 astronauts now on duty with NASA. The Shuttle was scheduled to fly 30 or 40 missions a year with up to seven astronauts on a mission.

Pilot selections were Lt. Col. John E. Blaha, U.S. Air Force; Maj. Charles F. Bolden, Jr., U.S. Marine Corps; Lt. Col. Roy D. Bridges, Jr., U.S. Air Force; Maj. Guy S. Gardner, U.S. Air Force; Maj. Ronald J. Grabe, U.S. Air Force; Maj. Brian D. O'Connor, U.S. Marine Corps; Lt. Cdr. Richard N. Richards, U.S. Navy; and Lt. Cdr. Michael J. Smith, U.S. Navy.

Mission-specialist selections besides Dr. William Fisher were Dr. James P. Baglan, anesthesiologist; Dr. Franklin R. Chang, physicist; Dr. Mary L. Cleave, research engineer; Bonnie J. Dunbar, JSC flight controller; Capt. David C. Hilmers, U.S. Marine Corps; Lt. Cdr. David C. Leestma, U.S. Navy; John M. Lounge, JSC flight controller; Capt. Jerry L. Ross, U.S. Air Force; Maj. Sherwood C. Spring, U.S. Army; and Maj. Robert C. Springer, U.S. Marine Corps. (*NY Times*, May 30/80, A-11; *W Post*, May 30/80, A-8; NASA Release 80-78; JSC Release 80-038)

• MSFC reported successful test firing of the Shuttle main propulsion system May 30 at NSTL. Firing time, 9 minutes 38 seconds, exceeded the duration required to place a Shuttle in orbit. Total test time on the main propulsion system (three engines, external tank, and associated parts of the orbiter) was now 41.3 minutes, in addition to 19 hours of single-engine tests conducted in a separate program. The Shuttle engines were gimbaled (steered) during the test firing, throttled in stages from 100% of rated thrust down to 65%. The Shuttle would have the first human-rated engines capable of throttle control during flight. (MSFC Release 80-79)

During May: GSFC reported discovery by a team of its scientists of the largest gamma-ray burst ever recorded and the first tracing of such a burst to a known astronomical object, providing for the first time evidence of the vibration of a neutron star. The burst, trillions of miles away, occurred March 5, 1979, and was recorded by a network of nine satellites. The uniqueness of the event and the time needed to coordinate data from the Soviet Union, France, and West Germany delayed completion of analysis until recently; a GSFC colloquium April 24 heard a report on the theoretical developments. The GSFC team was headed by Dr. Thomas L. Cline and Dr. Reuven Ramaty.

Gamma rays, the most energetic form of electromagnetic radiation, exhibit energy from tens of thousands to tens of billions of volts. The amounts of energy required to produce gamma rays had to come from extremely high-energy processes such as explosion of an atomic bomb or a star. Until the explosion of March 5, 1979, astronomers could only speculate that neutron stars went through giant vibration episodes explosively propelling their substance outward, then being pushed just as explosively by external forces back to their original shape. The theory of relativity says that these vibrations should emit gravitational waves. The March 5 burst, said to radiate more energy than the Sun could produce in 1,000 years, was measured by devices on nine spacecraft including five launched by the United States (three *Velas*, the *Pioneer Venus* orbiter, and the international Sun-Earth explorer *Isee 3*; three by the Soviet Union (*Prognoz 7*, *Venera 11*, and *Venera 12*, carrying French instrumentation); and one launched jointly by the United States and the Federal Republic of Germany (*Helios 2*). The satellites were widely separated in space or in Earth orbit when they detected the burst.

By timing and triangulation, scientists could trace the source of the March 5 event to a decaying star (supernova) in the Large Magellanic Cloud (one of two galaxies nearest the Milky Way) and specifically to a supernova remnant identified as N-49. A supernova would have blown its contents all over surrounding space, leaving a large compact body called a neutron star so dense that a spoonful of material from its center would weigh a billion tons. The unusually large output of energy and the fact that its release was very rapid led to the vibrating-source conclusion. Celestial gamma rays are detected only by aircraft above the atmosphere, or by spacecraft; detection of future bursts would require highly sensitive devices like the gamma-ray observatory scheduled for Shuttle launch in 1985. (GSFC Release G-80-23)

• Control of motion sickness might be learned as one learns to balance or to ride a bicycle, according to ARC's Dr. Patricia Cowings. Half of all astronauts exposed to the weightless environment of space had symptoms of motion sickness; young athletes were often the persons most sensitive to motion.

Cowings and her team had taught about 50 volunteers to suppress illness when subjected to a chair spinning ever faster; another 60 subjects were studied without the training. Of the trained subjects, 85% improved their ability to withstand effects of motion, 65% being able to suppress their symptoms completely. The other 20% took significant increase in rpms before becoming ill. In the control group of 60 subjects who received no training, no one showed any significant improvement with time.

The trained subjects monitored their own respiration and heartbeat during the tests, biological feedback long used by researchers and known to produce positive results. After the subjects were trained to detect the onset of sickness, 65% were able to suppress the symptoms by using the feedback. Biofeedback was preferred to conventional treatment, which is use of drugs, because it had no side effects, such as sleepiness.

The success of the theory led Cowings to propose a life-science experiment tentatively accepted for a Spacelab flight on which two trained crew persons would wear a harness feeding eight channels of a small data recorder collecting information on heart rate and other factors and providing the subjects with a feedback display. A subject feeling ill would consciously use the feedback training for a maximum 30 minutes. When subjects succumbed to motion sickness, they would mark the point where they became ill so the researchers could learn which responses led to the sickness. So far Cowings had found no sex differences in susceptibility to motion sickness; also, of a group aged 18 to 45, older subjects appeared less likely to suffer. (NASA Release 80-57; ARC Release 80-32)

• FBIS carried Tass and other Soviet news reports on the flight of *Salyut 6* and *Soyuz 35* with cargo ship *Progress 9*. On May 2, cosmonauts Leonid Popov and Valery Ryumin, in their fourth week of flight, used "bilateral television communication" to visit with their families who had come to the mission control center. A May 6 report said that for the first time in manned space flight the crew had pumped water from the freight ship to containers on the station, using a system called Rodnik. The crew had completed unloading the food, regenerators, and fresh equipment from *Progress 9* and refueled the joint propulsion unit; they would use the cargo ship to dispose of used material.

On May 8, the chief of the aerogeology organization said Ryumin and Popov before the launch of *Soyuz 35* had flown over certain linear and ring geological structures to acquire data for comparison with satellite observations; the *Soyuz 26* crew (Romanenko and Grechko) had identified 25 such structures in the Soviet Union that proved to contain mineral deposits.

By May 13 the crew repaired the on-board videotape recorder and replaced a motor in the biogravistat and a filter in the gas analyzer; some items would be returned to Earth for study. On May 16 they were putting plant sprouts in various stages of development into a special solution for study on Earth; they also used the *Progress 9* propulsion unit for another orbit adjustment. The cargo ship separated from the orbital complex May 20 at 21:15 hours Moscow time; on May 22 ground command switched on its engine, and it "ceased to exist" upon entering the atmosphere. The next big event was launch at 21:21 hours Moscow time May 26 of *Soyuz 36* carrying veteran Valery Kubasov and Bertalan Farkas, first Hungarian cosmonaut, to join Popov and Ryumin who had occupied *Salyut 6* since April 9. Docking occurred at 22:56 hours Moscow time, and the visitors went aboard Salyut for a 7-day program of international research. Kubasov and Farkas would return to Earth in *Soyuz 35*, leaving *Soyuz 36* for later use. (FBIS, Tass in English, May 2-27/80)

June

June 3: The *Washington Post* quoted a White House source as saying that "We're running out of patience on the Space Shuttle. . .There's a feeling here that we can't tolerate any more delays in the Shuttle program." Noting the six postponements that had done "serious harm to the space agency's credibility," the *Washington Post* said that "in fairness. . .the delays caused by engine and tile troubles are not all its fault." When Pratt & Whitney lost the engine contract to Rocketdyne, it sued NASA, delaying engine tests for a year; lack of money also caused delay.

JSC Director Christopher Kraft pointed out that money cutbacks in 1978 meant that "we delayed building the tiles, and that naturally delayed our test procedures, which naturally delayed us from getting at the answers we now have." The custom-built tiles, each shaped to fit a specific place on the fuselage, took 25 hours apiece to install. After many were attached, NASA found that half had lost their strength in the bonding process; technicians had to remove and coat the tiles before replacing them.

When NASA shipped the Shuttle orbiter piggyback on its Boeing carrier from Palmdale, Calif., to Cape Canaveral in 1979, only 10% of its 30,922 tiles were in place, and some of those fell off during the trip. NASA enlisted a force of 1,200 workers to install the tiles, working two 10-hour shifts six days a week at the Cape. When the coating problem developed, the crews were attaching 750 tiles a week but removing 100. About 5,000 cavities on the frame remained to be filled, and NASA forecast August as the finishing date for the task.

The other technological challenge was the Shuttle's engine cluster, three liquid-hydrogen engines, each 10 times as powerful as the largest jet engine and burning 1,000 degrees hotter than any engine before it. These were the first liquid-fuel rockets designed for reuse; said Shuttle program manager Robert Thompson: "We had to expect that in heating it and stressing it with repeated use we were going to run into problems." During tests, engines had caught fire and even blown up; 6 of the last 12 tests of the three engines firing together had to be stopped because of overheating. By summer's end the tests would have cost $1 billion more than the $500 million NASA estimated.

NASA's costs by the time the first Shuttle flew would be $264 million for solid-fuel rocket engines; $381 million for tiles; $442 million for the external fuel tank; $1.5 billion for development of the main liquid-rocket engine, amounting to an overrun of almost $1.6 billion.

Money was a lesser concern, however, than the slips in schedule. The Shuttle was the first civilian vehicle designed to carry surveillance satellites for the DOD; those due to fly in 1983 were the biggest and most sophisticated ever built, weighing up to 25 tons each, too big to be carried by any other rocket including DOD's Titan. Former astronaut Sen. Harrison Schmitt (R-N.M.), ranking Republican on the Senate subcommittee on space, said that DOD would have to alter its craft to fit on the Titan if they could not fly on the Shuttle in 1983. (*W Post,* June 3/80, A-2)

June 4: U.S. newspapers carried Tass reports that two cosmonauts launched May 27 in *Soyuz 36* to join Leonid Popov and Valery Ryumin on *Salyut 6* had returned safely to Kazakhstan the night of June 2-3 in the *Soyuz 35* that took Popov and Ryumin to *Salyut 6* on April 9. *Soyuz 36* remained with *Salyut 6.* Veteran cosmonaut Valery Kubasov and rookie Bertalan Farkas, first Hungarian in space, performed the fifth Soviet-bloc Intercosmos mission, photographing land and ocean surfaces and testing the effects of spaceflight on the human body. (*NY Times,* June 3/80, A-14; *W Post,* June 4/80, A-25; *W Star,* June 4/80, A-18)

June 5: The Soviet Union launched Lt. Col. Yuri V. Malyshev and Vladimir V. Aksyonov toward the orbiting station *Salyut 6* in *Soyuz T2,* an "improved model" of its manned capsule. An uncrewed Soyuz T1 tested in December 1979 docked automatically with *Salyut 6* and remained for 99 days. A U.S. expert on USSR space activity said that T2 was "a new ship" except in appearance: the main change was an on-board computer that for the first time let cosmonauts navigate independently of ground control. Launched from Tyuratam, the T2 arrived June 6 to join Leonid Popov and Valery Ryumin. (*W Star,* June 5/80, A-12; June 6/80, A-10; June 7/80, A-12; *W Post,* June 6/80, A-22; *NY Times,* June 6/80, B-6)

• NASA announced award by LeRC of parallel 1-year $1 million contracts to TRW's Defense and Space Systems Group and to Hughes Aircraft Company for designing an advanced commercial communications satellite system.

Operating in a high-frequency 30- to 20-GHz band not used in the United States commercially, the system would help handle the increased communications expected in the next 20 years which would saturate existing domestic communications satellite capacity. The new system, a network of ground stations using two shuttle-launched spacecraft, would lower costs of services such as videoconferencing, teletext, and electronic mail delivery. (NASA Release 80-84)

• The House Committee on Science and Technology said that on June 11-12 its subcommittee on space science and applications would hold hearings on the Space Industrialization Act of 1980 (H.R. 7412) for private commercialization of space. Rep. Don Fuqua (D-Fla.), committee and subcommittee chairman, said that the bill he sponsored would create a space industrialization corporation to develop new products, services, and industries using space technology and the properties of the space environment. NASA would continue to advance national capabilities in space, Fuqua said, but the corporation would be responsible for encouraging private development. (Committee Release 96-196)

• NASA announced that the Shuttle main engine had reached a milestone June 5 when two of the three main engines that would fly on Columbia's first mission demonstrated flight readiness in test firings at NSTL that sent total test time over the 80,000-second mark. This was the minimum needed to assure reliability of the liquid-fuel main engines. A third engine would undergo an identical test in two weeks. (NASA Release 80-85)

• NASA reported that GSFC had chosen Canadian Astronautics, Ltd., to negotiate a $3,042,500 contract for local-user terminals to process signals from search-and-rescue instruments aboard the NOAA-E, NOAA-F, and NOAA-G satellites in the early 1980s. The instruments would relay signals from distressed ships and aircraft to the terminals, which would use them to locate the distressed craft and aid rescue operations. The first terminal would be at Kodiak, Alaska, with others at Scott Air Force Base, Ill., and the Coast Guard station at San Francisco. The Soviet Union, Canada, and France would demonstrate the search-and-rescue capability. (NASA Release 80-87)

June 9: The Earth 34 million years ago might have had a ring like those that circle Saturn today, said Dr. John A. O'Keefe of GSFC's Laboratory for Astronomy and Solar Physics. A sudden event 34 million years ago, known to geologists as the terminal Eocene event, caused dramatic climate changes in Earth's temperate zones, dropping northern-hemisphere winter temperatures about 35°F (20°C). Botanical studies revealed that the temperature change, the most profound climatic event between 65 million and 2 million years ago, occurred at the end of the Eocene, but it had no acceptable explanation as yet.

O'Keefe noted that the changes coincided with a massive fall from outer space of tektites (glass meteorites) possibly from an eruption on Earth's Moon; studies of these tektites showed similarities to rocks brought from the Moon. Whatever the source, the tektites that hit Earth made a path around the globe from the eastern United States across the Pacific to the Philippines.

Tektites that missed the Earth would have formed a ring like the rings around Saturn; such a ring in the winter would block the Sun's rays in the northern hemisphere when the Sun was below the equator, and the shadow cast by the ring would lower winter temperatures. The ring disappeared when forces (such as pressure of sunlight or drag of the atmosphere) pulled it either into the atmosphere, where some particles burned and others fell to Earth, or upward into space away from the Earth. (NASA Release 80-86)

June 10: JSC said that a NASA board investigating the April 18 flash fire in a space suit backpack [see April 22] had found where the fire started and had recommended 11 changes to improve system safety. Apparently, when a technician during a test in the crew systems laboratory switched the secondary oxygen pack to the "spacewalk" position, ignition occurred in a V-shaped passage restricting oxygen flow between a shutoff valve and a chamber in the pack's regulator module. In the accident, which destroyed an unoccupied Shuttle space suit and life-support backpack, Hamilton Standard technician Robert A. Mayfield was severely burned but was recovering.

After five weeks of engineering detective work (including more than 2,000 unsuccessful attempts to reproduce the fire), the board had not found the exact cause, but reported to JSC Director Christopher C. Kraft, Jr., the four most probable causes of the fire: heating by compression or shock of a thin section of aluminum between the flow-restrictor passage and the adjacent cavity; heating by compression or shock of contaminants in the flow restrictor; heating of internal surfaces through mechanical shock from incoming high-pressure oxygen, or heating of particles; similar heating of shutoff valve O rings. The regulator module had undergone 19 cycles with high-pressure oxygen before the accident. The board found that all procedures followed during the April 18 test were proper.

Technicians at JSC's White Sands Test Facility could not duplicate the failure, although they cycled four regulator modules from the same factory batch 2,228 times. Disassembly after the tests revealed contamination inside the modules. The board recommended redesign, design reviews, inspections, and collection of high-pressure oxygen data to establish standards for equipment design and use. (JSC Release 80-039; NASA Release 80-91)

• NASA reported award to United Space Boosters, Inc., subsidiary of United Technologies Corporation, of a contract for a two-ship recovery force to retrieve used Space Shuttle solid-fuel rocket boosters from the Atlantic Ocean. This supplemented a contract under which the firm assembled and processed solid-fuel rocket boosters for flight. The ships would locate and retrieve expended booster casings, parachutes, and other equipment from the Atlantic and deliver them to a disassembly facility at Cape Canaveral Air Force Station. The disassembly facility was on the eastern shore of the Banana River, a shallow area where an endangered species, the sea cow or manatee, made its home. The ships would use a 425-HP waterjet stern thruster instead of propellers that could maim or kill the manatees [see May 29].

The ships, *UTC Liberty* and *UTC Freedom,* were being built and would be delivered in October 1980 and January 1981; both would be used on each Shuttle mission, each retrieving one booster and its components. At liftoff, the boosters would burn simultaneously with the three-engine cluster on the Shuttle. After about two minutes they would be jettisoned and land in the Atlantic about 257 kilometers (160 miles) downrange from KSC, their descent being slowed by three parachutes on each casing. Each vessel would carry four parachute-rollers to handle the three main and single drogue parachutes on each booster and cranes to hoist aboard the collateral flight equipment. The ships would carry equipment to plug the nozzles, pump water out of the casings, and ready them for towing to the disassembly facility, where they would be cleaned and taken apart for shipment to Utah and reloading with solid-fuel propellant. Each casing could be used for up to 20 missions, reducing the cost of flight operations. The ships would also have sophisticated electronic communications and navigation gear such as radars, sonars, loran, direction finders, fathometers, and gyrocompasses. (NASA Release 80-89)

• DFRC reported that it and the FAA had resumed wake vortex flight tests using an L-1011 widebody jet transport. The wake produced by a widebody aircraft could be severe enough to delay takeoffs and landings at airports; planned time separations were in effect because the wake could upset other aircraft landing or taking off. Diminishing the wake vortex could reduce traffic congestion, with significant savings in fuel and time.

Previous tests using a Boeing 747 [see October 29, 1979] showed that selected use of ailerons and spoilers on the aircraft could break up the vortex, an invisible flow of turbulent air streaming from flaps and wingtips in a tornado shape. Spoilers, normally used as speed brakes and to decrease aerodynamic lift after landing, would serve in flight to break up the vortex trailing from the flaps; ailerons, normally used for turning, would serve to break up the wing vortex. The L-1011 being tested was the Lockheed prototype with a direct-lift flight-control system using spoilers deflected upward at 8°; the proposed vortex alleviation system would not differ much from the system already in use on the L-1011. The tests would use a small highly instrumented NASA test aircraft for high-altitude recording of the L-1011 vortex, marked by smoke generators. (DFRC Release 80-7; NASA Release 80-92)

• The *Washington Star* carried a Tass report that cosmonauts Vladimir Aksyonov and Yuri Malyshev had soft-landed in Central Asia after a visit to orbiting space station *Salyut 6.* The two were launched June 5 in a new transport vehicle called *Soyuz T-2*. *Salyut 6* had been occupied since April 9 by Leonid Popov and Valery Ryumin, who would probably remain in orbit to greet visitors to the Moscow Olympics, the dispatch said. (*W Star,* June 10/80, A-8)

June 11: UPI reported that the 500-pound *Magsat* that gathered data indicating that Earth's magnetic poles would reverse in 1,200 years had fallen into the Norwegian Sea between Greenland and Norway at 3:30 a.m. EDT. NASA said that no debris survived the plunge. NORAD said earlier that the reentry occurred northwest of Spain but later moved the location north.

The Magsat program cost $19.7 million; project scientist Dr. Robert A. Langel said the findings predicting a magnetic reversal were only the first in a series expected as scientists from nine nations studied Magsat data. The magnetic-field reversal should have no bad effects, Langel said; reversals had occurred more than 130 times in Earth's history. Besides the United States, nations participating in the project were Australia, Brazil, Canada, France, India, Italy, Japan, and the United Kingdom. (UPI-045, June 11/80; NASA Release 80-90)

• DFRC announced that the HiMAT (highly maneuverable aircraft technology) plane would fly again in mid-June after four months of modifications, scheduled during the rainy season when flooding would prevent landing the plane on a dry lakebed. Modifications included airframe, flight-control and instrumentation systems, and data link. The 3,400-pound craft had reached speeds up to 595 mph at altitudes to 40,000 feet and a maximum load factor of 4.5 grams. (DFRC Release 80-8)

June 12: DFRC reported that an unmanned remotely piloted vehicle crashed during a research flight, impacting a dry lakebed north of the center. Air-launched from a B-52 mother ship at 7:10 a.m. PDT, the small plane called DAST (drones for aerodynamic and structural testing) exhibited wing-structure problems about 10 minutes later. NASA was investigating. The DAST program, to demonstrate the control of wing flutter by advanced flight-control systems, used a remotely piloted vehicle that could be launched from a mother ship and flown through the maneuvers using telemetry from a pilot in a ground cockpit. The likelihood of structural damage during flight called for a safer and more economical way of testing advanced high-risk concepts. (DFRC Release 80-9)

• NASA announced that WFC would begin testing this month at the Manassas, Va., municipal airport an experimental computer-advisory system that would increase data available to pilots using small airports without control arrangements. Designed as an extension of the procedural system now in use at uncontrolled airports, the system would keep track of aircraft in the vicinity and supply pilots with air-traffic information.

Computer-generated voice, radar, and weather-sensing information would automatically broadcast an airport advisory every 2 minutes and a traffic advisory every 20 seconds: the airport advisory would offer an airport identifier, broadcast time, windspeed and direction, favored or active runway, altimeter setting, and ambient and dew-point temperature. The traffic data would include the number of aircraft on each pattern, and position and heading of arriving or departing aircraft. Manassas was estimated to handle about 200,000 operations (landings and takeoffs) yearly; the demonstration would allow pilots using the system in an uncontrolled high-density environment to evaluate its effectiveness. (NASA Release 80-88; WFC Release 80-7)

• FBIS carried a Tokyo *Kyodo* story that Japan's Space Development Council had decided that the failure last February of its Ayame 2 communications satellite was caused by malfunction of the apogee motor. The ground station lost contact with Ayame 2 three days after launch when engineers tried to fire the motor to put it into proper orbit. The council report called for domestic production of the apogee rocket and other major satellite components in future; the apogee motor had been made in the United States. (FBIS, Tokyo *Kyodo* in English, June 12/80)

June 13: The House Committee on Science and Technology said that its subcommittees on space science and applications and on natural resources and environment would hold hearings June 24-25 on administration plans to develop a Landsat remote-sensing system with private-sector participation. (House anno 96-204)

• The *Washington Post* reported that Rep. Bruce Vento (D-Minn.) had called for congressional investigation of the Navy's new F-18 jet fighter, claiming the multibillion-dollar project was in "deep financial and technical trouble." The F-18 was the biggest single item in the military budget now before Congress; despite critical reports, Vento said the project had "eluded congressional scrutiny."

The GAO, Congress's investigative arm, in February reported that the F-18's planned performance had been reduced and various problems remained uncorrected. GAO said that during its investigation at Navy, DOD, and contractor facilities "we were not granted access to information we felt critical to our evaluation." Vento pointed out that the GAO report received little official notice and said that he had "startling information" as a result of his own investigation. In the past 15 months alone, he said, F-18 costs increased $10.9 billion, and the Pentagon was talking a $32.8 billion total cost for the project previously estimated at $24 billion. (*W Post,* June 13/80, A-16)

June 16: MSFC reported that the last of the three main engines scheduled for flight on the Columbia had successfully completed its second flight-acceptance test with an 8-minute 40-second test run that exceeded the time required to put a Shuttle into orbit. Engine no. 2007 underwent throttling and gimbaling during the test to show its ability to change speed and direction after liftoff. The other two engines (2005 and 2006) had completed their second acceptance tests June 2 and 5, respectively. Although the engines had undergone acceptance test firings last year, modifications made since that time had led NASA to retest them. Successful retest also demonstrated the on-line component replacement that would be required in repeated reuse. Testing of associated main propulsion equipment would continue at NSTL. (MSFC Release 80-86)

• The *Washington Post* reported that heat-resistant tiles on Columbia had survived without damage a critical test June 14 simulating separation of the giant fuel tank. Engineers scanned the tiles for 10 hours and were "all pretty ecstatic," said a NASA spokesman, adding that they would spend the next few days evaluating results of the "pyrotechnic shock test" before pronouncing it a complete success. Dr. Robert Gray, project office manager, said previous simulations had damaged Shuttle tiles; "if there are no major problems, we could launch our first flight in February," he added. (*W Post*, June 16/80, A-11)

• NASA reported that its five-year-old *Landsat 2* spacecraft, after nearly six months of inaction, was restored to service through "intensive efforts" by engineers at GSFC. Problems had developed November 5, 1979, when the yaw-attitude flywheel in the Landsat's Earth-pointing system stopped functioning, probably because of a lubrication breakdown. The attitude-control system could not keep the spacecraft sufficiently stabilized to acquire pictures of Earth, or keep the solar panels facing the Sun to collect enough energy for operation.

The spacecraft was "retired" on its fifth birthday, January 22, 1980, but GSFC engineers began trying to use magnetic compensation operating without either the flywheel or the control-system gas, which had been depleted. Magnetic control required defining the spacecraft's magnetic characteristics in order to plot interaction with Earth's magnetic field. As the spacecraft had no system for direct measurement of yaw attitude, engineers had to find a way to use the solar-array output, which varied with the spacecraft's attitude and its latitude position relative to Earth.

On May 5, 1980, apparently as a result of redistribution of the lubricant, the flywheel responded to an ON command and started running again, and the attitude-control system was once more able to keep the spacecraft pointed properly toward the Earth and Sun. However, lack of gas required use of the magnetic system to keep roll and yaw flywheels in a safe range.

Experience gained in magnetic control of attitude was applied to controlling wheel speeds without delays in development. The GSFC engineers believed that this new procedure would let *Landsat 2* operate almost at previous capacity, although this would be limited to readout since the tape recorders were not functioning. The return to operational status was important because the multispectral scanner, principal Earth-imaging device, would again provide data to three U.S. and nine foreign sites, supplementing operations of *Landsat 3*. (NASA Release 80-94)

June 17: ESA reported the complete engine D that malfunctioned May 23 during the launch of Ariane L02 had been located the morning of June 16 about 5 kilometers south of the Iles du Salut off French Guiana, and brought to the surface early in the afternoon. It was in good condition, capable of being subjected to a thorough inspection. Engineers from CNES (Centre National d'Etudes Spatiales) and SEP (Societe Europeenne de Propulsion) dismantled it at the Ariane launch site and would send it to SEP's facility at Vernon, France, with propulsion elements of the other engines that had been recovered, B entirely and A and C partially (servomotors and turbopumps). Working groups studying launch data would report their results at the end of June; a schedule of further test flights would not be set up until then. (ESA Info 16)

• The *Washington Post* reported that demonstrators trying to keep Howard Hughes's Spruce Goose from being carved up rallied at its hanger Saturday, June 14, to voice concern about sending parts of the plane to museums. Summa Corporation, the Hughes holding company, said that it would go ahead with plans to dismantle the plane in two weeks. A spokesman for the Committee to Save the Hughes Flying Boat said the group had received no replies from corporations it asked to donate the $750,000 needed to keep the plane in one piece. (*W Post,* June 17/80, B-3)

• MSFC reported selection of two firms, Grumman Aerospace and the Harris Corporation, to negotiate parallel contracts for concept-definition studies of a deployable space antenna [see April 15]. MSFC would demonstrate use of such an antenna flown in low Earth orbit until completion of definition studies by the two firms. (MSFC Release 80-87)

• The *Washington Post* reported that Great Britain's postal service June 17 became the first international public service to send letters by satellite. Intelpost, the new system, used a satellite 25,000 miles above Earth to send documents and letters by facsimile, an electronic means of transmitting the written word from one place to another. The first letter using the new system took just over 1 minute to get from Great Britain's Post Office chairman-designate Ron Dearing to a receiving center in Toronto. (*W Post,* June 18/80, C-2)

June 23: INTELSAT announced election of Irving Goldstein, previously vice chairman of its board of directors, to be chairman succeeding Randolph Payne of Australia. Goldstein, U.S. signatory in the organization, had been working with the board since its formation in 1973. He was vice president and general manager for international communications of ComSatCorp, responsible for activities including planning, installation, and operation of ground stations using the INTELSAT system. (INTELSAT Release 80-10-I)

June 24: INTELSAT said that its board meeting in Bogota approved use of time-division multiple-access equipment with its global communications satellite system; the new devices, to be installed in the 1980s, would offer three times more telephone channels on INTELSAT satellites than available from frequency-modulation (FM) equipment now in use. (INTELSAT Release 80-11-I)

• ESA said that the six groups investigating the malfunction at the Ariane L02 launch ended four weeks of study on one of the four first-stage engines. They reported that the suspect engine recovered from the sea [see June 17] had a foreign body at the injector level: an identification plate was found near the injection orifices, and they were trying to determine if it was there at launch or got there during the engine's immersion in the sea.

Analysis of engine noise showed differences from results recorded at ground tests in Europe; also, engine start-up parameters (combustion-pressure build-up time) showed abnormal dispersions, but researchers had not been able to link them to observed phenomena. ESA said that the L03 test flight originally set for November 1980 might not occur until February 1981, and the fourth test flight by midyear, to qualify the rocket for operational launch. (ESA Info Bltn 17)

June 25: NASA reported that MSFC had chosen Ball Aerospace Division to negotiate a $9.5 million contract for design, development, and manufacture of a chemical release module for use in the first large-scale controlled investigations of dynamic phenomena outside Earth's atmosphere. Information on such processes in Earth's magnetosphere, ionosphere, and upper atmosphere was hard to obtain because the areas were so enormous and the dynamic activity was invisible.

Scheduled for mid-1983 launch on the Space Shuttle, the self-contained free-flying module would release in space chemical elements that would absorb sunlight and reflect distinctive colors; other chemicals would glow when reacting with oxygen particles in the upper atmosphere. Motion of atoms and ions colored in this way could be tracked. During the module's six-month lifetime, it would make 20 to 30 chemical releases for visual, camera, and radar observation. (NASA Release 80-99; MSFC Release 80-89)

June 26: NASA announced that scientists studying data from *Heao 2* had confirmed the emission of X-rays from Jupiter, making the giant planet the only one besides Earth to produce X-rays. *Heao 2,* launched November 13, 1978, carried a focusing X-ray telescope with four different instruments that could be positioned at the focus, including the imaging proportional counter used to view Jupiter. Dr. Albert Metzger of JPL, leader of the scientific team making the discovery, reported it to a meeting of the American Astronomical Society at the University of Maryland last week.

The X-ray find indicated the power needed by the intense radiation belts in the Jovian magnetosphere: from the brightness observed, scientists said that energetic electrons in the system emitted nearly a quadrillion watts of power. To maintain the radiation belts, an equal amount of power had to come from the planet's rotational energy and the force of the solar wind. Also, energetic ions and electrons impacting the surfaces of satellites orbiting inside the Jovian radiation belt might also produce X rays; observing those X rays might help determine the composition of Io, Europa, Ganymede, and Callisto. (NASA Release 80-98)

• MSFC announced that it would mark its 20th anniversary July 1 with an assembly honoring the 1,039 "charter members" who had been there since its founding. In 1960, the Development Operations Division of the Army's Ballistic Missile Agency (ABMA) became the nucleus of a center belonging to the space agency founded in 1958, bringing to NASA property worth hundreds of millions of dollars and a staff headed by Dr. Wernher von Braun, the center's first director. President Eisenhower had decided to name the center after George C. Marshall, five-star general, Secretary of State, and winner of the Nobel Peace Prize, an appropriate name for an organization devoted to peaceful uses of space. (MSFC Release 80-92)

June 27: A panel of the NRC said that the FAA had lost the engineering expertise to say whether airplanes were safe and waited until accidents occurred before seeking regulations that might have prevented them.

Both the *Washington Post* and the *Washington Star* reported a briefing by panel chairman George M. Low, president of Rensselaer Polytechnic Institute and former deputy administrator of NASA. "The FAA engineering staff today is considerably less competent than the engineering they regulate," Low told the press. The latest of a series of studies of the crash of an American Airlines DC-10 in Chicago May 25, 1979, that killed 273 people, the panel study was sought by Transportation Secretary Neil Goldschmidt, who said he had ordered an immediate analysis of the panel's findings "with the intent of putting into effect promptly any recommendations that will improve our procedures."

The Chicago accident was blamed on improper maintenance procedures by American Airlines, but a contributing cause was found to be the plane's design. The panel said that the FAA relied too much on manufacturers and was performing "only a cursory review" of industry tests; FAA officials charged with supervising manufacturers and airlines had "gotten too close to their industry counterparts, weakening their independence and objectivity."

The panel recommended reassignment of officials on a periodic basis to work with different manufacturers and airlines. It also recommended new licensing and training certification rules for airline and airplane mechanics "more like those for aircraft flight crews." FAA should require aircraft to be designed to continue flying after any structural failure unless the failure would prevent flight, such as loss of a wing. In the Chicago crash, an engine mount had ripped from the plane, destroying vital controls in the cockpit; the mount, certified as safe, would not have failed except for maintenance-induced damage. Asked if the DC-10 would have survived if the proposed rule had been in effect, Low replied "Yes." (*W Post,* June 27/80, 1A; *W Star,* June 26/80, A-1)

• JSC reported that its engineers were working on automated ways to fabricate in space the beams and trusses needed in space construction projects of the future. Recently arrived on center was a truss such as a "beam builder" in space would form, the product of three years of analysis, design, and testing at General Dynamics-Convair Division. JSC engineers would begin evaluating it in July using a hydraulic cylinder to apply various loads to measure stiffness and strength of the truss. (JSC Release 80-040)

June 30: NASA announced that MSFC had awarded a $230 million cost-plus-award-fee contract to Martin Marietta Aerospace for full-scale production of Space Shuttle external tanks, the only part of the Shuttle not recovered for reuse. Martin Marietta had an earlier contract for design, development, and delivery of nine tanks—three test articles and six flight articles—for Shuttle test flights.

The new contract, for delivery of 7 flight tanks to support Shuttle operating missions, included long lead-time procurement of components and subassemblies for 5 additional tanks and raw material for 24 other additional tanks. Manufacturing of the external tanks would take place at NASA's Michoud assembly facility. (NASA Release 80-100; MSFC Release 80-90)

—MSFC announced that it planned to reduce the weight of the Shuttle external tank by 6,000 pounds, a change that could increase the Shuttle's payload-carrying capability by about the same amount. The center amended its tank design and development contract with Martin Marietta, adding more than $42.9 million to cover the weight-reduction effort and modify tools used in future production. The change would affect tanks built under a new contract for full-scale tank production to support operational Shuttle launches. The first lightweight external tank would be delivered in the summer of 1982. (MSFC Release 80-93; NASA Release 80-102)

• In an editorial headed "Shuttle at the Crossroads," *Aviation Week & Space Technology* reviewed the delays and difficulties besetting NASA's program, starting with the budget problem in Congress. The first flight, now set for early 1981, would be two years behind schedule, and "even that date may keep on slipping." Technical problems other than tiles included retest of the first set of flight-rated engines "over objections of technical management but with the endorsement of the flight crew." NASA's dilemma in risk assessment was real, particularly because of the tile problem. *Aviation Week & Space Technology* said: "Loss or damage to one of the orbiters of its limited fleet, not to mention of a crew, could decimate public support and disrupt operations of the shuttle program. On the other hand, at some point fairly soon NASA's top management is going to have to decide that risk has been reduced to a reasonable minimum, draw a deep breath and commit to first flight." (*AvWk,* June 30/80, 9)

During June: Republic Airlines said June 9 that its representatives had signed a pact with Summa Corporation and the estate of Howard R. Hughes, Jr., under which it would purchase Hughes Airwest for $38.5 million. Acquisition would occur next fall, if legal and other regulatory problems were solved. (*W Star,* June 10/80, C-10)

• United Airlines began a six-month test June 11 of air-to-ground telephone service for passengers, using a standard 12-button wall model installed on one of the airline's DC-10s. The firm was conducting the test with Sky-Tel, a subsidiary of Page-America. The caller would press buttons for connection with the ground station nearest to flight path, where an operator would place the call. The charge would be $10 plus cost of the call. (*W Post*, June 11/80, B-2)

• The FCC authorized the ComSatCorp to begin construction of a $15 million ground station on Saipan, in the western Pacific Ocean, to bring the first satellite communications to the northern Mariana Islands. The ComSatCorp-owned and -operated station would provide direct communications between the northern Marianas and the United States, Hawaii, Guam, Japan, and other points in the Pacific. (*W Star*, June 12/80, B-7)

• FBIS carried Tass reports on the continuing flight of *Salyut 6* with its international crew, Bertalan Farkas of Hungary and Valery Kubasov, working with longtime occupants Leonid Popov and Valery Ryumin. Preparing *Soyuz 35* for return to Earth, the cosmonauts carried into it containers of materials on which research had been completed: exposed rolls of film, space navigation charts, flight logs, biological objects, and substances produced in materials experiments. Used-up equipment would be taken into the "living compartment." The crew had shot a film about their joint operations, including development of plants in weightlessness and production of metal alloys and castings.

Tass reported June 3 that the descent module of *Soyuz 35* had landed safely near Dzhezkazgan and that the Intercosmos crew were well. The *Soyuz 36* that took them to *Salyut 6* was still attached to it; on June 4, the *Salyut 6* crew moved *Soyuz 36* to the other docking port to make room for another craft. On June 5 at 1719 Moscow time the Soviet Union launched *Soyuz T-2* carrying Lt. Col. Yuri Malyshev and, as flight engineer, veteran cosmonaut Vladimir Aksyonov, tenth crew to visit *Salyut 6* since its launch. An unmanned *Soyuz T* launched in December 1979 had docked with *Salyut 6* and remained for more than three months, testing new automated features. Before docking with *Salyut 6*, the crew turned the Soyuz toward the Sun to test its solar batteries, one of the new features.

On June 6 *Soyuz T-2* docked with *Salyut 6* at 1858 Moscow time. Tass said that the approach was automated up to within 180 meters, after which it was controlled by the crew. Konstantin Feoktistov explained that "earlier, during manual approach the station was. . .automatically aligned with the ship and was always directed toward it with its docking unit. . . [the crew] regulated the longitudinal speed and made sure that it went in straight. This time the station was immobile: the craft approached from the side. . . A quarter turn was made around the station and it came on to the axis level. The manual control system worked well. We think the crew was even better." Later reports mentioned a malfunction of some automated part and the need for an unplanned manual docking.

The visiting cosmonauts performed "dynamic operations" including a photographic turn around the station, which had not been possible before.

After a four-day mission, Malyshev and Aksyonov undocked *Soyuz T-2* June 9 and returned to the spot near Dzhezkazgan where the previous Soyuz crew landed. Popov and Ryumin remained in *Salyut 6*, which logged its thousandth day of flight June 24. *Progress 10* was launched June 29. (FBIS, Tass in English, June 1-29/80; *NY Times*, June 10/80, C-2; *A/D*, June 10/80, 219; *AvWk*, June 23/80, 18)

July

July 1: NASA announced selection of General Electric Space Division, Lockheed Missiles and Space Company, RCA Astro-Electronics, and Rockwell International to negotiate 9-month $750,000 fixed-price contracts for parallel definition studies of alternate ways to implement the NOSS. Studies would include flight segments, ground segments, and orbit operations.

NOSS would acquire ocean-surface data for delivery to selected users in weather and sea-ice forecasting, climate research, fisheries management, and ocean acoustic-propagation predictions. A large free-flying high-inclination spacecraft carrying a coastal-zone color scanner, scatterometer, altimeter, and large-antenna multichannel microwave radiometer would measure the ocean's emitted and reflective energy in radio, infrared, and visible frequencies to satisfy both civilian and defense needs. DOC's NOAA and DOD would cooperate in the NOSS program with NASA, which had given GSFC project responsibility. (NASA Release 80-103)

July 2: INTELSAT said that its board of governors meeting in Bogota last week had made decisions that would determine the course of international communications satellite system development for the decade. INTELSAT would purchase key items needed for a ninth Intelsat V series satellite; order from NASA three more Atlas Centaur launch vehicles with improved capability; procure from the ESA two more Ariane launch vehicles; and define specifications for an improved satellite, Intelsat V-A, and a high-capacity satellite to be called Intelsat VI. INTELSAT would spend more than U.S. $230 million, said W. Wood, deputy director general for operations and development. (INTELSAT Release 80-12-I)

July 7: NASA said that it had agreed with ESA to let two European scientists enter the mission-specialist training program for Shuttle astronauts at JSC [see May 30]. The Europeans, Claude Nicollier of Switzerland and Wubbo Ockels of the Netherlands, were both ESA employees and, as Spacelab 1 payload-specialist candidates, had undergone a screening and selection process like that of U.S. candidates. NASA agreed to train them in view of Spacelab delay and in recognition of ESA's contribution to the STS in funding Spacelab development; ESA would reimburse NASA for the cost of training the two. (NASA Release 89-106; ESA Info 19)

July 8: WFC observed the 35th anniversary of the launch on July 4, 1945, of its first research rocket, a 17-foot Tiamat. Since it became a rocket range, Wallops Island had seen the launch of about 12,000 research vehicles of from

1 to 7 stages, sent as high as 19,000 miles above the Atlantic at speeds over 38,000 mph, and the launch of 19 satellites. From Wallops, rhesus monkeys Sam and Miss Sam rode into space on a Little Joe booster in 1959-60 to test the Mercury spacecraft before Alan Shepard took it into space; first test of the Echo balloon also occurred here.

Early research at Wallops collected aerodynamic data at transonic and low supersonic speeds as part of the push to break the sound barrier; today, the launches gathered data on space, aeronautics, and characteristics of aerospace flight and tested ideas and devices for future spaceflight.

NASA's predecessor agency, the National Advisory Committee for Aeronautics (NACA), put its Pilotless Aircraft Research Station on Wallops Island under the direction of LaRC; its mission was aeronautical research to supplement wind-tunnel and laboratory work at LaRC. When NASA came into being in 1958 and took over LaRC and other field centers and research facilities, it put the Wallops station directly under NASA Headquarters and renamed it Wallops Flight Center in 1974. (WFC Release 80-8)

• NASA had no plans to carry tourists into outer space, the *Washington Star* said, even though its offices around the United States had floods of requests for rides since the Space Shuttle project was unveiled in 1977. At least 15,000 people had tried to book seats, and 1,200 new requests arrived each week. "Non-astronauts may be aboard some missions to conduct experiments," said Chester M. Lee, NASA's director of space transportation systems, "but we're not ready to book tourists. There is absolutely no provision or thought for non-working passengers." (*W Star*, July 8/80, A-2)

July 9: JPL reported that Viking orbiter 1, after more than four years of circling Mars, was reaching the end of its mission. JPL would command it off some time between July 23 and 30 after it had exhausted the attitude-control gas that kept its solar panels pointed at the Sun and its antenna toward Earth. A controlled burn during that time would change its orbit to fulfill planetary quarantine requirements, avoiding impact with—and contamination of—Mars before the year 2019. The orbiter would keep observing until commanded off, and thereafter circle Mars for decades in silence.

Viking 1 launched toward Mars in August 1975 arrived there June 19, 1976. Its lander reached Mar's surface July 20 with a planned 90-day lifetime but on July 20, 1980, would have observed the planet for more than two full Mars years (four Earth years) and would operate unattended on Mars into 1990, perhaps into 1994. The orbiter and lander of *Viking 2* had been commanded off on July 24, 1978 and April 11, 1980, respectively. Fewer than 30 people at JPL remained in Viking operations and data processing. (JPL Release 940; NASA Release 80-108)

• MSFC's *Marshall Star* reported the return of Shuttle main engines 2005 and 2007 from NSTL to KSC after modification and testing. The third engine

(2006) of the cluster scheduled to power orbiter Columbia in its first flight was still at NSTL. NASA had called for retest after the engines were modified on the basis of flight readiness tests last year. (*Marshall Star*, July 9/80, 2)

*July 10:*ESA announced that its science program committee had approved a major space first: sending a spacecraft to Halley's comet. The mission, called Giotto, would send a spacecraft derived from the Goes design through the comet in 1986 at a speed of 70 kilometers. Objective of the mission would be to measure the substances (atmospheric, ionized particles, and dust) from the coma boiling off the nucleus under the effect of solar heating and to photograph the nucleus with an on-board camera. The payload would consist mainly of the camera and spectrometers for measuring atomic composition.

The Giotto mission was named for the "Adoration of the Magi" scene in a fresco in Padua's Arena Chapel done by Florentine artist Giotto di Bondone. The sky in the Adoration scene shows Halley's comet, which made one of its periodic 76-year appearances in 1301; Giotto was thus able to use it as a model for the Bethlehem star in his painting, completed in 1304. The fresco might be called the first scientific description of Halley's comet. (ESA Info 20)

*July 11:*NASA reported award of an $8.5 million contract to Thiokol Corporation for Caster IV auxiliary motors for the Delta launch vehicle, part of a fixed-price supplement to an existing contract being negotiated with Thiokol for 63 of these motors at an estimated price of $20.9 million, all to be delivered to the KSC launch site by the end of 1982.

The *Wall Street Journal* commented that the "old-fashioned" liquid-fuel Delta rockets had long served to put vehicles into space, and its job was to have been taken over by the reusable Shuttle. But the Shuttle was two years behind schedule, so that NASA had to buy more solid-fuel Castors to help with the extended schedule of Delta launches. (NASA Release 80-110; *WSJ*, July 11/80, 3)

*July 14:*MSFC reported that a planned 542-second test July 12 of the three-engine cluster for Shuttle's main propulsion system lasted only 106 seconds because of fire indication in the aft compartment of the orbiter simulator. Up to cutoff, all engines and other parts of the propulsion system apparently worked normally, including completion of the scheduled gimbaling and throttling of the engine. About 45 seconds of the firing reached 102% of rated thrust, first time for the cluster at this performance level. Inspection after the test showed a small hole in the no. 3 engine's fuel preburner that allowed burning gas to escape into the area above the heatshield containing the powerheads. Damage was confined to the one engine, with none to the facility or the rest of the test article, MSFC engineers said.

The damaged engine would probably be returned to the manufacturer, Rocketdyne Division of Rockwell International at Canoga Park, Calif., for inspection and repair. A committee headed by Dr. Herman Thompson, deputy director of the science and engineering directorate at MSFC, was appointed to find the cause of the accident; no date would be set for further testing until the committee made its report. (MSFC Release 80-97; NASA Release 80-113)

• ComsatCorp said that it had signed a contract with MultiVisions, Ltd., of Anchorage for the first commercial use of a new 10-meter multiple-beam torus antenna, a revolutionary design allowing a user to work with as many as seven geosynchronous satellites at the same time. The usual parabolic dish antenna could work with only one satellite at a time.

The torus, scheduled to be in operation in Anchorage next year, would be equipped initially to receive television programs from three satellites simultaneously. With three dual-polarization receive-only feeds, the new antenna could receive up to 72 different programs from 72 different transponders from U.S. domestic satellites, and additional feeds would provide even greater capacity. Where access to more than one satellite was needed, the torus would be cheaper both to build and to operate than the two or more conventional antennas that would usually be required. It would also reduce the amount of real estate needed for several parabolic antennas and the amount of interference in congested frequency areas (of which Anchorage was one). ComSatCorp had asked the FCC for permission to locate torus antennas at Etam, W. Va., Andover, Maine, and Jamesburg, Calif. (ComSatCorp Release 80-30)

• INTELSAT announced that Guinea became the 105th member in a ceremony at the U.S. State Department when Ambassador Mamady Lamine Conde signed the operating agreement. Guinea planned to operate a ground station using the Intelsat spacecraft located over the Indian Ocean. (INTELSAT Release 80-15-I)

*July 15:*The *Wall Street Journal* said that ESA would go ahead with a $125 million probe of Halley's comet because original plans for a $370-$470 million joint mission with NASA had become impossible due to U.S. budget cuts. The original plan called for launch of a Space Shuttle that would have sent a satellite to Halley's as well as to Tempel 2, a comet much farther out in space.

NASA had to scrub the two-comet mission because it couldn't get the money for a new kind of space engine to make the flight; the *Wall Street Journal* said that it was still studying a stopgap plan to use an old-fashioned rocket to shoot a spacecraft past Halley's when it approached Earth. ESA now planned to put up a 750-pound satellite, Giotto [see July 10], from Kourou in July 1985 to rendezvous with Halley's in March 1986. (*WSJ*, July 15/80, 30)

*July 17:*The *Washington Star* reported that discovery of a "serious potential safety defect" in the nation's most widely used jet engine had led the FAA to order mandatory inspections for two-thirds of the short- and medium-range commercial jetliners in the United States. The engine was standard on three major planes: the medium-range Boeing 727, with three engines, and two short-range planes with two engines each, the Boeing 737 and the McDonnell Douglas DC-9. Each FAA-ordered inspection on a Pratt & Whitney JT8D engine would take 170 hours to disassemble it to the point where it could be checked. Some of the engines were nearly new; others had been serving for several years: a JT8D would normally be retired after 20,000 cycles in service.

When a Hawaiian Airline DC-9 blew up on takeoff at Honolulu June 15, FAA inspection revealed that a portion of the engine was subject to metal fatigue and failure because of the factory machining of the metal. No serious injuries occurred in the Hawaii incident. However, random FAA checking showed that other planes equipped with JT8D engines had cracks in the same engine spot as the Hawaii plane. The potential flaw in the engines was the eighth compressor hub, a 591-pound wheel with an array of blades located in the middle of the 3,000- to 4,000 pound engine. Each engine had 13 compressor hubs, each with a successively smaller set of fans to collect air and force it through smaller areas into the fuel-combustion chamber. Machining of a flange on the eighth compressor hub was ground against the grain of the metal, putting unusual strain on that part. FAA spokesman Dennis Feldman could not estimate the cost of the inspection programs, thought to be in tens of millions of dollars; nor could he give any definitive answer as to whether the manufacturer or the airline would have to cover the cost. (*W Star*, July 17/80, A-1)

July 18: Newspapers reported the launch at 8:04 a.m. local time of the 771-pound *Rohini 1* by India's space research organization (ISRO), making India the sixth country in the world to build and launch its own satellite. *Rohini 1* was launched from Sriharikota Island near Madras on a four-stage SLV-3 solid-fuel rocket into an orbit with a 919-kilometer apogee, 306-kilometer perigee, 44.7° inclination, and 97-minute period. "This is a great day for India," said Prime Minister Indira Gandhi, who estimated the cost of the launch vehicle at $25.2 million.

The *Washington Post* said that the launch was remarkable "for a country that still used bullock carts as a prime mode of transportation." Despite its poverty, India had the world's third largest pool of technically trained personnel. Dr. Satish Dhawan, head of ISRO, said that the successful launch would pave the way for liquid-fuel rockets carrying larger payloads up to 1,300 pounds. India's 17-year-old space program had had setbacks, including a failure in August 1979, when its rocket dropped into the Bay of Bengal about 5 seconds after liftoff because the second stage failed to ignite. Launch of Rohini "underscored India's place as the most powerful nation of the South Asian subcontinent," said the *Washington Post*. (*W Post*, July 19/80, A-13; *W Star*, July 19/80, 4; *NASA Dly Actv Rpt*, July 21/80)

• Since Mt. St. Helens erupted May 18, NASA reported what it called the most complete observations to date of volcanic aerosols in the stratosphere.

Large volcanic eruptions had previously changed Earth's weather (short-term) and climate (long-term). ARC had collected Mt. St. Helen's data for its aerosol climate effects (ACE) program, using the U-2 aircraft in sampling missions on May 19, 22, and 27, and June 14 and 17.

A preliminary analysis of the volcanic plumes showed solid ash and sulfuric acid, the proportions varying in different samples. The acid in the stratosphere was several hundred times greater than before the eruptions. The first flight found ash particles as large as 30 microns, of composition similar to ash on the ground near the volcano. (Largest particles found on later flights were about 3 microns.) Gaseous sulfur dioxide also increased: levels on the first flight were 10 to 1,000 times ambient levels, and on the second flight were 100 times normal. The second flight found water vapor in the plume to be 10 times the normal amount, showing that volcanic water was injected into the stratosphere. A July 1979 ACE flight over Alaska gave baseline levels for comparison with conditions after the eruption.

On the day of the eruption, one of NASA's SAGE teams in Wyoming launched instruments on a balloon to enter and measure the dust plume; it detected dust concentrations 400 to 1,600 times normal in the stratosphere. The SAGE satellite launched in 1979 tracked the Mt. St. Helens' clouds as it had those of two previous eruptions. WFC sent an Orion P-3 a plane on an "underflight" as the cloud went over North Carolina and the Atlantic Ocean, along with a Super Loki rocket; these flights gave scientists simultaneous data readings from above and below the atmosphere. By late June, LaRC scientists decided that, although Mt. St. Helens could have boosted stratospheric aerosols by 50%, there was as yet no sign of adverse climate change. (ARC Release 80-62; NASA Release 80-107)

July 22: NASA unveiled the first scientific and applications payload for the STS (Shuttle) at GSFC's clean room, where instruments were installed in the package planned as an alternate payload on orbital test flight 4, scheduled for April 1982. (Prime payload for this flight belonged to DOD.) Called OSS-1 for NASA's Office of Space Science, the entire payload was designed, built, tested, and integrated by a team of GSFC engineers and scientists headed by Ken Kissin, OSS-1 mission manager, and Jon Busse, project manager for Shuttle payload integration and rocket experiments. Project scientists were Drs. Siegfried Bauer and Werner Neupert. The seven principal OSS-1 experiments were in the disciplines of space plasma physics, solar physics, astronomy, and life sciences, each represented by one or more instruments. (NASA Release 80-114, 80-117)

• NASA announced that a sunspot hotline set up at GSFC would keep the public informed about solar flares during the 1980 peak cycle of activity. Daily recorded messages would contain information on sunspots, solar flares, geomagnetic storms, and the impact of solar activity on radio transmissions, for instance. The recordings provided jointly by NASA and NOAA through its space environment services center in Boulder, Colo., would originate in the SMM facility at GSFC. The "Solar Max" spacecraft launched February 14 was an orbiting solar observatory carrying seven instruments whose data, coordinated with data from scientists at ground-based observatories throughout the world, would permit the most comprehensive investigation of solar flares ever made. Information from these sources would be relayed to GSFC on a 24-hour basis so that NASA scientists could determine which active regions of the Sun to study during the next 24 hours. (NASA Release 80-116)

*July 23:*The Soviet Union launched *Soyuz 37* at 9:33 p.m. Moscow time, carrying Col. Viktor Gorbatko and a 33-year-old Vietnamese air force pilot, Lt. Col. Pham Tuan, first Asian space traveler and sixth citizen of an eastern-bloc country to be part of the USSR's Intercosmos program. The Soyuz would link up within 24 hours with the orbiting *Salyut 6* space station where Leonid Popov and Valery Ryumin had been working for more than three months. The Salyut's docking port had been cleared July 19 by jettisoning cargo ship *Progress 10,* which burned up reentry. (*W Post*, July 24/80, A-15; *Today*, July 24/80, 1A; *W Star*, July 20/80, 2; July 24/80, A-7)

• Forthright criticism of Carter-administration space policy came from Rocco A. Petrone, former director of MSFC, and Dr. Thomas A. Paine, who was NASA administrator during the early manned lunar landing years, the *Huntsville Times* reported. The two testified July 23 before the House Committee on Science and Technology's subcommittee on space science and applications.

Committee chairman Don Fuqua (D-Fla.) and ranking minority member Larry Winn (R-Kans.) both expressed support of the NASA veterans; Winn remarked that it was :"like old timers' day up here." Under Carter, Paine said, the U.S. had "lost both our senses of direction and our resolution. . . Ringing rhetoric proclaiming U.S. leadership in space is no substitute for plans and programs. In my view it is self-delusive to give lip service to leadership while avoiding initiative and commitment."

Petrone said the usual pause for evaluation after a large program like the lunar mission "is now becoming dangerously close to a condition of stall and possible loss of minimum momentum needed" for complex space programs. He expressed concern over "technological timidity in a nation that has been built over the years on technological strength." (*Htsvl Tms*, July 24/80, 6)

*July 25:*A rescue training exercise at KSC was about to begin: a mock-up of the Space Shuttle was set down in a pond, and the rescue team was ready to practice its procedures in case the Shuttle overshot the runway upon its return to launch site and landed in the drink. Then, Fat Albert rose from the pond and lumbered up to Sun himself about 10 feet from the mock-up. The test was halted until wildlife officers arrived on the scene.

Fat Albert, a local alligator, used to share lunches with KSC employees until (so it is said) he ate an employee's tennis shoe right off his foot. The wildlife officers who lassoed and carried away the alligator weighed him (1,00 pounds) and measured him (13 feet, 9 inches). With Fat Albert gone, the maneuver continued: the rescue team dropped from a helicopter into the pond and rescued two dummy astronauts from the mock-up. (JSC *Roundup*, July 25/80, 1)

*July 28:*NASA reported on a solar-flare "first" resulting from coordination of data from the Solar Max spacecraft and from a network of sophisticated ground observatories participating in the International Solar Maximum Year.

On the basis of worldwide predictions, instruments on the Solar Max and at observatories in 18 nations had focused on an active region of the Sun June 24. On June 28-29, that region produced two major flares, captured by all seven spacecraft instruments (first all-instrument simultaneous measurement of the same flare since the spacecraft was launched in February). The observation was also the first in which scientists traced material ejected from a flare into the solar atmosphere. (NASA Release 80-120)

• The first Viking soft-landed on Mars just four years ago, the *Washington Star* noted, but "it seems now like ancient history": this week, the Viking orbiter would shut down for good [see July 9]. It had been mapping Mars with high-resolution photographs since 1976; even more remarkable was the lander, scheduled to last for 90 days and now programmed to operate possibly through 1994.

"All this suggests an extraordinary contrast," the paper said, "On Mars, American technology is thriving. . .on earth, the American genius that made such things possible is not being encouraged." As the last messages arrive from the Viking orbiter, "its most important message—what the end of its useful life has to say about America's scientific and technological future—is the one not heeded." (*W Star*, July 28/80, A-6)

*July 30:*LaRC said that its researchers, working with the FAA in a Radio Technical Commission for Aeronautics, might have solved a problem relating to general aviation aircraft distress-signal equipment, six of every seven failing to transmit after a plane crash and about 75% of all signals being false alarms.

The devices, emergency locator transmitters, emitted a signal on a wavelength designated for emergency use to locate downed aircraft and were supposedly activated by the impact force of a crash. The problem was in the sensor switch, which was sometimes too sensitive to normal aircraft vibrations (and sent false alarms), sometimes not sensitive enough to forces in a crash.

Langley engineer Huey D. Carden had designed and tested an experimental switch sensitive to low-cycle vibrations out of the range of normal aircraft vibrations and closer to the low-cycle pulselike force of a crash. The researchers were also looking into the general usefulness of the beacons and their performance as a total system. (LaRC Release 80-53; NASA Release 80-118)

• MSFC reported that July 21 had marked the end of an era: Gustav A. Kroll, last of the original 118-man "von Braun team" to leave the center, retired just six weeks short of having 35 years of U.S. government service. He had headed the structures division of MSFC's Structures and Propulsion Laboratory.

Kroll arrived in the United States in 1945 in Operation Paperclip and worked at Ft. Bliss, Tex., with the von Braun team, which transferred to Huntsville in 1950. Kroll became a U.S. citizen in 1954. He received NASA's exceptional service medal in 1976 for "guiding the overall structural design of the solid rocket boosters," two of which would be used in the first two minutes of flight on each Space Shuttle launch, recovered, and refurbished for reuse. He had worked in structures throughout his career: "all of them—every one of Marshall's projects—Redstone, Jupiter, Saturn, Shuttle—all of them," he said. Looking back, "there are no favorites, but the highlight would have to be the Saturn V flight and landing on the moon." (MSFC Release 80-101)

• The *Washington Star* said that prospects of mining on the Moon brought senators, scientists, and lawyers together to discuss profits that would not be earned for years, if ever. Witnesses at a Senate commerce subcommittee hearing said that some companies thought private investment would be hindered by any treaty that called for dividing lunar products among Earth's nations. A proposed Moon treaty approval last year by the United Nations said that lunar resources were "the common heritage of mankind," a phrase that might threaten profits of the few nations or companies that could mount successful moon-mining expeditions.

NASA's Dr. Robert Frosch said the treaty was not a problem, noting that years of development would have to precede any actual "issues of investment or returns in extraterrestrial resources." Former astronaut Sen. Harrison Schmitt (R-N.M.) asked if the treaty might have a chilling effect on investment; Frosch replied, "Only if you want to be chilled." (*Washington Star*, July 30/80, G-7)

July 31: Following an intensive review of the Space Shuttle program over the past few weeks, NASA confirmed a decision made earlier in 1980 to schedule the first Shuttle launch in March 1981. NASA administrator Dr. Robert Frosch said the decision was made in spite of a potential setback when fire damaged a Shuttle engine cluster during a test [see July 14]. A study of the engine fire and its possible impact had already begun but would not impede the effort to maintain the launch schedule. The decision to commit to a March launch came after a series of meetings in which NASA and contractor personnel examined the status of hardware and software required for the first flight.

On the 15-week work schedule from rollout to launch, Frosch said that experience of previous "first launches of new vehicles" showed that original schedules were seldom carried out in the time planned, but "the best chance of the earliest successful first flight comes in working to a tight but achievable work schedule." (NASA Release 80-122; MSFC Release 80-102)

During July: ESA's monthly newsletter said that the launch failure of its Ariane L02 launch vehicle [see May 23, June 17] did not call into question the continuation of the program. When the cause of the engine failure was known, program officials would conduct the other two qualification firings. The six Arianes now being manufactured would launch Marecs B, Sino 2, Intelsat V, Exosat, ECS, and Telecom 1A, the organization said. (ESA newsletter, July 80)

• NASA announced appointment of Dr. Stanley I. Weiss, DOE's deputy assistant secretary for industrial and utility applications and operations, as associate administrator for space transportation operations, effective July 7. He would be responsible for STS functions including Shuttle, Spacelab, and expendable launch vehicles during transition to the Shuttle. (NASA anno July 2/80)

—NASA announced appointment of Gerald D. Griffin, deputy director of KSC, as acting associate administrator for external relations at Headquarters effective July 7. He would have responsibility for policy-level management, direction, and coordination of NASA's Offices of Public Affairs, International Affairs, DOD Affairs, Government/Industry Affairs, and University Affairs, reporting to the NASA administrator. His KSC responsibilities would be given temporarily to senior managers at that center. (NASA Release 80-104; NASA anno July 3/80)

• The *Washington Post* reported the death of Walter R. Dornberger, 84, who as a German general had supervised Wernher von Braun's work on the V2 rocket during World War II. Cause of death June 26 was not given in either the *Washington Post* or *Aviation Week & Space Technology*. Dornberger was visiting in West Germany. He had come to the United States in 1947 after two years in a British prisoner-of-war camp; like more than 100 other German-born rocket scientists who worked for the U.S. Army and U.S. Air Force, he became a U.S. citizen. He also worked for Bell Aerosystems Company, where he was a vice president.

A volunteer in the imperial German army of World War I, Dornberger was a career soldier to the end of the second war. In 1932 he was given charge of a group of scientists working on rocket concepts and moved to Peenemunde in 1937. When the first test of the V2 October 3, 1942, was successful, Dornberger asked von Braun: "Do you realize what we accomplished today?" Von Braun said "Yes, today the spaceship was born." In 1958, nearly three years before President Kennedy voiced the goal of landing a man on the Moon by 1970, Dornberger predicted that man would be on the moon in 10 years:

"whether he is Russian or American depends on how much money Congress is willing to spend," he said. (*W Post*, July 2/80, B-6; *AvWK*, July 7/80, 25)

• The *Washington Star* reported five new members for the Aviation Hall of Fame: former astronaut Charles Conrad, third man to walk on the Moon; Anthony H. G. Fokker, founder of Fokker Aircraft Company; William T. Piper, founder of Piper Aircraft Corporation; retired U.S. Air Force Gen. Bernard A. Schriever, "architect of the Air Force's ballistic missile program"; and Robert F. Six, founder of Continental Airlines. Fokker and Piper were honored posthumously in the announcement at Dayton, Ohio's, exhibition center. (*W Star*, July 21/80, A-2)

• NASA announced that its quiet short-haul research aircraft (QSRA) had made more than 500 landings on a simulated aircraft-carrier deck in a NASA/U.S. Navy study of the application of propulsive-lift technology to aircraft carriers. The landings were made at a naval auxiliary landing field near ARC in California. Using a carrier-deck outline painted on the runway, the craft in 23 mph (37 kmh) headwinds touched down at about 52 mph (84 kmh), slow enough to make unnecessary the arresting gear normally used on carriers.

Actual operations would be demonstrated on a U.S. carrier at sea off San Diego later in July. Built by Boeing under NASA contract, the plane was essentially a new aircraft making extensive use of existing parts: fuselage and tail from a deHavilland C-8 Buffalo, landing-gear parts from a Boeing 727 jet transport, and engines from the US A.F. A-9A prototype. (NASA Release 80-111)

• FBIS carried Tass reports on the flight of *Salyut 6*, with Leonid Popov and Valery Ryumin aboard for 12 weeks. The crew spent the first week of July unloading cargo ship *Progress 10*, which linked with the Salyut July 1. Unloading was completed, and the orbiting station was refueled by July 15.

Experiments with Isparitel apparatus were performed, using a powerful beam of electrons to plate metal and glass surfaces with precious metals and alloys of aluminum and copper. Properties of plating done in weightlessness differed from those under Earth conditions, Tass noted. First tests of the apparatus were made last year when Lyakhov and Ryumin brought back 24 titanium plates with metal covering from *Soyuz 32*; the current tests should produce about 200 specimens covered with films of varied thicknesses.

Progress 10 separated from the *Salyut 6-Soyuz 36* complex at 1:21 Moscow time July 18 after a 17-day stay, during which its engine was used to adjust the station's orbit. On July 19 the cargo ship engines were switched on by ground command; it reentered over the Pacific and "ceased to exist."

Soyuz 37, launched at midnight July 23 Moscow time, carried the first Vietnamese cosmonaut, Lt. Col. Pham Tuan, and veteran cosmonaut Col. Viktor Gorbatko as the sixth Intercosmos crew to visit with Popov and Ryumin, fourth main crew on *Salyut 6.* At the launch, Boris Petrov, vice president of the Soviet academy of sciences, noted that "although space school in Vietnamese science was established later than in other Soviet countries," experiments in space medicine and technology and in mapping of land and ocean surfaces had been prepared for the Soviet-Vietnamese expedition. *Soyuz 37* docked with *Salyut 6-Soyuz 36* at 2302 Moscow time July 24; on July 25, the visitors began a study of head blood circulation during adaptation to weightlessness, with Pham Tuan as first subject. The visitors returned in *Soyuz 36* at 1815 hours July 31 to the preset area near Dzhezkazgan. (FBIS, Tass in English, July 4-31/80)

August

August 1: WFC reported the successful launch July 31 or a two-stage sounding rocket to test both the vehicle system and a "mother-daughter" two-part payload, an electrodynamics package to be used in a series of three launches from Norway later in 1980. Launched at 8:18 a.m. on an Honest John-Orion rocket, the 216-kilogram (476-pound) instrumented payload was programmed to separate at about 95 kilometers (59 miles) altitude and measure the electric field and profiles of ion density and conductivity in the atmosphere. (The three experiments to be launched in Norway would measure energetic-particle and X-ray fluxes and ultraviolet light from the aurora in addition to the electric field and ion density and conductivity.)

Telemetry showed that the payloads separated as planned and both the sections reached peak altitude of 111 kilometers (69 miles). The "daughter" payload, a sphere with six 1-meter booms extending from it, performed well and exhibited good stability until descent. At 73 kilometers (45 miles) on the way down, a 65-foot-diameter mylar parachute deployed from the "mother" section; this was a lower altitude that planned, resulting in a faster fall than planned, but the section's stability allowed it to acquire usable data. This section also contained a movie camera to film parachute deployment; recovery of the section from the Atlantic was in progress. (WFC Release 80-9)

August 4: The *Wall Street Journal* reviewed the competition for locating the Large Space Telescope's science institute at one of three sites, each the protege of a university consortium: Princeton University in New Jersey, the Johns Hopkins University in Baltimore, and the Fermi National Accelerator Laboratory west of Chicago. NASA teams visiting the sites would make a decision in October.

In November 1979, five sites were being promoted with two others as minor contenders: Princeton, Hopkins, Fermilab, the University of Colorado, and the University of California at San Diego (UCSD) plus the Universities of Arizona and New Mexico, where numerous ground telescopes were already located [see November 18, 1979]. Usually the site for an astronomical installation would require clear skies and steady air, but "any old kind of sky" would do for the Space Telescope, the *Wall Street Journal* said, as the images its computers received would originate above Earth's atmosphere. The winning manager would provide his own building, either a new one or a remodeled existing one; a resident staff of 100 to 150 persons; and room for a constant flow of visiting astronomers. (*WSJ*, Aug 4/80, 15)

MSFC reported that students from the Massachusetts Institute of Technology (MIT) had returned to the center to continue a study begun last

January on in-space assembly of large structures in MSFC's neutral-buoyancy simulator, this time with a manned maneuvering unit they had built themselves. The MSFC simulator, a 1.3 million-gallon water tank, closely approximated a zero-gravity environment. The students had spent three weeks on a NASA-MIT project, assembling in the tank a tetrahedral truss containing 48 parts: 36 tubular beams 11 feet long with 12 joints, largest in number of components ever tested in the simulator.

Since their January stay, the students had modified the beams and joints (designed and made in MIT machine shops) on the basis of data derived from their work at MSFC and had been building an alternative crewed maneuvering unit. Testing it at MSFC would show whether it would be of use in assembling large space structures; like one previously built by MSFC engineers, it had instead of the gas jets needed to move it in space five small motor-driven propellers to move it in the tank. The motors were enclosed to prevent injury to other divers or damage to hoses and lines in the simulator. The unit would fit on the backpack worn over a pressurized space suit. (MSFC Release 80-103)

• Press reports said that Maxie Anderson, who made a transatlantic crossing in the balloon Double Eagle II in 1978, crashed his balloon Columbine II into a lake near LaCrosse, Wisc., August 4 during opening ceremonies of the U. S. National Hot Air Balloon Championships. Anderson, his wife Pattie, and copilot Don Ida escaped injury, but the balloon was destroyed.

August 6: A small device flown in space for the first time had detected small changes in the Sun's brightness over periods of days to months, NASA said. An experiment on the Solar Max satellite had registered fluctuations of about a tenth of 1% in solar radiation, corresponding to a change of up to 10°C (18°F) in the Sun's average temperature. This trend lasting for several years could make major alterations in Earth's climate; measurement of even the slightest change in the Sun's emitted heat and light might enable scientists to predict future changes in climate. A drop of 1% in the output of solar radiation would lower Earth's mean temperature by more than a degree (2°F); if solar radiation decreased by only 6%, the entire Earth would be covered with ice.

Evidence showed that Earth had been cooling down for about 90 million years; it was about 8°C (15°F) warmer 150 million years ago than it was today and might cool by 10° or more in the next several million years. Cycles with frequencies ranging from 22 years to millions of years had caused ice ages ranging from glacial epochs to "little ice ages." Most recent of the latter, beginning in the mid-17th century and lasting about 200 years, was a 1.5° drop from mean global temperature of 14°C (58°F): it resulted in observable increase of glaciation in the Alps. (NASA Release 80-124)

August 7: The *Washington Post* reported that schoolteacher Janice Brown, 32, piloted Paul MacCready's solar-powered Gossamer Penguin as high as 12 feet off the ground for 14 minutes, 21 seconds, going 2 miles along a desert streambed at Edwards Air Force Base in the first sustained flight by an aircraft powered only by the Sun. The top speed was 16.5 mph. The Gossamer Penguin had a 72-foot wingspan and weighed about 68 pounds, including the bank of 2,800 photovoltaic cells mounted above the wing. Unlike other electrically powered aircraft, Penguin had no storage batteries and relied only on direct solar power. (*W Post*, Aug 8/80, A-6; *Indl Dsgn*, Sept/Oct 80, 18; FRC *X-Press*, Aug 22/80, 2)

• JPL engineers had sent a command August 7 to Viking orbiter 1, switching off its transmitter and ending its four year mission. Viking project manager Kermit Watkins said that its attitude-control gas would have been depleted before it completed another orbit: by commanding it to turn off, instead of allowing it to occur automatically, "we will be sure that the radio transmitter has been shut off." Confirmation of the switchoff was received at 4:16 EDT August 7. The Viking lander would continue to transmit meteorological and engineering data weekly on command until about December 1994. (NASA Release 80-129; *NASA Dly Actv Rept*, Aug 11/80; *W Star*, Aug 5/80, A-2)

August 8: DFRC said that it was awaiting delivery of a new aircraft that would take off and land like a helicopter and cruise in flight like a conventional airplane: the XV-15A, built for NASA and the U. S. Army by Bell Helicopter Textron in Ft. Worth, Tex. Another XV-15 was at ARC preparing for research flight tests. The one being delivered to DFRC would serve to expand performance limits reached by NASA, military, and contract pilots in a flight-test program expected to last one year; the ARC craft would be flown within limits established at DFRC to accomplish specific research objectives. (NASA Release 80-127; DFRC Release 80-16)

• NASA reported that its QSRA was the first four-engine transport jet to land and take off from an aircraft carrier at sea [see During July]. It made 37 touch-and-go landings and 16 full-stop landings on the carrier during the evaluation, and 16 takeoffs without the aid of catapult gear. The tests, by a Navy pilot, Lt. Cdr. Pete Strickland, and two NASA research pilots, Jim Martin and Bob Innis, deomonstrated QSRA's use on short runways and its quieter operation. (NASA Release 80-126)

August 10: DOC reported that the *Nimbus 7* satellite successfully tracked between October 16, 1979, and June 15, 1980, the 800-mile journey of a 2121-pound loggerhead turtle called Diane from a point south of Gulfport, Miss., past Louisiana and Texas to an area in the Gulf of Mexico near Brownsville, Tex., where Diane apparently shed the signal transmitter. (NOAA officials said that, after a break in transmission, a mystery developed when the signal resumed, moving inland to stop in Kansas—far from the turtle's ocean or river habitat. A fisherman had found the 7-pound transmitter on a beach near Port Arthur, Tex., and had taken it home, where he used the $5,000 device as a doorstop.)

Robert Timko, electronic engineer at NOAA's Marine Fisheries Service (NMFS) laboratory in Galveston, said that no technology except satellite tracking could have followed a wide-ranging and generally inaccessible animal like the loggerhead turtle (a threatened species) over so large an area. NMFS would use the data to identify feeding, nesting, and mating areas to help manage the stock of sea turtles. The test was inspired by previous work with polar bears, which were tracked from 60 to 90 days. (NOAA Release 80-102)

August 11: ARC reported that eight men aged 35 to 50 would participate in a study of weightlessness to help NASA learn why spaceflight dehydrates humans. Dr. Joan Vernikos-Danielis of ARC's biomedical research division would use a head-down method in prolonged bed rest for the study; the rush of blood to the head in the first exposure to zero gravity might trigger the body mechanism that eliminated fluids and salts. The Soviets for some time had been using bed rest with head down 6° from the horizontal to simulate weightlessness. Usable measurements were not obtainable during actual spaceflight because of the heavy demands on astronauts in the first stages of a mission. (ARC Release 80-68; NASA Release 80-131)

• LaRC staff working this summer at NOAA's National Severe Storms Laboratory at Norman, Okla., guided a modified F-106B jet fighter plane through severe southwest thunderstorms to show that lightning could strike not just once but two or even three times in the same place. Most lightning study had been at ground level; LaRC was studying its effect on planes in flight.

The F-106, holder of a world single-engine speed record set in the 1950s, was still used by the Air Force and could fly up to 50,000 feet (15,250 meters); most flights would be around 15,000 feet (4,500 meters), the altitude where lightning was most statistically likely to strike. LaRC used an F-106B on loan from DFRC, considered top choice for the mission because of its thick wing skins and its larger-than-average bay with room for much experimental equipment.

All F-106B work was on storm hazards, divided into those that did or did not involve lightning (those unrelated to lightning were turbulence, wind shear, and storm-hazards correlation). Hazards from storms were factors in aircraft operations and design. Through the summer, WFC instruments would map thunderstorms and the exact location of the F-106B in them, to compare with pilot and instrument observations. (NASA Release 80-130; LaRC Release 80-56)

August 13: WFC reported that it had made nighttime electric-field measurements in the "middle atmosphere" from balloon ceiling to the ionosphere (30 to 100 kilometers), to extend measurement capability into this region, and to compare techniques simultaneously on a worldwide basis. During the past decade scientists had become able to obtain reliable data elsewhere in the atmosphere (troposphere, stratosphere, ionosphere, magnetosphere, and even in deep space) but not in the middle region. WFC used rockets and a balloon for its local experiments; radars in Massachusetts, Alaska, Peru, Puerto Rico, France, and Scandinavia made supporting ground measurements.

At 8:35 p.m. EDT August 13, WFC launched a hundred-thousand cubic-foot balloon inflated with helium, carrying a 21-kilogram (46-pound) payload to measure AC and DC electric fields from to 10 kHz in the middle atmosphere. The mission ended 10 hours, and a chase plane located the payload near Roanoke, Va. At 10:40 p.m. EDT, WFC launched a two-stage Nike-Orion rocket carrying a 232-kilogram (510-pound) payload that reached peak altitude of 90.2 kilometers (56 miles) and recorded data during both ascent and descent. The payload included a water-recovery system; it was recovered at 11:58 p.m. and returned to WFC.

At 11:11 p.m. EDT, WFC launched a single-stage Super Arcas to reach 90 kilometer (58-mile) altitude, carrying an experiment called Blunt Probe to measure electric fields as well as positive and negative conductivity in the middle region, for comparison with balloon and Nike-Orion measurement. (WFC Release 80-11)

• ARC would close the free world's largest wind tunnel for an $85 million modification. The 40 x 80 foot (12 x 24 meter) tunnel, in continuous use since completed in 1944, would have a 600-foot (183-meter) addition to house a new test section 80 x 120 feet (24 x 37 meters) with an air intake 362 feet (110 meters) wide and 132 feet (40 meters) high. The six 6,000-hp electric motors used since 1944 would be replaced with 22,500-hp units, raising drive from 36,000 hp to 135,000 hp. (NASA Release 80-125)

• NASA reported results of a coordinated balloon and rocket launch at WFC August 13 to measure fair-weather electric fields. A balloon carrying Aerospace Corporation instruments measured vector electric fields on six booms and evaluated the data with an on-board COSMAC microprocessor. At 30-kilometer altitude, it saw unexpectedly large fields for about one hour. Rockets carrying payloads from Cornell and Penn State Universities launched 20 minutes apart during the balloon flight, both saw anomalously large electric fields that peaked near 70 kilometers. The results would call for revision of present theories, as they suggested that some other generator of electricity was active in addition to the thunderstorm-driven system and the ionospheric system. (*NASA Dly Actv Rpt,* Sept 23/80)

August 20: NASA announced a student involvement project, a joint activity with the NSTA. Up to 200 semifinalists in a competition to develop experiments for flight on the Shuttle and their teachers would attend preliminary conferences in 10 regions to discuss the proposals with other students as well as NASA and industry scientists; many of the regional conferences would be at NASA centers. NASA awarded the science teachers' group a contract to conduct the competition and select the winners.

From the 200, 10 would be selected whose concepts would best use the capabilities of the Shuttle. The 10 national winners would attend a special conference at KSC late in 1981; all entrants would receive a certificate of participation. Shuttle flights should begin in March 1981; the winning experiments might go on flights in 1981 or 1982. (NASA Release 80-132)

August 22: JSC reported on its new water-immersion facility (WIF) for Shuttle crew training. MSFC would furnish some payload training mock-ups; JSC would build others including a full-sized Shuttle bay. The new pool, measuring 33 x 78 x 25 feet and located in a building formerly housing an Apollo manned centrifuge, would hold half a million gallons—as much water as 25 average backyard swimming pools—heated to a constant 85°F for diver comfort over long periods of time. It would replace a 25-foot-diameter tank built in the mid-1960s for Gemini and Apollo emergency training.

Filter and chemical systems would reduce bacteria and provide a clear medium needed for underwater photography. Six submersible television cameras, two operated by divers and four mounted under water, would follow the training operations, with pan, tilt, and zoom operated from a console at the pool edge. The facility would include a 5-ton air-powered overhead crane to lift trainers and mock-ups out of the water (and eliminate electrical shock), as well as air compressors to fill scuba tanks. (JSC *Roundup,* Aug 22/80, 1)

August 25: ARC reported on a space-technology assessment workshop held at the University of Santa Clara in California on robotics, automation, remotely operated systems, and artificial intelligence vital to future missions such as an orbiting space factory, a self-directed deep-space robot explorer, a fully automated Earth-resources and Earth-environment monitor, or a lunar base able to expand through self-replication of its elements. The 10-week workshop would end August 29 with an oral report and submission of other reports for publication.

Drawing on work by research institutions such as Stanford University, MIT, and SRI International as developers of computer-based "intelligence," the program participants included 18 professors of engineering, mathematics, and science, 15 NASA engineers and scientists, and several representatives of manufacturer groups. The workshop emphasized four areas:

—A versatile "intelligent" satellite information system able to select and interpret the data from its sensors to give specific items to a specific user, unlike previous systems recording everything they saw to produce great masses of superfluous data.

—A deep-space exploration system for reconnaissance, exploration, and intensive surface study of planetary bodies, specifically Saturn's moon Titan, bigger than the planet Mercury and with its own atmosphere. Uniting functions of previously separate craft (orbiter, atmosphere probe, mobile surface explorer), the vehicle would observe an unknown environment and modify its "knowledge model" and exploration techniques according to its observations. Systems of this sort could explore distant bodies in the solar system such as outer planets and their satellites, comets, and asteroids; such systems would be required for exploring planetary systems of other stars when communications distances and flight time of many years would preclude manned involvement.

—A permanent automated Earth-orbiting facility initially geared to process Earth-supplied raw materials in the space environment; later it would make progressively larger use of nonterrestrial materials from the asteroids and moons of Earth and other planets. The workshop considered a number of processing and manufacturing techniques adaptable to a space environment, starter facilities capable of producing a wide range of items, and the tools that would be needed to expand the facility's capabilities.

—A factory on the Moon to use lunar materials and replicate itself, its first major product being another lunar factory or factory segment. Such a self-replicating facility had been of theoretical interest for some time as a way of rapidly expanding space resources. The workshop had studied types of logical organization for such a factory, and requirements for an Earth-based demonstration of the concept. (ARC Releases 80-69, 80-70; NASA Release 80-134)

August 26: Press reports said that the U.S. Air Force wanted to spend about $1.4 billion to replace the wings of 81 "trouble-ridden C5A cargo transports." In 1965, Lockheed Corporation had decided to reduce the weight of C5A wings by 5 tons each, so as to underbid Boeing on a contract for building aircraft capable of carrying outsized loads. Robert B. Ormsby, Jr., president of Lockheed-Georgia, which built the planes, told a congressional hearing that the company's sole objective was to reduce wing weight to "the absolute minimum within the design requirements" and denied any company plan to replace the wings later when they should prove unsatisfactory. The 10,000-pound weight reduction apparently caused cracks in the aircraft calling for wing replacement: "Ormsby did not explain why Lockheed did not know that the modification would reduce the effective life span of the wing from the 30,000 hours specified by the Air Force to an estimated 7,100 hours," the *Washington Star* noted.

Principal focus of the hearings was on whether the 30,000-hour service life presented by Lockheed and the U.S. Air Force as justification for the $1.4 billion wing-replacement program was really necessary. Sen. William Proxmire (D-Wis.), chairman of the subcommittee on priorities and economy in government of the House-Senate Joint Economic Committee, said Lockheed's $2 billion cost overrun on the contract, discovered in 1968, was the largest in defense procurement history. He said the $1.16 billion Lockheed-Georgia would get for wing replacement would be "the biggest cost in history to correct a mistake." When Ormsby said that his firm would make a $140 million profit on the contract, Proxmire said "a lot of businessmen would love to make a mistake like that."

The subcommittee heard David Keating, legislative director of the National Taxpayers Union (NTU), charge that such a profit would set up "a terrible incentive system." The message to defense contractors would be, "The more inefficient you are, the more profit you make. Build failures into the system and you'll be rewarded." Ormsby responded that, in terms of the critical need for the C5A in the nation's defense, the $1.4 billion was a "bargain" for taxpayers.

Paul C. Paris, director of the center for fracture mechanics at Washington University (St. Louis), said that the U.S. Air Force set up a Structural Information Enhancement Program (SIEP) after receiving a 3-volume report from Rand Corporation suggesting that C5As could serve under "present constraints on operational use" until the year 2000 without significant modification. The U.S. Air Force had put "severe restrictions on the C5A to prevent it from being flown in accord with its design specifications," Paris said, or it would have lasted "fewer than 3,000 flight hours"; it was "absolutely incredible" that a major aircraft producer would miss the fatigue life of a wing by a factor of more than 10. He said the SIEP assumed "since the [wing replacement] was going to be done, other less expensive options were not to be considered." (Paris was the only member of the SIEP steering committee not an employee of Lockheed or the U.S. Air Force.)

The Rand report recommended appointing a panel of independent specialists to assess the situation; Proxmire, Paris, and the NTU wanted the assessment done by the congressional Office of Technology Assessment. (*W Star,* Aug 26/80, A-8; *W Post,* Aug 26/80, A-8)

August 27: ARC announced selection of Burroughs Corporation and Control Data Corporation to study system design for its supercomputer, the numerical aerodynamic simulator, that would aid in developing and testing new designs for aircraft and other flight vehicles and perform research in areas of fluid flow such as meteorology, gas dynamics, and computational chemistry. The two parallel fixed-price studies, each valued at $350,000, should produce a data processor 40 times faster and with a high-speed memory 60 times larger than those presently in use.

The new computer would use fluid-flow equations for continuous calculation of three-dimensional air flows simultaneously at thousands of points; it could simulate conditions of wind-tunnel testing far more cheaply than actual model tests. It would do a billion operations per second, using a data base of 40 billion words, and could handle 100 users simultaneously. ARC, with project responsibility for the numerical simulator, had been working on the system since 1975. (ARC Release 80-71; NASA Release 80-135)

• NASA announced selection of McDonnell Douglas Technical Services Company to negotiate a cost-plus-award-fee contract to support JSC STS engineering and operations from October 1980 through September 1986. The contract, divided into three increments, would cover technical and analytical support in engineering-systems analyses, flight design, flight operations, and management-systems support. Contractor estimate of the cost for the first two-year increment, plus a firm two-year option, would be about $25 million. JSC would manage the contract. (JSC Release 80-053; NASA Release 80-136)

August 29: NASA announced that the GOES-D meteorological satellite, scheduled for early launch from KSC for NOAA, would carry a new type of instrument: the visible-infrared spin-scan radiometer (VISSR) atmospheric sounder. GSFC would join with the University of Wisconsin in long-term evaluation of the VISSR's usefulness in predicting severe local storms, hurricanes, and other short-term weather phenomena.

Earlier spacecraft in the series had provided 24-hour two-dimensional cloudcover photography; the new sounder would measure temperature and moisture in various altitude layers besides returning high-resolution images. The synchronous GOES satellites, useful in observing storms during development, required observation schedules, data processing, and data analysis markedly different from those for polar-orbiting satellites such as the TIROS series. GSFC, NOAA, and the University of Wisconsin had set up facilities over the past few years to handle the atmospheric sounder data. (NASA Release 80-137)

• In the last of a series on "Life Aboard the Space Shuttle," KSC's *Spaceport News* described the unisex space suits provided for the pilot and the ranking mission specialist on each flight. No longer tailor-made for an astronaut, the Shuttle space suit would come in small, medium, and large sizes to be worn by men or women. It consisted of an upper and a lower section snapping together with sealing rings, with a life-support system in the upper half.

In an emergency, each of the other crew members would use a "personal rescue enclosure," a 34-inch-diameter ball fitted with life-support and communications gear for one person. Nonsuited crew would climb into the enclosures, and the suited astronauts would transfer them from a disabled vessel to a rescue ship by carrying them, by attaching them to the remote-manipulator arm used for deploying payloads, or by using a pulley line between the two spacecraft. (*Spaceport News,* Aug 29/80, 4)

During August: NASA distributed its *Program Plan, Fiscal Years 1981 through 1985,* containing "initial guidance for NASA's activities over the short-term and, to some extent, the long-term future." The introduction noted the current drive to curb inflation and resulting cuts in the federal budget—"including NASA's"—but called for a perception of the work the agency was technologically ready to undertake "and should undertake in the interest of the

Nation." Citing problems raised by "absence of major new initiatives," the introduction called for "sound, logical, technological progression toward achievement" of U.S. goals in aeronautics and space.

Major goals to be met by the plan's 46 "major initiatives" were:

—to fill the transportation and orbital operations needs of science and applications space missions and most transportation needs of national security space missions;

—to apply space technology in remote sensing, communications, materials processing, and technology transfer that "hold promise for immediate or potential benefits to humanity";

—to continue developing aeronautical technology;

—to improve "by a factor of 10 to 100" NASA's ability to acquire, transmit, and process data;

—to advance knowledge of how energy is transported from the Sun and through the interplanetary medium and how that energy effects Earth;

—to ensure good health and performance of humans in space and to study the effects of gravity on living systems;

—to understand the origin and distribution of life in the universe and the relationship between life and its habitat.

Major initiatives in the field of aeronautics numbered 6; in space science, 8; in space and terrestrial applications, 20; and in space transportation systems, 12, for a total of 46.

Half the initiatives listed in a similar program plan (for FY80-FY84) had been postponed: Of the 23 missions, 11 were previously scheduled for 1981; 7 for 1982; 4 for 1983; and 1 for 1984. Of the 11 previously scheduled for 1981, 9 were now postponed to 1982; and 1 each, to 1983 and 1984. Of the 7 missions previously scheduled for 1982, 5 were postponed to 1983; 1, to 1984; and 1, to a time "to be determined." Of the 4 missions previously scheduled for 1983, 1 was scheduled for 1984; and 3, for 1985. The sole mission previously scheduled for 1984 had been postponed to 1985.

International programs in which NASA would be concerned during the next fiscal years would include cooperative activities (Space Shuttle and Spacelab; space applications such as remote sensing, geodynamics, materials processing, and communications; space science such as astrophysics, planetary research, solar-terrestrial relationships, and solar energy; exchanges of experiments with the People's Republic of China and the Soviet Union); reimbursable launches; and foreign competition in remote sensing, communications, spacecraft launching, and aircraft development.

The volume included probable schedules for NASA missions and tables of funding and development needed to carry out the program. Space transportation funding, for instance, showed increases in FY81 and FY82, then leveled off. Funding for applications showed rapid increase; that for aeronautics, space technology, and space science would also increase but at a slower rate.

The 235-page program plan contained detailed lists of activities in each program area, with graphs and tables showing schedules and funding for that area. The book concluded with an index and a list of the abbreviations and acronyms used in NASA's programs. (Text, NASA Hq Mgmt Sppt Ofc, distributed Aug 80)

• *Aviation Week and Space Technology* reported that the Secretary of the Interior had asked the Secretary of Commerce to cancel the Hughes-built thematic mapper [see April 14] that was to form part of an operational Landsat system, originally scheduled for launch on Landsat-D. Cecil D. Andrus wrote Philip M. Klutznick that the main obstacle to achieving an operational Landsat system was "the presumption" that Landsat-D research missions must come first. Andrus noted that Interior had proposed two years ago to give priority to solid-state multispectral linear-array technology [see June 16] instead of the "elaborate, expensive, and research-oriented" thematic mapper.

Andrus, who *Aviation Week and Space Technology* said was "extremely concerned about competition" from France, Japan, and the Soviet Union in remote sensing, emphasized the "implications for the President's policy of leadership in space if France and others are able to offer better resolution data at lower cost before our core system becomes operational." (*AvWk*, Aug 11/80, 17)

• The British Interplanetary Society's publication *Spaceflight* carried an article by one of its fellows (barrister Cyril Horsford, also a director of the International Institute of Space Law), on the agreement covering the activities of states on the Moon and other celestial bodies, opened for signature at the United Nations (U.N.) December 18, 1979. The "moon treaty," 10 years in the making, was adopted by the U.N. General Assembly as a resolution; some of its principles were already in the first outer space treaty in 1967, but several nations, "notably the USSR," had expressed the need for a separate agreement specially directed at exploration of the Moon. The treaty now awaiting signature would apply to all bodies in the solar system and their orbits, as well as the Moon; the text (reproduced as appendix to Horsford's article) was already the subject of controversy among international lawyers and others in two particular areas.

First, Article IV said use of the Moon was "the province of all mankind"; Article XI said the Moon and its resources were "the common heritage of mankind." The difference had raised questions whether the meaning was the same. Article I of the 1967 space treaty had used the words "province of all mankind," whereas the words "common heritage" first appeared during a Law of the Sea conference, when a moratorium on exploration preceded a General Assembly resolution affirming the common-heritage principle. International law had not defined the limits of the principle; the new "moon treaty" would reserve privileges under it to States Parties to it (although "all mankind" would be beneficiaries). Also, the concept of "common heritage of mankind" was apparently limited to the terms of Article XI.1.

Second, the third paragraph of Article XI would apparently prohibit any appropriation of resources found on the surface or subsurface of the Moon; in its literal meaning, this wording would preclude any mining or exploitation of valuable minerals found there in future. Some felt the language was "merely legal," reaffirming the existing principle that no legal property in lunar resources in place could accrue to an exploring state. The U.S. delegate to the United Nation's legal subcommittee was confident that the wording did not place any moratorium on exploration, pending the international "regime of management" required under Article XI.5. Horsford noted that opposition to Article XI had already led the U.S. Senate to postpone ratification of the treaty this year.

Although the 1967 space treaty "clearly enshrined" the principle of non-sovereignty over celestial bodies, "some quarters" feared that such a clause would inhibit space powers (particularly the United States) from embarking on "the costly adventure of lunar exploitation" while such a restraint existed or where an international regime of shared resources would result in little or no profit. "This danger is already apparent in. . .deep sea mining, when an international regime is involved," said Horsford. (*SF,* July-Aug 80, 273)

• The NAA reported that Howard Hughes's Spruce Goose would remain intact under an agreement signed by the Summa Corporation, executor of the Hughes estate, with the Aero Club of Southern Calif. (NAA's California chapter) and with the Wrather Corporation which would display the aircraft near the Queen Mary at the Port of Long Beach. Summa, under pressure to vacate the hangar site, had announced plans to dismantle the Goose and display parts of it at the Smithsonian and eight other museums [see May 23, June 17]. Now it would transfer the flying boat to the Aero Club after agreement on details of display and management. (NAA newsletter, July/Aug 80, 7)

• NASA reported on its 17-year-old art program of inviting well-known artists to document major agency activities. Among participants were traditionalists like Peter Hurd and James Wyeth and modernists like Robert Rauschenburg and Lamar Dodd. NASA had stationed artists at the closest possible observation points during Moon launches and on recovery ships when astronauts returned from space and let them pilot simulators of travel to make-believe moons.

In 1977 NASA commissioned Robert T. McCall to document the rollout of Enterprise at DFRC (McCall was muralist for the National Air and Space Museum). In 1978 Franklin McMahon and Tom O'Hara painted the first flight of the orbiter. Arthur Shilstone and Clayton Pond covered vibration tests at MSFC; Shilstone and Nicholas Solovieff recorded Shuttle progress, including rollout in May 1979 at KSC. NASA would send a team to paint the launch and landing of Columbia. The New York Society of Illustrators had given Shilstone a certificate of merit for his painting "The Crawler: Rollout of the Enterprise" which had been in an international exhibition, including

Japan and China, and would appear in the society's 1980 art annual. (*NASA Actv,* Aug 80, 18)

• *Science* magazine carried R. Ganapathy's report on existence in Earth's Cretaceous-Tertiary geological boundary of debris from a major meteorite impact 65 million years ago, discussing the possible effects of such a catastrophe as extinction of the dinosaurs. (*Science,* Aug 22/80, 921)

• NASA announced appointment of Roy S. Estess as deputy manager of NSTL, replacing Henry F. Auter, who retired in February 1979. Estess joined NSTL in 1966, working on the Saturn V acceptance tests and directing the advanced planning for Shuttle testing at NSTL. Since 1977 he had managed satellite remote-sensing research in NSTL's Earth resources laboratory. (NASA anno Aug 29/80)

—The *New York Times* reported the death from a heart attack at her home in California of Jacqueline Cochran, first woman to fly faster than the speed of sound and director during WWII of the Women's Air-Force Service Pilots (WASPS), which trained more than 1,200 women to fly transport planes. Brought up in poverty and working in a cotton gin in Georgia at the age of 9, she took her first flying lesson when 22 and in 1935 was the first women to enter the Bendix transcontinential air race, winning the Bendix trophy in 1938. She had married Floyd Odlum in 1936 and served as a captain in the British Air Force Auxiliary, returning to the United States after Pearl Harbor. She set more than 200 flying records, breaking the sound barrier in 1953 in an F-86 jet fighter plane. In 1961 she set a new altitude record of 55,253 feet and in 1964 a women's world speed record of 1,429 mph in an F-104G SuperStar. She retired in 1970 as colonel in the Air Force Reserve. (*NY Times,* Aug 10/80, 40)

• ESA observed the fifth anniversary of its first satellite, *Cos B,* designed for an operational life of one year. ESA commended the quality of the spacecraft and its subsystems, especially the spark chamber for which no space experience existed at the time of its construction. The eighth satellite built by European industry for ESA's predecessor, the European Space Research Organization (ESRO), *Cos B* made the first complete detailed survey of the Milky Way in high-energy gamma-ray spectra and discovered a score of new gamma-ray sources. The spacecraft was made by the CESAR consortium led by Messerschmitt-Bölkow-Blom with industrial firms of seven ESA member states: Belgium, Denmark, France, West Germany, Italy, Spain, and the United Kingdom. (ESA Info 21)

• Progress reports on the continuing flight of Leonid Ryumin and Valery Popov in the *Salyut 6-Soyuz 37* orbiting space station noted that their mission had lasted 115 days as of August 1. The cosmonauts were busy redocking *Soyuz 37* (which Pham Tuan and Viktor Gorbatko had used to get to the Salyut) to make room for more supply-ship missions. The visitors had returned to Earth safely July 31 in the *Soyuz 36* craft; next on the list for the long-term occupants was "cleaning of the premises of the orbital complex" and physical training, Tass said.

On August 5 Tass reported completion of various crystal experiments using Splav and Kristall apparatus in "cosmic material studies" of semiconductors cast from gallium arsenide, and crystals of indium antimonide and gadolinium cobalt, a magnetic material. Tass August 9 reported a first: crystallization of a substance from a smelt in "directional microgravitation." The idea was to form crystals at more than "minimum microacceleration." The crew put into the Splav an ampule of raw material and activated it; they then used the space station's motors in a twisting maneuver during which the station became "a sort of centrifuge" for a few hours. Acceleration, zero at the center, "near the transfer compartment and transfer chamber. . .was at its maximum."

Previous experiments had always been during sleep periods, as movement of people around the station affected the results. For more data on crystal formation in orbit, the crew tried it in the span between Earth gravity and zero gravity. Tass called the test a first step in a new science of "weightlessness physics" whose practical conclusions were already being felt. On August 12 Tass noted the crew had been in space for 18 weeks; further tests were going on, making special glass in zero gravity and monocrystals of germanium.

On August 22, Moscow radio said that this expedition had had more technological tests than any previous ones: the Isparitel apparatus alone had provided more than 186 samples, most of them delivered to scientists on Earth by Pham Tuan and Viktor Gorbatko. One substance, a solidified solution of cadmium telluroid and mercury telluroid, would be impossible to obtain on Earth where "when molten they separate out as oil and vinegar do when poured into the same glass." The large crystals of this obtainable in space would permit "heat viewing" or detection of negligible variations in temperature, important to industry and to medicine. (FBIS, Tass in English; Moscow Dom Svc, Aug 1-26/80)

September

September 2: JSC reported that its television engineers were working on modifications of a U.S. Air Force camera for live television broadcast by crew members on spacewalks outside the Space Shuttle orbiter. NASA would buy three systems for flight, training, and qualifications at a cost (including integration, testing, and mission planning) of about $750,000.

The camera (which would include a battery pack, FM transmitter, antenna, and a receiver inside the orbiter, with other support hardware), located on an astronaut's visor assembly, as miners' lights are mounted on their foreheads, would see what the astronaut saw and send black-and-white pictures to a television monitor watched by crew members on the spacecraft. A wide-angle lens would give a 19.7-mm focal length with a 32° horizontal field-of-view; lens range would be present to focus from about 15 inches to the distance needed. The inside crew members could see hardware or spacewalk activity in real time, helping make joint decisions on repair. (JSC Release 80-052)

September 4: NASA issued a prelaunch summary of the GOES-D mission, sixth of a series designed for continuous cloud-cover observation from synchronous orbit. The program had two prototypes (*Sms 1* and *Sms 2*) developed by NASA and follow-on craft (GOES-A through GOES-F), funded by NOAA of the DOC. The NOAA-funded craft were designated Geostationary Operational Environmental Satellites (GOES).

Since the *Sms 1* launch in May 1974, the satellites had continuously viewed Western Hemisphere weather patterns and relayed video scenes from orbit as part of everyday television weather reports. The reports five were produced by Ford Aerospace; GOES-D, GOES-E, and GOES-F would be from Hughes Aerospace.

The primary instrument on previous craft was a visible/infrared spin-scan radiometer with one visible and one infrared channel. GOES-D would be the first of three carrying a modified VISSR sounding the atmosphere in 12 infrared bands, acquiring temperature and moisture data profiles at various levels.

NOAA's National Environmental Satellite Service (NESS) program required two operating satellites at all times to cover Atlantic and Pacific ocean approaches, as well as the American landmass. *Sms 2* launched in 1975 and *Goes 3* launched in June 1978 were covering east and west stations, respectively; *Sms 1* and *Goes 1* and *Goes 2*, none fully functional, were on operational standby. GOES-D, initially located at 90°W for a demonstration of the atmospheric sounder, would later be located either east or west depending on operating need. Should one of the operating craft fail before the demonstration ended, NASA would configure a time-sharing operating mode to continue coverage. (NASA MOR E-612-80-02 [prelaunch summary], Sept 4/80)

• NASA announced that JPL's Dr. Stephen P. Synnott, the Voyager project navigator who discovered a 15th moon of Jupiter [see May 6], had done it again: searching through Voyager photographs taken in 1979 to confirm discovery of a 14th satellite, he discovered a 16th.

The new find was about 40 kilometers (25 miles) in diameter and circled the planet every 7 hours, 4 minutes, 30 seconds. the same process had located the 15th satellite, found by Synnott in March 1980; at that time, he thought he was confirming an earlier sighting of a 14th moon because they had similar sizes and orbits. But, upon comparing data from *Voyager 1* and *Voyager 2*, Synnott found that "the object I was looking at was on the opposite side of the planet—it couldn't be J14, so it had to be a new one." Before *Voyager 1* reached Saturn the planet was believed to have 13 moons; a 14th (the one Synnott was trying to confirm) had been seen in October 1979. (NASA Release 90-139)

September 5: Joseph B. Mahon, director of NASA expendable launch vehicles program, said that NASA would use such vehicles in 18 missions through the end of September 1981. Of these, 7 would be flown on Deltas, 7 on Atlas Centaurs, 3 on the solid-fuel Scout, and 1 on the Atlas F.

Two flights would carry NASA science satellites; NASA would launch the other 16 (for which the energy would be reimbursed) for other government agencies or private firms. The latter would include three weather satellites for NOAA; five DOD payloads; and eight commercial geosynchronous communications satellites for SBS, RCA, Comsat General Corporation, and the INTELSAT consortium. The Office of Space Transportation Systems Operations would run the program. (NASA Release 80-140)

September 8: DOC announced that it had upgraded the satellite division of NOAA and renamed it the National Earth Satellite Service (NESS), reflecting broader responsibilities for the former National Environmental Satellite Service. Earlier in 1980, NOAA became responsible for developing and managing a remote-sensing satellite system based on NASA's experimental Landsat program.

Since 1965, NOAA had managed operational weather satellites whose data served in navigation, commercial fishing, and water-resource management as well as weather forecasting. The greater resolution of the Landsat system should offer similar monitoring as well as data for uses such as farming, urban planning, and mineral exploration. (DOC Release 80-106)

• The *NY Times* reviewed advances in phototypesetting technology, including satellite transmission, that had made it possible for publications to print identical copies simultaneously anywhere in the world.

"Cold type," the first generation of phototypesetting, replaced use of individual characters with a matrix of symbols on a transparent material. Light sent through characters produced an image on high-contrast photographic paper. The second generation of typesetting machines also used a photographic negative to generate characters, but used digital computer scan to produce the symbols, recreating them on a cathode-ray tube as a series of minute dots or lines reproduced on photographic paper. The third generation, developed in the late 1960s, encoded text on a disk and printed out entirely by computer, working 10 times as fast as previous machines. By the 1970s, publications such as *U.S. News and World Report, Newsweek,* and the *New York Times* had switched from either hot type or less sophisticated cold type to the third-generation technology, which was amenable to satellite transmission. Some of the machines could produce entire pages of newspapers and magazines, including advertisements, artwork, and text, reducing time and cost of publication.

A fourth generation would abandon photographic imaging altogether: using lasers, it would produce characters directly on paper without use of a cathode-ray tube. One such unit had the advantage of producing its output on non-photographic paper, made without silver, at a price a third that of conventional light-sensitive paper. (*NY Times,* Sept 8/80, D-5)

• INTELSAT said that an "extraordinary session" of its signatories in Washington had authorized increasing the organization's capital ceiling from $990 million U.S. to $1.2 billion to buy a follow-on to the Intelsat V series of satellites and launch vehicles that could fill "booming world demand" for international and domestic communications until the Intelsat VI is available around 1986.

INTELSAT's announcement said that the actual cost per unit of satellite communications was dropping steadily, in spite of the increased investment required; its charges were about a sixth of the level in 1965 when the first Intelsat went into service. (INTELSAT Release 80-18-I)

September 9: NASA launched the fourth geostationary orbital environmental satellite (GOES-D) for NOAA from ESMC on a Delta at 6:27 p.m. EDT. The Delta put *Goes 4* into a synchronous transfer orbit close to nominal. Firing an apogee kick motor at 8 a.m. September 11 would put it into geosynchronous equatorial orbit over 90°W for flight testing, after which it would be turned over to NOAA for operational use of the VISSR [see August 29]. The 103-day gap since NASA's unsuccessful launch of NOAA-B May 29 almost set a record for inactivity. (*NASA Dly Actv Rpt,* Sept 11/80; *Df Dly,* Sept 12/80, 62; *Spacewarn,* Sept 30/80)

September 15: NASA announced plans to join a university research team in first-time transcontinental laser-radar soundings of the volcanic veil still hanging in the upper atmosphere over the United States from the eruptions of Mt.

St. Helens. Using NASA's SAGE satellite with an aircraft "crammed with the latest in laser and electronic remote-sensing and near-sensing technologies," scientists from LaRC and WFC and from Drexel University, the Universities of Maryland, Arizona, and Alaska, Dartmouth College, Michigan Technological University, and the Oregon Graduate Center would study volcanic aftermath.

This joint effort scheduled for September 17-21 by teams for the SAGE program and the Research on Atmospheric Volcanic Emissions (RAVE) project funded by NASA and operated through the universities would measure quantities of gases ejected by Mt. St. Helens and atmospheric dispersion of aerosols. Launched in 1978, SAGE had used a four-channel solar radiometer to track volcano plumes and take profiles of ozone and aerosols in the stratosphere, site of most of the ozone preventing harmful solar radiation from damaging life on Earth. (NASA Release 80-143; LaRC Release 80-61)

September 17: A partnership of the American Institute of Architects, Pacific Gas & Electric, and NASA's ARC announced selection of the architect for a space-age advanced technology house to be built at ARC and opened to the public late in 1982 [see February 12]. The house, about 2,500 square feet, with additional facilities to accommodate visitors, would incorporate experimental techniques, new materials, and systems originating in the U.S. space program.

Advanced technology that let astronauts live in the hostile environment of space under a controlled life-support system would be used in the house, as would self-contained water and sewage systems, recycling all its water and disposing of wastes by incineration; heat from the incineration would serve as an energy source. Energy-saving and water-saving design features would make the house 80% self-sufficient. (AIA/PG&E/ARC anno, Sept 17/80)

September 18: Tass reported that *Soyuz 38,* launched September 18, carried a Cuban cosmonaut and a Soviet mission commander to join cosmonaut Leonid Popov and Valery Ryumin, who were within two weeks of breaking a space-endurance record on the orbiting *Salyut 6* space station. Armando Tamayo Mendez, 38, was the seventh non-Soviet citizen to fly in the USSR's Intercosmos program. His companion on *Soyuz 38* was veteran cosmonaut Yuri Romanenko. (*W Post,* Sept 19/80, A-30)

• NASA announced that Administrator Dr. Robert A. Frosch had signed a memorandum of understanding with Dr. David H. Jacobson, vice president of South Africa's council for scientific and industrial research, for establishment of a Landsat ground station near Johannesburg. The pact would let the South African council, an early user of Landsat data, operate a ground station at Hartebeesthoek and receive, process, and disseminate data. The council would pay for a ground station and attending costs, plus an annual access fee of $200,000 after the first six months of data receipt, and would have to make

Landsat data available on a nondiscriminatory basis. Landsat users in southern Africa would have access to regular coverage of the region, as a contribution to development efforts of southern African nations.

Nine Landsat stations were operating outside the United States, two in Canada and one each in Argentina, Australia, Brazil, India, Italy, Japan, and Sweden. The People's Republic of China and Thailand were buying ground-station equipment, and other ground stations were being planned. (NASA Release 80-147)

• ComSatCorp announced appointment of Dr. Delbert D. Smith, vice president for corporate affairs, to a three-year term on the board of the International Institute of Communications (IIC) at the latter's annual conference. Smith led a conference discussion of satellite communications for social and developmental purposes.

The IIC, based in London, was set up to further international cooperation in the field of communications; it put out research and policy studies of the impact of media on society and analyzed the implications of communications technology, seeking to eliminate barriers to the free flow of communications. (ComSatCorp Release 80-33)

• INTELSAT announced that it would buy an additional Intelsat V satellite from Ford Aerospace and an additional NASA Atlas Centaur vehicle to launch it. The first Intelsat V launch had been scheduled for December 1980. The ninth in the Intelsat V series would help fill domestic and international demand until higher capacity comsats became available in the mid-1980s. INTELSAT's decision would add about U.S. $70 million to the cost of the Intelsat V program, estimated at U.S. $650 million. (INTELSAT Release 80-19-I)

September 19: NASA reported selection of Rockwell International's Energy Systems Group to negotiate a cost-shared $9 to $11 million contract under a DOE program for design, construction, installation, and test of an advanced multipurpose 350-kilowatt wind-turbine system with blades 38 meters (125 feet) in diameter.

LeRC with its expertise in aerodynamics and structures would direct the project for DOE; it was currently running a 100-kilowatt turbine testbed at its Plum Brook test area near Sandusky and four 200-kilowatt versions built and installed by Westinghouse in New Mexico, Rhode Island, Puerto Rico, and Hawaii. A 2,000-kilowatt machine by General Electric was supplying power to the Blue Ridge Electric Cooperative System in North Carolina. Boeing was building a 2,500-kilowatt machine, three of which would be working in the Bonneville Power System by the end of 1981. (NASA Release 80-148)

• The *Washington Post* reported that NORAD in Colorado Springs, Colo., had identified a flaming object that streaked across the sky and plunged into the Gulf of Mexico earlier in the week. The object was apparently the remains of a Soviet rocket, probably *Cosmos 549,* that had been in orbit for seven years. (*W Post,* Sept 19/80 A-5)

September 20: Today newspaper said that a 13-nation U.N. committee that met in Geneva, Switzerland, had drafted a report on a proposed satellite system to scan the Earth and spot disarmament violations. Ending a closed two-week session of the committee, the report said that the scientific, financial, and legal experts would meet there again in February 1981 to consider and approve the draft for submission to the United Nations. The statement contained no details of the proposed satellite monitoring system.

U.N. Secretary General Kurt Waldheim had appointed the committee after a special General Assembly session in 1978 on disarmament received a proposal by France for U.N. establishment of an international satellite agency to check up on disarmament pledges. (*Today,* Sept 20/80, 10A)

September 22: JPL Director Bruce C. Murray announced appointment of Dr. Freeman Dyson, theoretical physicist and leader in studies of new systems for spacecraft propulsion, as a distinguished visiting scientist. A professor at Princeton University's Institute for Advanced Study, Dyson participated in Project Orion at the General Atomic Laboratory, San Diego, from 1958 to 1965, studying the potential use of atomic explosions to propel crewed spacecraft. In 1977 he led a laser-propulsion study for the Defense Advanced Research Projects Agency (DARPA) and was later active in studies of solar sailing and NASA's SETI (research for extraterrestrial intelligence) project.

Author of "Disturbing the Universe," Dyson would join Jacques Blamont of France, Klaus Hasselmann of Germany, Giuseppe Colombo of Italy, Michael Longuet-Higgins of the United Kingdom, and Richard Goody and Gene Shoemaker of the United States as a JPL distinguished visiting scientist. (JPL anno Sept 22/80)

September 23: ComSatCorp announced the formation of a new organization, ComSatCorp World Systems Division, to handle all matters of global telecommunications through the INTELSAT system and global maritime services through the INMARSAT system. John L. McLucas, most recently ComSatCorp vice president for international communications and technical services, would head the new division. Joseph V. Charyk, president and chief executive of ComSatCorp, said that the change responded to FCC concern expressed in a study of ComSatCorp organization, as it would let FCC regulate rates and costs within an organization segment. (ComSatCorp Release 80-34)

• LaRC reported that staffer Wesley R. Cofer, Jr., would participate during October with other researchers from the United States and Europe in an expedition on the Atlantic Ocean to evaluate the effect of humans on Earth's troposphere by studying environmentally important trace gases. Cofer would measure hydrocarbon concentrations with an instrument he and Gerald C.

Purgold developed at LaRC: designed for marine operation, the device was built during a 1978-1979 LaRC remote-sensor technology study, for use in aircraft tracking of atmospheric pollutants up the eastern shore of Virginia. (LaRC Release 80-64)

September 27: Today newspaper attended the christening of the first ship built to recover NASA's Shuttle boosters from the Atlantic after launch. United Space Boosters, Inc., subsidiary of UTC would operate the *UTC Liberty,* first to be named, and *UTC Freedom* out of KSC. *Today* said that everybody "involved in the lengthy process of building the ship was in attendance from the banker to the builder to the ship's captain." (*Today,* Sept 28/80, 16A)

September 30: NASA reported that the Winkfield tracking station completed its last Spaceflight Tracking and Data Network (STDN) support pass at 2345Z and was transferred to U.K. ownership at 0001Z. It would now be operated by Britain's Science Research Council. Part of NASA's network for about 20 years, the station had "performed in an exemplary manner," NASA said. (*NASA Dly Actv Rpt,* Oct 1/80)

During September: NRC's *News Report* included an article on asteroids, comets, and meteroids, subject of a report by the Space Science Board's committee on planetary and lunar exploration, calling for investigation and analysis of the solar system's "primitive objects" to determine their chemical and isotopic composition and deduce their history through Earth-laboratory and theoretical studies as well as from spacecraft and space probes, as part of a strategy for understanding solar system development. The committee, chaired by Eugene Levy of the University of Arizona, called for initial exploration and reconnaissance of asteroids and comets by spacecraft encounter as a "goal of high priority" for the period 1980-1990. (NRC *News Rept,* Sept 80, 1)

• NASA issued a summary of Saturn encounter events for the period August 22 through December 15, beginning with "in-bound movie sequences" from *Voyager 1* through Saturn-Titan close approach and ending with a post-encounter movie sequence. Subjects of Voyager research at Saturn would be the planet itself, its rings, its satellites (especially the Mercury-size Titan), and Saturn's magnetosphere; the summary listed points of special interest and the unique properties to be investigated. (NASA Release 80-145)

October

October 1: Cosmonauts Leonid Popov and Valery Ryumin set a new record for spaceflight duration, breaking the mark of 175 days, 36 minutes set last year by a crew in *Soyuz 32*. Ryumin had been on that record mission also; he had stayed on Earth for only 236 days since February 25, 1979. Popov, 40, and Ryumin, 34, had set out April 9, 1980, in *Soyuz 35* to occupy the orbiting *Salyut 6* launched September 29, 1977, one of 13 crews to visit the 20-ton 49-foot-long space station.

Three times during the spring and summer visiting crews brought the "permanent occupants" food and experiment materials, life-support equipment, and companionship. These relief missions included the first Vietnamese, Hungarian, and Cuban cosmonauts. Earlier this week, an unmanned cargo ship *Progress 11* arrived with fresh supplies of food, fuel, and technical equipment for the cosmonauts. The Soviet Union had not set a time limit for the Salyut-Soyuz flight; Popov and Ryumin reported themselves healthy. (*NY Times*, Oct 2/80, A-17)

October 2: Rep. Don Fuqua (D-Fla.), chairman of the House Committee on Science and Technology, said that his space science subcommittee would hold hearings at the Severe Storm Forecast Center in Kansas City, Mo., on the consolidated storm information system, a joint NASA-NOAA program. The committee heard about the project in July 1979 when it was merely a concept: "it will be a pleasure to see it coming to fruition."

When fully operational, the system would give a forecaster real-time atmospheric data such as temperature, air pressure, and wind forces from around the globe, a substantial improvement on current systems requiring several hours to obtain the data. It would combine communications links with data sources, such as environmental satellites and atmosphere soundings, into a single computer system. (H Comm Sci Release 96-235)

• *Nature* magazine described equipment problems on *Heao 2*, also called the Einstein observatory, that might end the mission prematurely. Launched in 1978, *Heao 2* carried the first X-ray telescope "as sensitive as ground-based optical telescopes"; it had a planned lifetime of only one year. Its success in generating new scientific data had led to extension of its mission; until the recent setback, NASA scientists hoped that it would continue to return data well into 1981 when atmospheric drag would take it from orbit. The outcome would depend on the "behavior of the gyroscopes used to position it."

Data transmission was halted three weeks ago when two of the six gyroscopes failed after a temporary blackout. *Heao 2* needed three functioning gyroscopes for positioning. One of the other four was already dead; another, running erratically, was on standy. NASA was working on software for backup control using the two gyros still functioning, along with either a Sun sensor or star tracker on the satellite. (*Nature*, Oct 2/80, 379)

October 4: Cosmonaut Aleksey Yeliseyev, veteran of *Soyuz 5, Soyuz 8,* and *Soyuz 10,* told a press conference that the flight of Ryumin and Popov on *Salyut 6* "is coming to an end. The flight will be completed in the first half of October and no more Soyuz expeditions will visit." "The station today," he added, "is in a perfectly good state and the question of its being manned in the future may be answered in the affirmative." (FBIS, Mosc Dom Svc in Russian, Oct 4/80)

October 7: Dr. Robert A. Frosch, NASA administrator, told President Carter that he would leave January 20 to become the first president of the American Association of Engineering Societies, a federation created in January of 39 major engineering societies of the United States representing more than a million engineers. In a memorandum headed "Dear Colleagues," Frosch said that he could "no longer ignore the competitive opportunities available to me and to my family in private life. . . I continue to be devoted to our common interests in aeronautics and space."

Frosch was sworn in as NASA administrator June 21, 1977. He had been associate director for applied oceanography at Woods Hole Oceanographic Institution since 1975. He had attended Columbia University, where he received a bachelor's degree in 1947, a master's in 1949, and a doctorate in theoretical physics in 1952. He had been assistant secretary of the Navy for R&D, assistant executive director of the U.N. environment program, and deputy director of DOD's DARPA. (NASA Release 80-151)

• NASA announced award of its largest contract so far to a small business firm. KSC entered a fixed-price contract of $6,689,666 to W&J Construction Company of Cocoa, Fla., for work on Pad B of Launch Complex 39 where the Space Shuttle would be launched in 1982 when it became operational. W&J would put in long-run pipes and cables to pump and monitor fuels, coolant, nitrogen and gaseous helium, compressed air, and hydraulic fluids, from storage areas to the fixed and the rotating service structures. Connections to the Space Shuttle would be from the two service towers. The contract would be completed in 20 months. (NASA Release 80-152)

• NASA announced an MSFC award to Martin Marietta and Aerojet Liquid Rocket Company of contracts to define a liquid-propellant boost module for the Shuttle external tank, to increase its cargo-carrying capacity to 5,400 kilograms (12,000 pounds).

Under the new terms, modifying initial program-definition contracts let earlier in 1980, the two firms would study adapting Titan hardware and systems to the boost module. They had been building Titans for years; the U.S. Air Force had used Titan 2 in the mid-%1960s to launch Gemini and was still using it. Martin Marietta, under a contract valued at $1.18 million, would carry out follow-on studies and design activities on the overall system; Aerojet, under a contract for $782,500, would work on modification of the Titan 3 stage 1 engine. A modified version of Titan had launched communications satellites and other Earth orbiters as well as deep-space Viking and Voyager payloads. The first use of the augmenting booster would be in 1986. (NASA Release 80-154; MSFC Release 80-126)

October 8: ComSatCorp announced that it would dedicate its new ground station on Saipan in the Marianas in November [see During June]. At the ceremony would be Carlos Camacho, governor of the Northern Marianas; ComSatCorp head Joseph V. Charyk; officials of the U.S. Department of the Interior and of U.S. communications carriers; and dignitaries from several Pacific nations. The Saipan station working with an Intelsat 22,300 miles over the Pacific could offer a wide range of services: in addition to more reliable telephone calls, residents would have access to television, telex, data, and facsimile, "an era of modern and improved communications," the organization said. (ComSatCorp Release 80-38)

October 10: LaRC announced an award to Dynamic Engineering Inc., Newport News, Va., of a three-year cost-plus-fixed-fee contract valued at $4.3 million for design and fabrication of dynamic models for NASA research and development programs. It would include personnel, equipment, materials, and facilities for feasibility studies, engineering design, and assembly and calibration of models.

Used primarily in wind-tunnel tests, the models would be of three kinds: general-performance, holding a fixed geometry through a range of angle-of-attack and dynamic pressure; free-flight and spin models, simulating mass properties of aircraft; and aeroelastic models simulating configuration changes with load, for performance and flutter investigations. The models would consist of fiberglass-reinforced resin, wood, metal, moldable or formable materials, or combinations of these. (LaRC Release 80-73)

October 11: The longest spaceflight in history ended at 12:50 Moscow time when cosmonauts Leonid Popov and Valery Ryumin landed near Dzhezkazgan in the descent module of *Soyuz 37* after 185 days aboard the *Salyut 6* space station. A previous record of 175 days was set last year by Ryumin and Vladimir Lyakhov; shown on Soviet television immediately after landing, they seemed to have trouble walking and talking. The Soviet Union did not have television coverage of the Ryumin-Popov landing, but the two appeared on television at 9 p.m. local time in recliners, being interviewed. A Reuters report from the landing, carried by the *New York Times*, said that the two men appeared well when they climbed from their capsule in the rain, Ryumin noting "it's always pleasant to have a soft landing." He joked with journalists and insisted on walking two yards unaided "almost without staggering," said *Trud*, a trade-union newspaper. Doctors said that neither man seemed to show the physical deterioration suffered by other long-mission crews; Popov had gained 6.5 pounds, Ryumin almost 11. They had kept up their strength in space with exercises.

(The *New York Times* noted that the new record far outdistanced the longest U.S. space mission, the 84-day mission of *Skylab 4* with Gerald Carr, Edward Gibson, and William Pogue, that ended in 1974. In the absence of U.S. space exploits since the Moon landings, Western observers said that the new Soviet feat might indicate that the Soviet Union had regained the lead in space; coupled with the delay in the U.S. Shuttle program and public awareness of growing Soviet military might, the Salyut accomplishment might translate into political advantage.)

Salyut 6 had been orbiting for three years, being manned for about half that time. Four main and eight visiting expeditions had been working there, backed by automatic cargo craft bringing fuel and supplies. Tass said that the preventive maintenance and resupply procedures carried out by the crews were a big step toward "lasting manned complexes for scientific and national economic purpose." (FBIS, Tass in English, Oct 11/80; *NY Times*, Oct 12/80, 23; Oct 13/80, A-13)

October 14: The FCC called for public comment on ComSatCorp reorganization, to prevent its role as sole U.S. representative in the global communications satellite system from interfering with its growing competitive activities. An official said that this "could lead to changes" in ComSatCorp operations.

An FCC staff study earlier in 1980 said that the potential for conflict was substantial enough for ComSatCorp to need two separate parts: one for its role in the global system, the other providing services like a long-distance telephone system or satellite-to-home subscription television. As a result, ComSatCorp had set up a World Systems Division to take charge of its congressionally mandated role in the global system, its competitive activities remaining with its subsidiary Comsat General [see September 23]. However, research and development by Comsat Laboratories would remain in the parent company. FCC noted that the subsidiary could obtain new technology developed by the laboratories either free or below cost, enabling it to undercut competitor prices. It was debating further action to ensure that ComSatCorp did not use the knowledge gained in its monopoly role to compete unfairly with other communications firms. (*W Star*, Oct 14/80, D-7)

October 15: NASA reported that it had begun a three-year program with the Pennsylvania Department of Environmental Resources using Landsat data to detect gypsy-moth damage. Under an agreement signed recently, the data would identify and locate damage so that subsequent satellite images could be used to monitor affected areas. Foresters could identify infestations and isolate areas for pest management.

Results would be passed on to other states in the eastern United States that could use the techniques to control spread of gypsy-moth damage initially mapped in New England in 1910. Damage to hardwood forests in Pennsylvania over the past 10 years was an estimated $32 million; in 1980 alone, gypsy-moth caterpillars defoliated 440,000 acres of hardwood forest. (NASA Release 80-155)

• MSFC reported that it had recovered scientific packages launched from Palestine, Tex., on two 30-story-tall balloons after both balloons "by a remarkable coincidence" floated directly over the Alabama center. The 300-foot balloons traveled 20-35 mph about 23 miles up. Dr. Gerald Fishman, of MSFC's space science laboratory, said that it was "almost unbelievable" that the payloads flew over the center after drifting some 700 miles. MSFC had run a research balloon program for seven years, but not one balloon had ever come over the center, much less two.

The two experiments were also the most successful, Fishman said, recording more than 28 hours of gamma-ray data and more than 38 hours of cosmic-ray data. The first, which had been launched October 6 with a gamma-ray package, was seen by unaided eyes over MSFC about 1:30 p.m. October 7; MSFC scientists tracked it and took pictures by telescope. The second, launched October 7 with a cosmic-ray detector, flew over about 3 a.m. October 8. Both balloons were tracked by a telemetry station on Redstone Arsenal that received experiment data. A National Scientific Balloon Facility team recovered the gamma-ray package after it came to Earth near Roanoke, Va., and then sought the cosmic-ray package in a heavily wooded area near Elkins, W.Va., where a helicopter retrieved it. Both packages were returned to MSFC for analysis. (MSFC Release 80-129)

October 16: ESA announced that the cause of the failure of Ariane L02 May 23 was "combustion instability" on one of the four first-stage engines 5.75 seconds after launch. The violent event "altered the characteristics of the injector" and destroyed the vehicle 108 seconds after liftoff. ESA had analyzed telemetry, looked over hardware recovered from the ocean, conducted acoustic simulations and 37 static firings between July and mid-October, and investigated manufacturing processes. It would change its procedure for buying injectors. (ESA Info 24)

October 17: ComSatCorp announced that it would reduce its charges for international satellite communications by 11.8%. FCC was concerned over the increase in international carrier earnings for these services and had begun a formal rate procedure against ITT Worldcom for the same reason. ComSatCorp president Joseph V. Charyk said that the reduction could save its members about $19 million in 1981 and asked FCC to see that the savings reached the public. (ComSatCorp Release 80-39)

October 20: NASA declared successful the mission of Magsat, launched Ocober 30, 1979, to measure Earth's magnetic field. The satellite's lifetime exceeded that planned for it by three months and met or exceeded accuracy requirements in instrumentation and in attitude and position determination. The mission had met the objectives of developing a worldwide magnetic-field model; acquiring data for crustal magnetic-anomaly maps; and adding to knowledge of Earth's magnetic field and its temporal variations. (NASA MOR E-662-80-01, Oct 20/80)

• NASA reported that *Voyager 1* would approach closest to Saturn November 12, third episode in a 10-year multibillion-mile trip to the outer planets. A briefing on the encounter would take place October 28 at Headquarters with Andrew Stofan, associate administrator; Angelo Guastaferro, director of planetary programs; Dr. Edward Stone of CalTech, project scientist; Ray Heacock of JPL, project manager; and Dr. Bradford Smith, University of Arizona, of the imaging team. (NASA Release Oct 20/80; LaRC Release 80-77)

October 21: The *Washington Star* reported a warning from the Center for Defense Information ("an unofficial defense study group") that technological progress in U.S. and Soviet space programs could spark an arms race in space. The United States had a 12×13-inch device—the miniature homing interceptor vehicle—that could home in on infrared radiation "to destroy a target satellite by high-speed impact," the group said; if the device were actually tested in space, "it could destroy more than the target satellite: it could destroy U.S. and Soviet negotiations aimed at limiting antisatellite warfare as well."

The group said that the Pentagon believed that the Soviet Union had an operational but limited antisatellite weapon that had been tested about 17 times; 7 of the tests were failures, but 10 were "possible successes" in that the interceptor passed less than a mile from the targets. No target was destroyed, suggesting that the Soviet Union might be working on inspection of foreign satellites. PRC reconnaissance satellites traveled in orbits like those of the Soviet test targets, and an interception program might be aimed mainly at the Chinese, the group said.

Rear Adm. Gene LaRocque (USN-ret.), head of the center, said wars might begin in space "but they're going to end right here on earth. It won't be a Star Wars show with a lot of robots. . .vaporizing each other in the remote regions of space. . . . Once those nuclear missiles start to fly, the science-fiction drama will be over." (*W Star*, Oct 21/80, D-10)

October 23: *Nature* magazine commented on Dr. Robert Frosch's leaving NASA, "the latest to join the exodus of science administrators from the federal government" with the departure in June of Dr. Richard Atkinson, director of the NSF, and the "widely expected" appointment of Dr. Frank Press, head of the White House Office of Science and Technology Policy, as president of the National Academy of Sciences. Dr. Frosch's time at NASA had seen "the agency struggling increasingly against the escalating costs of the [Shuttle] which is now biting deeply into the space research budget." (*Nature*, Oct 23/80, 673)

October 27: DFRC announced plans for a ceremony at which ARC officials representing NASA and the Army's Tilt Rotor Research Aircraft project would accept the first of two aircraft built under a joint program. One of the two planes built by Bell Helicopter Textron arrived at ARC in March 1978 for tests in its full-scale wind tunnel; the other arrived at DFRC August 13 for follow-up of tests by Bell. So far, two contractor pilots, two NASA pilots, one Army pilot, and one Marine pilot had tested and evaluated the aircraft. (DFRC Release 80-28)

• MSFC noted the arrival of the age of automation in its Materials and Processes Laboratory, where industrial robots were improving manufacturing techniques in Space Shuttle hardware production. Robotics, integrated into totally computer-controlled systems, would help meet high launch-rate fabrication and between-flight refurbishment requirements of reusable Shuttle items.

One of the two MSFC robots was helping spray foam insulation for thermal protection on booster structures such as forward and aft skirts or nosecones. The second, currently used for advanced welding, would serve in a thermal protection process for the external tank. A third robot to arrive in December would run a high-pressure water blaster to strip insulation from reusable Shuttle hardware. (MSFC Release 80-138)

• *Aviation Week & Space Technology* said that General Dynamics Convair had developed a prototype deployable space truss as a building block in large space structures. A 26-foot beam stowed in a flat pack 3 feet long, 5 feet wide, and 9.5 inches high would unfold in five segments to 5 feet in width and 7.5 feet in height. The hinged and folded struts of graphite-epoxy bonded to aluminum would deploy in three automatic steps, forming first a triangular, then a diamond-shaped, section. A Shuttle could carry 24 500-foot beams into space on a single mission. (*AvWk*, Oct 27/80, 49)

Ocotober 28: NASA reported that DFRC had conducted a "highly successful" sixth HiMAT flight October 28, lasting more than 32 minutes and reaching 45,000 feet and a maximum Mach number of 0.9. No anomalies occurred. (*NASA Dly Actv Rpt*, Oct 29/80)

• INTELSAT announced that its assembly had agreed to technical and some economic compatibility with seven other satellite systems. Found technically compatible with existing and planned INTELSAT systems were Eutelsat, spare craft for a European communications satellite system; Germany's TVSat broadcasting system; India's Insat 1-A and Insat 1-B for television and meteorological use; Indonesia's Palapa-A system for limited regional service to remote areas in southeast Asia; the Intersputnik system for limited use by Algeria; Japan's GMS-2 metesat system; and Saudi Arabia's broadcast-satellite system.

Algeria's proposal was the first instance of an INTELSAT signatory's seeking use of another system for general international public traffic instead of for limited regional service. INTELSAT said that its permission would apply only through 1985 and to a total of 22 telephone lines; similar proposals by other members would require separate handling. The specific request by Algeria for use of Intersputnik would not constitute significant economic harm to INTELSAT at present; however, the assembly noted that INTELSAT's objective was to promote development of "a single" global communications satellite system, and all signatories must continue to consider that a goal. (INTELSAT Release 80-23-I)

October 29: Newspapers said *Voyager I*'s Saturn approach had discovered two new moons, a 13th and 14th, and confirmed existence of three previously shown in Earthbound observations. Until the recent discoveries, the giant planet was thought to have only nine satellites. Closing on Saturn at 45,000 mph, *Voyager 1* should come within 77,000 miles of the surface on or about November 12 and obtain high-resolution photographs of the planet and its satellites. It was already returning pictures with resolution far higher than those taken in 1979 by the less sophisticated *Pioneer 11.*

Images relayed over the past 10 days showed dozens of divisions never seen before between Saturn's rings, meaning that the six known rings would have to be recounted. "Almost everything we're seeing at Saturn right now is brand new," said Dr. Bradford Smith, head of the Voyager imaging team. JPL's Ray L. Heacock, project manager, said that 9 of Voyager's 10 instruments were working, 1 having failed after encounter with Jupiter, and the spacecraft was in good shape after traveling 1.3 bilion miles through space. (*NY Times*, Oct 29/80, A-20; *W Post*, Oct 29/80, A-2; *W Star*, Oct 29/80, D-18)

• MSFC said that it would static-fire for 581 seconds a test prototype of the Shuttle main propulsion system in one of two tests remaining before the first flight in March 1981. Rockwell International would conduct this 11th firing of the system at NSTL. The test would serve to evaluate thrust-vector controls, low-level fuel cutoff, and liquid oxygen and liquid hydrogen pressurization. Final main propulsion-system test firing would be in late November. (MSFC Release 80-139)

• Comsat General announced that it was providing consulting service to Alascom Inc., based in Anchorage, on a new generation of communications satellites to meet Alaska's future communications needs. Alascom was now leasing 15 to 17 transponders on a domestic Satcom to relay communications throughout Alaska, but growth by the late 1980s should require double that number. Comsat General would help design a spacecraft to meet increased transponder demand. (ComSat Gnl Release 80-5)

October 30: NASA launched FltSatCom-D into a synchronous transfer orbit from Launch Complex 36, ETR, on an Atlas Centaur at 10:54 p.m. EST. An apogee kick motor fired November 1 at fifth apogee put it (as *FltSatCom 4*) into the desired synchronous orbit [see October 20]. Spacecraft systems were turned on and operated normally. (NASA MOR M-491-202-80-04 [postlaunch] Nov 21/80)

October 31: The *Washington Post* reported that SBS was "having a hard time getting off the ground" with launch of its first satellite put off for the third time in a month. Technical problems with the Delta had delayed the launch of SBS 1, built by Hughes Aircraft, first of its kind to offer a high-frequency interference-free signal. Liftoff had been postponed to November 6 because of insulation damage, then to November 12 when a motor bolt broke. The latest problem was a leak in the liquid oxygen system. (*W Post*, Oct 31/80, E-3)

• MSFC reported signing a $2,271,391 contract with a small business, OAO Corporation of Beltsville, Md., for design, assembly, delivery, test, and checkout within 18 months of a data-base management system to handle an "immense volume" of instrument data transmitted at "extremely high rates" by spacecraft during missions between 1985 and 1995. The system would accept data at rates up to 50 million bits per second (44,650 pages of computer printout per minute). "Firsts" to be included in the system would be a data bus of fiber-optic cabling for use in a computer configuration and use of lasers to transmit and receive data at the high rates required. (MSFC Release 80-141)

During October: NASA appointed Dr. Jack L. Kerrebrock, head of MIT's aeronautics and astronautics department, as associate administrator for aeronautics and space technology as of June 1, 1981. Replacing Dr. James J. Kramer who retired in October 1979, he would be responsible for aeronautics, space and energy research, and technology programs. Dr. Walter B. Olstad would act as associate administrator in the interim. (NASA Release 80-156)

—JSC announced that Dr. Edward G. Gibson, scientist-astronaut, would leave October 31 to become advanced systems manager for TRW Defense and Space Systems Group. The science pilot on the record 84-day *Skylab 4* mission in 1973-1974, he had left NASA in 1974 to work for Aerospace Corporation and for ERNO but had rejoined the agency in March 1977. (JSC Release 80-057)

—C.A. Syvertson, ARC director, named Angelo Guastaferro of the Headquarters Office of Space Science as his deputy, replacing A. Thomas Young, recently named director of GSFC. John Boyd, associate deputy director, would remain acting deputy director for six months. (ARC anno Oct 31/80; NASA Release 80-165)

—The NAA newsletter reported that Maurice Bellonte, copilot of the first east-to-west transatlantic nonstop flight in 1930, was guest of honor at the National Air and Space Museum on the 50th anniversary of his flight from Le Bourget airfield near Paris to Curtiss Field, N.Y. In 1929 Bellonte and his copilot Dieudonne Coste had set a world record for longest nonstop flight, 4,788 miles from Paris to Manchuria in 51 hours, 39 minutes. The Atlantic crossing had taken 37 hours, 18 minutes. (NAA nsltr Sept-Oct 80, 2)

—The *New York Times* reported that after long service in orbit and "a galaxy of discoveries" the astrophysics observatories Copernicus and Galileo were nearing the end of their useful lives. Copernicus (*Oao 3*, launched in August 1972 and named to honor the 500th birthday of the Polish astronomer) carried the first UV telescope above Earth's atmosphere and made precise measurements of the amount of deuterium in the universe. Galileo (*Heao 2*, launched in November 1978) carried the only imaging X-ray telescope ever orbited and mapped X-ray emissions from every known quasar. (*NY Times*, Oct 31/80, A-19)

—INTELSAT announced that its Italian signatory member, Telespazio, had set up an award of U.S.$10,000 for contributions to the field of satellite communications. Established on the 10th anniversary of the death of Dr. Piero Fanti, first general manager of Telespazio, the award would go every two years to a researcher or student in an INTELSAT member country who made a contribution of significant value to the field. (INTELSAT Release 80-22-I)

• FBIS carried Tass reports during October on the flight of Popov and Ryumin aboard *Salyut 6*, beginning with resupply of water from the cargo vessel *Progress 11* October 3 and completion of unloading by October 6, including resupply of air. On October 8 Tass said that the crew was measuring the dynamics of the orbital complex for use in designing new space systems. Launched September 29, 1977, *Salyut 6* had received 13 Soyuz (7 with international crews), 2 Soyuz-T, and 11 Progress craft during its three-year flight, manned about half that time by four main and eight visiting expeditions; 24 dockings occurred, plus 4 redockings from one port to another. On October 11, after Popov and Ryumin returned to Earth, Tass reported that no irreversible effects of weightlessness had occurred. The crew's diet included meat and dairy products, confectionery, beverages, and various seasonings. Fresh vegetables and fruits brought from Earth during the flight helped diversify the meals. On October 13, Tass said that the cosmonauts had gone for a walk in less than 24 hours after their return from six months in space and had met with journalists for interviews. Both said that working in space would be possible for longer than six months; Ryumin said that he felt better after his second prolonged flight, thanks to better ground training and better scheduling of on-board activity. A rest period every fourth day had made them "more eager to do exercises." On October 29, the cosmonauts reported to a meeting of the State Commission representing 400 organizations and agencies interested in their results on the 3,500 photos and 40,000 atmospheric spectra, more than 70 materials experiments, and the medical and biological tests. (FBIS, Tass in English, Oct 3-29/80)

November

November 1: OMB told Dr. Robert A. Frosch, NASA administrator, that President Carter concurred with NASA's request for a 1986 mission to make a detailed examination of the surface of Venus. Previously, both U.S. and Soviet probes had penetrated the planet's cloud cover to send data over a few minutes to several hours; Pioneer Venus returned data on the atmosphere, but none had given an idea of the surface. The President would request the necessary funds in his FY82 budget.

The Venus-orbiting imaging radar (VOIR) spacecraft, managed by JPL, weighing about 5,000 kilograms (11,000 pounds) at launch, and costing $500 to $600 million, would carry a synthetic-aperture radar (SAR) and other scientific instruments. Lanched from the Space Shuttle in May or August of 1986, it would arrive at Venus in December 1986 and circle it for seven months in a 300-kilometer (180-mile) near-polar orbit, taking radar pictures and measuring atmosphere as well as surface. VOIR images should disclose the presence of continents, ocean basins, mountain chains, rift valleys, fault belts, or volcanoes, as well as nature and timing of plate-tectonic activity (continental drift) or the size and frequency of occurrence of impact craters. (NASA Release 80-166)

November 2: ComSatCorp said that telephone and other services in Saipan improved with dedication of a new ground station there [see October 8]. Saipan communications carried by high-frequency radio had suffered delay and interference from atmospheric disturbance. Better telex, facsimile, and television would also be possible through a large dish antenna working with an Intelsat spacecraft 22,000 miles over the Pacific. (ComSatCorp Release 80-42)

November 3: NASA said that Dr. Floyd W. Stecker of GSFC had found evidence to suggest that subatomic particles called neutrinos might have mass, redefining the nature of all matter and the ultimate fate of the universe. Observations of rocket-launch results had detected a spectral line that might mean neutrino decay near the UV wavelength of 0.00017 mm. Neutrinos were previously thought to lack mass, like photons. In the "Big Bang" theory, an explosion of all matter in the universe 15 billion years ago formed galaxies that continued to expand away from the original site. The theory suggested roughly a billion neutrinos for every proton (protons, the nuclei of hydrogen atoms, made up 90% of the atoms in the universe).

If Stecker's findings were correct, a spherical area of "heavy" neutrinos created by the Big Bang would surround the galaxy; they would live so long

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that only one in 10 million would have decayed since the time of the Big Bang. The weight of a billion would equal the weight of one nitrogen atom, but they would be so numerous that they would account for the mysterious "missing mass" in large clusters of galaxies. Absence of this mass had thwarted calculation of whether the original expansion would continue forever or would collapse on itself to produce another Big Bang. (NASA Release 80-163)

• Ground testing of Space Shuttle engines suffered another setback, the *New York Times* reported, when three engines shut down prematurely during a static test firing in Mississippi. The engines, identical to three now on the Columbia at Cape Canaveral, were supposed to fire for 9 minutes, 41 seconds, the time it would take to put a Shuttle into orbit. NASA said that instruments indicated overheating in part of a turbopump. This 11th firing of the three engines in the test series would have been the 5th for the full time needed to launch a Shuttle. Columbia was scheduled for its maiden launch in March 1981. (*NY Times*, Nov 4/80, C-3)

• NASA said that JPL would arrange for media coverage of *Voyager 1*'s Saturn encounter over a 47-hour period on or about November 11-13, relaying live television to television stations, science centers, and planetariums across the United States. The Smithsonian's National Air and Space Museum in Washington, D.C., also planned to change its regular closing time from 5:00 to 8:30 p.m. during the encounter to handle the expected crowds and had scheduled special programs around the encounter. (NASA Release 80-164)

November 6: ESA announced plans to mark a milestone in space cooperation on or about November 28 when prime Spacelab contractor VFW-ERNO delivered the engineering model to NASA. After 6.5 years of development and manufacture, the model would be ready for shipment to KSC for verifying flight-unit interface with ground equipment and for training.

Delivery of the prototype, not meant for flight, would be the first Spacelab-hardware transfer under a 1973 memorandum of understanding, followed in 1981 by delivery of the first flight unit, which would carry experiments being developed in Europe and the United States. NASA, which had ordered a second flight unit for delivery in 1982-1983, had scheduled Spacelab launches for June and November 1983. (ESA Info 25; NASA Release 80-180; MSFC Release 80-152)

November 10: The *Washington Star* reported the latest photographs from *Voyager 1* on its way to Saturn revealed that the ring system was far more complex than Earth-based observation suggested. Besides rings within rings and a collection of particles filling the gaps between the major rings, the images showed in the brightest and widest inner rings fingerlike shadows like spokes, first seen two weeks ago, that scientists could not explain. Dr. Bradford A.

Smith, imaging team leader, called the photos "baffling." (*W Star*, Nov 7/80, B-2)

• LaRC announced selection of Martin Marietta Corporation for negotiations leading to a $2 million, two-year contract for design and development of a real-time signal-processing system using new technologies to perform on a spacecraft several processing functions formerly carried out on the ground.

Elements to be developed included radiometric and geometric correction and packeting of data. The contractor would demonstrate these operations on Landsat-type data in a laboratory and would incorporate new signal-processing functions into commercial-grade electronic components. Martin Marietta would do the work at its Denver facility. (LaRC Release 80-93)

• ESA reported that Professor P. Wild, University of Berne, had discovered a supernova in spiral galaxy NGC 6946, a relatively close galaxy appearing nearly face-on to the Earth and a prolific source of supernovas (5 in the past 63 years). Within three hours after Dr. Wild alerted the astronomical community, the Villafranca (Spain) tracking station used the international ultraviolet explorer *Iue* to acquire the first spectrum, before optical astronomers could do so from the ground.

Early spectra taken by the station near Madrid showed the supernova nearly at maximum and fading slowly, with a strong continuum representing a temperature of about 20,000°C. Before the object faded too far, it would be a target of concerted observations over the electromagnetic spectrum. ESA noted that such supernovas were rare, only two occurring per decade on the average; *Iue* observers were fortunate in witnessing the event, second seen since *Iue*'s launch in January 1978. (ESA Info 26)

November 11: Only a day away from its closest encounter with Saturn, *Voyager 1* had surprised scientists again with images of a huge hill on the moon Tethys and some distorted "ringlets" inside Saturn's concentric ring system. The head of the imaging team, Dr. Bradford Smith, said Saturn's rings were a complex system with dozens of small ringlets forming perfect circles within circles; traditional theories did not explain even the series of concentric ringlets.

Of one ringlet offset in a ring gap, Smith said that it was not circular and not of uniform width, varying from 15 to 50 miles wide; this and another found elsewhere might be caused by small moonlets not yet visible on either side, distorting the ring particles with their gravity. (*W Star*, Nov 12/80, A-5)

• ESA announced that France had deposited its "instrument of ratification" of the convention establishing the agency, completing legal formalities for its going into force. Countries that signed the convention May 30, 1975, had agreed to make it applicable immediately, permitting ESA to operate *de facto* for more than five years. Formalizing the agency meant that the 11-member states could now avail themselves of all possibilities offered by the convention intended to give a "truly European dimension" to the space effort.

Current member nations were Belgium, Denmark, France, West Germany, Italy, Ireland, Netherlands, Spain, Sweden, Switzerland, and the United Kingdom. Ireland had signed the convention December 31, 1975, and would soon deposit with ESA its own instrument of ratification to obtain the legal status of a member state. Austria, under various agreements to participate in ESA programs, would be an associate member as defined in the convention. Canada and Norway, which had also participated in some ESA programs, would remain in observer status. (ESA Info 23; *Df Dly*, Nov 14/80, 65)

November 12: Climaxing a 1.3 billion-mile, 38-month trip from Earth, *Voyager 1* came within 77,000 miles of Saturn for "man's best-ever look" at its surface, the *Washington Star* reported. Cameras surveying some of Saturn's moons revealed a huge crater with a central peak on Mimas; bright cobweb markings on Rhea and Dione; and a 500-mile canyon cutting through the frozen surface of Tethys, all moons that until now were only points of light as seen by Earth telescopes.

Voyager 1 showed particles in the narrow outer F ring orbiting in three "braided" strands, as JPL scientists described them; from 470,000 miles, the ring appeared about 20 miles wide with small "knots" that might be clumps of ring material, or mini-moons. (*W Star*, Nov 13/80, A-5)

November 14: NASA reported that the People's Republic of China had been admitted as the 48th member of the United Nations outer space committee, which the General Assembly had expanded from 48 to 53 members. The president of the General Assembly would appoint five new members, one each from the U.N.'s regional groups; those expressing interest were Upper Volta, Syria, Uruguay, Peru, Vietnam, and Bangladesh. The United States supported admission of the People's Republic but was the sole nay in a 113-1 vote to expand the committee. (*NASA Dly Actv Rpt*, Nov 14/80)

• The *Washington Star* reported that SBS had bet its future on the launch of a $20 million satellite as the basis of a revolutionary long-distance telephone service. SBS had promised new communications at lower rates than those of AT&T; its network would be the first in the world to use satellites and ground stations alone to transmit voice, data, and video messages from one place to another. Telephone firms had previously transmitted messages by underground cable or microwave-relay towers.

The system would connect a firm with its faraway offices without reference to local phone lines: it would use a 16- to 25-foot-diameter antenna installed on a roof or in a parking lot to signal the satellite, which would relay the signal to ground stations at distant company offices and give service not presently available. Computers at far locations could talk to each other at speeds 20 times faster than was now possible; facsimile pictures could be transmitted

200 times faster; and the system would allow customers to hold videoconferences with executives located all over the United States.

SBS had had difficulty in selling its services, designed for companies or government agencies conducting a large amount of nationwide business. It estimated a need for 25 to 30 private-line customers to break even by 1983. Two of its owner companies, IBM and Aetna, were among its 10 customers, and General Motors had asked for three stations to link Detroit, Atlanta, and Dayton. SBS said that the launch, scheduled for November 15, should attract attention and more customers to the company. (*W Star*, Nov 14/80, B-5)

November 15: NASA launched SBS-A, the SBS spacecraft, from ESMC on a Delta at 5:49 p.m. EST into a transfer orbit. At 5:30 p.m. EST November 17, the apogee motor fired it as *Sbs 1* into a circular geosynchronous orbit over 176°W. The final station would be over the equator at 106°W, south of Santa Fe, N.M., for coverage of the continental United States.

Sbs 1, first of a new satellite series built by Hughes Aircraft, was a spin-stabilized 1,212-pound (550-kilogram) craft 216 centimeters (7 feet) in diameter, 282 centimeters (9 feet, 3 inches) high when stowed for launch. In geosynchronous orbit, extension of its telescoping solar-panel cylinder and communications antenna would make its height 660 centimeters (21 feet, 8 inches). *Sbs 1* would also be the first U.S. domestic communications satellite to use the less congested 12- to 14-GHz (K-band) high frequencies. Its high-speed all-digital 10-transponder system could relay up to 480 million bits per second, equal to more than 10 million words. It would begin early in 1981 to provide integrated all-digital interference-free transmission of telephone, computer, electronic mail, and videoconferencing to SBS business and industrial clients.

This launch was also the first use of a new McDonnell Douglas solid-fuel payload-assist module (PAM) as part of the SBS-A payload, to increase Delta capability on launches to geosynchronous orbit by 20% over that of the usual Delta third stage. (*NASA Dly Actv Rpt*, Nov 19/80; NASA Release 80-167)

November 18: NASA reported that LeRC awarded a two-year $2,917,800 contract to Energy Research Corporation, Danbury, Conn., under a DOE program managed by LeRC, for fuel cell technology to provide 120-kilowatt capacity needed to meet all heating, cooling, and electrical needs of an apartment complex or small shopping mall with greater efficiency than that of usual systems. Fuel cells would combine hydrogen and oxygen electrochemically to produce electricity as well as a usable by-product, heat. A fuel-conditioning system would produce hydrogen from natural gas or naphtha, oxygen coming from the air; future such systems could make hydrogen from synthetic fuels, liquid or gaseous, derived from coal. The LeRC contract would aid the government's effort to develop high-efficiency means of reducing U.S. dependence on scarce fuels while meeting environmental standards. (NASA Release 80-170)

• NASA reported selection of Hughes Aircraft's space and communications group for negotiation of a $40 million contract to be managed by ARC for a carrier spacecraft to transport the Galileo probe to Jupiter. Launched from the Space Shuttle in March 1984, the probe would reach the planet by July 1987, separate from the carrier, and enter the atmosphere to measure it for about one hour down to a level where pressure would be 10 times that of Earth's.

The carrier would be powered by two radioisotope thermoelectric generators (RTGs); solar energy at Jupiter's distance would be too weak to furnish power to the carrier, which would maintain contact with Earth during the entire mission, returning data both in real time and for playback on tape recorders. The carrier would receive data from the probe during its entry and descent into Jupiter's atmosphere, transmitting it to Earth stations. Data on Jupiter's atmosphere, believed to consist of the original material that formed the stars, would give scientists better understanding of Jupiter's and Earth's weather mechanisms. (NASA Release 80-171; ARC Release 80-79)

• NASA launched an eighth space-processing applications rocket, SPAR 8, November 18 from the White Sands missile range in New Mexico. Its payload, developed and tested by MSFC, was three experiments processed in about five minutes of zero gravity in the coast phase of the suborbital flight, using a three-axis room-temperature acoustic levitator; a single-axis acoustic-levitator furnace to produce 1,575°C; and a specialized processing furnace.

All experiments had apparently performed as expected: two were on acoustic levitation (use of soundwaves to keep liquids from contamination in touching the walls of a container), one of them to produce a high-temperature glass; the third experiment studied movement of bubbles in molten glass. The payload, damaged at impact on Earth, was recovered for damage assessment and study by the investigators of the results. (MSFC Release 80-148)

November 19: NASA announced that it had signed a memorandum of understanding with TVA on NASA support of TVA programs in energy research, development, and demonstration. The two agencies were currently negotiating an agreement for TVA reimbursement of NASA for MSFC support of TVA's coal-gasification project. NASA for some time had supported DOE and other agencies' programs on energy research and development (R&D) because its facilities were adaptable to such research. TVA had requested NASA assistance because of the NASA staff's experience in engineering and scientific disciplines applicable to energy research and technology, as well as in managing such programs. (NASA Release 80-172; MSFC Release 80-145)

November 20: NASA said that the Shuttle orbiter Columbia would move out of the orbiter-processing facility at KSC no earlier than November 23 for tow to the VAB and mating with the external fuel tank and solid-fuel rocket booster. Actual date would depend on results of final inspections now in process; NASA would issue an update November 22. (NASA Release 80-173)

• ESA reported that INMARSAT had awarded it a five-year contract at U.S.$1 million a year for leasing MARECS satellites A and B when located over the Atlantic and Pacific oceans. The completed INMARSAT system would cover the Atlantic, Pacific, and Indian oceans by using those satellites with Intelsat Vs carrying maritime communications payloads, and with one of the MARISAT satellites already in orbit. For the first time a European-built satellite would let ships at sea dial shore-based subscribers directly and establish telephone and telex links with them, through the real-time highly reliable MARECS system operating in the 4- and 6-GHz band and on 1.5- to 1.6-GHz frequencies. (ESA Info 28)

• NASA announced that Dr. John E. Naugle, its former chief scientist, would return December 1 on a temporary basis as acting chief scientist, principal scientific adviser to the NASA administrator, and continuing member of the Advisory Council responsible for planning long-range solar system exploration and other long-range goals for the agency. Naugle had joined GSFC in 1959 as head of its nuclear emulsion section and retired from the agency in June 1979.

During those 20 years, he had been chief, physics and astronomy programs, at Headquarters Office of Space Sciences in 1961; director of physics and astronomy programs, Office of Space Science and Applications, from June 1962 to May 1966; associate administrator for space science and applications in 1967; and deputy associate administrator of NASA in 1974. He became acting associate administrator in April 1975 and associate administrator in November 1975. He was appointed chief scientist in the 1977 reorganization. (NASA Release 80-175; Hq anno Nov 21/80)

November 21: LeRC awarded a one-year $150,980 grant to Atlanta University for research in high-strength fibrous polymers (a low-cost silicon product) for use in solar cells, and complex iron molecules for a chemical-storage system. Lockheed-Georgia Company would give $25,000 in technical support. (NASA Release 80-174)

November 24: The Space Shuttle Columbia, OV-102, rolled out of KSC's orbiter-processing facility at 6:01 p.m. and moved to the VAB for mating to its external tank and solid-fuel rocket boosters. Next rollout, from VAB to launch pad, would occur late in December. (*NASA Dly Actv Rpt* Nov 26/80; NASA anno Nov 24/80)

• NASA reported that Dr. Robert A. Frosch, its administrator, had signed an agreement November 18 in Bangalore, India, with Dr. Satish Dhawan, secretary of the Indian government's Department of Space, for launch by

NASA of two India communications satellites/metesats. In geosynchronous orbit, India's national satellites (INSAT) 1A and 1B would provide the subcontinent with point-to-point television and voice, community broadcasting, and weather data. Launch would be either by Shuttle or, at India's option, on Delta (expendable) launch vehicles.

Under the agreement, India's Department of Space would be responsible for manufacture of the satellites (under contract to Ford Aerospace), and for checkout and integration of a spinning solid upper stage (SSUS) to boost them into transfer orbit for maneuver to geosynchronous stations. NASA through KSC would provide all other launch-related services. INSAT 1A was scheduled for Shuttle launch in August 1983, or on a Delta in February 1982; INSAT 1B, by Shuttle in December 1983 or a Delta in July 1983. (NASA Release 80-176)

November 25: ARC announced that it would host a workshop in December on the atmosphere of Titan, largest of Saturn's moons and bigger than the planet Mercury. Experts on Titan from NASA, the university community, and elsewhere would discuss the temperature, pressure, and physical nature of Titan's surface, in view of new data from *Voyager I*'s flyby. (ARC Release 80-85)

• ARC announced a briefing December 4 on findings from the *Pioneer Venus* orbiter and five atmosphere probes. Scientists could now explain the planet-wide circulation of the Venus atmosphere; ultraviolet photography over a two-year period showed long-term patterns of cloud circulation; more new work seemed to explain the "hothouse effect" that produced Venus's heat; and new measurements were available of elements in that atmosphere. For television, ARC had prepared large color illustrations of Venus atmosphere circulation as well as new color pictures of the planet and models of the Pioneer orbiter. (ARC Release 80-84)

• NASA announced selection of Ball Aerospace Systems to negotiate a cost-plus-award-fee contract estimated at $21 million for an Earth Radiation-Budget Satellite ERBS and mission operations support. The satellite would be integrated, tested, and delivered for Shuttle launch by April 1984. Working with NOAA-F and NOAA-G, it would become part of a three-spacecraft system using scanning and nonscanning radiometers to measure solar radiation received and reflected from various regions of Earth. NASA's experimental *Nimbus 6* and *Nimbus 7* carried radiation-budget instruments, but the (ERBS) would offer for the first time measurement of radiation on a global basis 24 hours per day. (NASA Release 80-178)

• NASA reported that Peter Bird, a 33-year-old London photographer, who in 1974 crossed the Atlantic with a friend in a rowboat, had left Baja California for Australia November 11 alone in the same vessel (Royal Navy rescue boat

Britannia II) carrying a NASA locator beacon of the type used on *Nimbus 6*. This type of beacon had tracked a two-man balloon crossing of the Atlantic, an expedition into the Egyptian desert, and a Japanese explorer's hike from Canada to the North Pole and the length of Greenland, all in 1978, sending data to GSFC for computation and relay to pinpointing locations. Bird would use the locator for his own position computations. (NASA Release 80-177)

November 26: ARC announced plans to flight test the parachute system for the Galileo Jupiter-atmosphere probe, third and last test of the system at the Naval Weapons Center test range at China Lake, Calif. Previous tests revealed the need for improvements, which had been made on the chutes to be tested. On completion of the test program, the design would be ready for delivery.

Early in 1982 a U.S. Air Force Geophysics Laboratory balloon would carry a fully equipped probe to 100,000-foot altitude over the White Sands missile range and release it in a drop like the Jupiter descent, including parachute and hardware staging. When launched by a Shuttle and released from its carrier at the planet in September 1987, the parachute would slow descent of the probe in the turbulent atmosphere, using its six instruments to measure chemical elements and compounds, weather patterns, and pressures. (ARC Release 80-81)

• ESA said that Erik Quistgaard, its director general, would meet in London November 27 with Olof Lundberg, director general of INMARSAT, to sign a contract for lease to ESA of 2 Marecs satellites [see Nov. 20]. The contract, worth about U.S.$65 million, would go into effect in 1982. ESA was first of three entities expected to contract with INMARSAT for satellites to provide a new worldwide maritime telecommunications service for the international shipping community. (ESA Info 29)

November 27: The Soviet Union launched a redesigned spacecraft, *Soyuz T3*, carrying three cosmonauts in what the *New York Times* called a possible bid to break the 185-day endurance record set in October. Launch at 5:18 p.m. Moscow time was from the cosmodrome at Baykonur in Soviet central Asia; Tass reported that all systems were working well. The pilot of the flight was Lt. Col. Leonid Kizim, 39, a first-time flyer in space; flight engineer Oleg Makarov, 47, had flown on *Soyuz 12* in September 1973 and *Soyuz 27* in January 1978, as well as the "anomaly" of April 1973. Research engineer Gennady Strekalov, 40, also a rookie, had worked for 20 years in spacecraft design. This was the first three-person flight launched by the Soviet Union in nine years, since the crew of *Soyuz 11* died during reentry in June 1971 when their capsule sprang a leak and lost pressure. The cosmonauts had not worn their space suits because of crowded conditions on the capsule.

Vladimir Shatalov, head of cosmonaut training, said that *Soyuz T3* had "all the latest accomplishments of science and technology" including a fast on-board computer to free the crew "to the maximum from . . . . routine operations." The system was said to perform all calculations needed to dock with another craft such as *Salyut 6*. However, Radio Moscow did not say how long the flight would last, and Moscow media did not say whether *Soyuz T3* would link with *Salyut 6*, which had been in orbit three years—only that the crew would test a new spacecraft.

Soyuz T3 was first of that type to carry a three-person crew, 39th in the Soyuz series, and sixth manned craft to be launched in 1980. Two tests of the new design had been successful: an unmanned *Soyuz T* had docked with space station *Salyut 6* in December 1979, and *Soyuz T2* carrying Yuri V. Malyshev and Vladimir V. Aksyonov had joined the *Soyuz 36* crew (record-holders Valery Ryumin and Leonid Popov) there in June of this year. *Salyut 6*, designed to last only 18 months, had supported four expeditions over its three years in orbit. When Ryumin and Popov left it six weeks ago, after a thorough overhaul of its equipment, they said that it was fit for further use. (*NY Times*, Nov 27/80, A-3; *W Post*, Nov 28/80, A-28)

During November: MSFC announced that Dr. William R. Lucas, center director, had appointed Thomas J. (Jack) Lee deputy director, effective December 1. Lee had worked at the center and its predecessor since 1958 and for the past six years had managed the Spacelab program, working with ESA on this Shuttle payload. John W. Thomas, Lee's deputy, would succeed as manager of the Spacelab office.

Lucas named John S. Potate, associate director for management, to a new position as associate director. Potate had come to MSFC in 1973 from the Apollo lunar-landing program at KSC and at Headquarters. (MSFC Release 80-149)

December

December 1: Astronomer Robert Victor, a professor at Michigan State University, said that the Christmas season would be marked by a triple conjunction of Jupiter and Saturn "worth gazing at" that would not occur again until A.D. 2238 or 2239. The event had occurred in 7 B.C. and resembled a similar conjunction of Jupiter and Venus in 2 B.C., either of which could have appeared as the guiding light of the Magi or star of Bethlehem. (*W Star*, Dec 1/80, A-2)

• ARC announced plans to mark the second anniversary of Pioneer Venus's orbiter when it would complete two Earth years (equivalent to three Venus days) circling the cloud-covered planet. It should remain in orbit there until 1992, looking at Venus from a variety of new vantage points.

Since its arrival December 4, 1978, Pioneer had made 730 24-hour orbits and returned more than a thousand UV pictures of Venus's clouds. It has mapped 93% of the surface by radar, showing a terrain of mountains, high plateaus, and wide plains. To transmit its 40 billion data bits back to Earth, its antenna had made more than 5 million rotations relative to the spinning spacecraft; it had recorded 75 gamma-ray bursts from other parts of the galaxy, and its other instruments had measured Venus's atmosphere and surface, interior, and surrounding environment.

During the first two years, Earth commands had kept Pioneer in a fixed position; from now on it would "float" in response to pressures of solar radiation and of Venus and solar gravity, orbiting over the planet's equator by 1986. It would be able to measure the bow shockwave of Venus and its wake region in the solar wind, or "tail," possibly in cooperation with USSR spacecraft scheduled to arrive there in 1982 and 1984. (ARC Release 80-88)

December 2: The NSTL in Mississippi completed a fourth and final cycle of certification tests on the Shuttle main engine. Certification required successful completion of four test cycles each of 13 tests and more than 5,000 seconds of operation, using two different engine assemblies. A cluster of three main engines and two solid-fuel rockets would thrust the Shuttle into orbit. (NASA Release 80-182; MSFC Release 80-158)

• MSFC said that the Michoud facility near New Orleans had begun assembling the lightweight external-propellant tank for the Space Shuttle. Built by Martin Marietta Aerospace, the modified tank would weigh 6,000 pounds less than its predecessor, increasing Shuttle payload capacity by about that amount. Recent structural tests showed that reducing thickness of skin panels would not affect tank integrity; changing materials of some components would also take advantage of recent research.

The external tank (actually two tanks connected by a collar-like intertank) would contain liquid-hydrogen and liquid-oxygen propellants for the three Shuttle main engines and would be the only major element not recovered for reuse. First of the lightweight tanks should be ready for delivery in the summer of 1982 for the fifth Shuttle launch. (MSFC Release 80-155)

• The *New York Times* reported that the first attempt at long-distance solar-powered flight lasted 22 minutes when Solar Challenger, Dr. Paul MacCready's lightweight high-strength plastic-and-balsa craft driven by a 2.75-hp motor, took off December 3 about 1:00 p.m. from an airport north of Tucson, Ariz., headed for Phoenix, and came down six miles away. Former teacher Janice Brown, 32, who piloted Challenger, said that it was "fantastic" and she would "try again tomorrow."

Powered like other record-setting MacCready vehicles by solar cells covering its wing and tail, Challenger apparently experienced failure of its motor (no larger than a champagne bottle, and of lighter weight, the *New York Times* noted) and Brown set the 1351-pound plane down on the desert, where nearby farmers and several American Indians came to look at it. (*NY Times*, Dec 4/80, A-18)

• GSFC said that a team of its scientists and technicians had pioneered a stereo-imaging technique for studying hurricanes, using photographs of the top of the same hurricane taken by two spacecraft, geostationary operational environmental satellites Goes East and Goes West, hovering over the equator at 75°W and 135°W. The team combined time-lapse cloudcover photos of Hurricane Frederic over the Gulf of Mexico September 12 in a stereo display showing changes in the storm as seen from space and allowing estimates of its intensity. (NASA Release 80-181)

• ESA said that it was training at Toulouse and Marseilles the U.S. and European Spacelab mission and payload specialists to give them a better idea of the scientific objectives and let them operate 2 of the 11 French experiments. The first Spacelab payload would be launched in June 1983.

PICPAB (phenomena induced by charged-particle beams), a plasma-physics experiment under test at Toulouse, would study results of energetic-particle emission along Earth's magnetic-field lines, such as neutralization and instability, for use in remote measurement of electric fields and creation of artificial auroras. At Marseilles the crew would become familiar with the very-wide-field camera for general UV survey of most of the celestial sphere and study of galactic and extragalactic sources. (ESA Info 30)

December 4: NASA adjudged Solar-Maximum Mission *Smm* successful in observing solar flares using five or six experiments simultaneously, coaligning the narrow field-of-view instruments and measuring total solar radiation over at least six months. Launched February 14, 1980, *Smm* had collected the most data ever on solar flares, about 25 in number, coordinating with ground-based optical and radio telescopes under the International Solar-Maximum Year program. These valuable joint observations would continue. (NASA MOR-S-826-80-01 [postlaunch] Dec 4/80)

• NASA reported successful static-firing for 591 seconds December 4 at NSTL of the main Shuttle propulsion system. The test exceeded the firing time needed to put the Shuttle into Earth orbit. This 11th test of the three-engine cluster brought total test time on the main system to almost 32,000 seconds, in addition to more than 86,400 seconds of tests on individual engines conducted in separate firings. (NASA Release 80-184; MSFC Release 80-160)

December 5: KSC reported that Shuttle orbiter Columbia, mated with other elements on a mobile launcher in the VAB, was ready for its first major test as a unified system. On November 24, Columbia moved 300 yards from the VAB to the orbiter-processing facility where solid-fuel rocket boosters and external tank had been assembled on the mobile platform. A Shuttle-interface test running more than two weeks would check electrical and mechanical connections between elements and on-board flight systems. Interface tests originally scheduled earlier this week were delayed by problems including failure of a device providing umbilical link with the orbiter.

This was the first flow of flight hardware through KSC processing facilities: the orbiter Enterprise, not built for spaceflight, served as "pathfinder" through the facilities in 1979 but lacked many of the systems installed in Columbia. Individual Columbia systems had passed checkouts in late 1979 and early 1980, but the upcoming test would check the entire Shuttle system as a unit with the prime and backup crews taking part in simulations of ascent to orbit, abort, and descent to landing.

William H. Shick, chief of prelaunch test operations, noted that this would be the first time the astronauts had occupied the cabin with the vehicle in a vertical position; they would "get a feel of what they can and can't reach," he added, to assess crew comfort while awaiting launch. (KSC Release 206-80)

• Press reports said that the FCC had voted 7 to 0 to approve construction and launching of 20 new communications satellites by 8 companies, tripling the number of commercial satellites providing domestic communications service, in what the *New York Times* called "in a single action the greatest impetus ever to the expansion of satellite service."

Besides alleviating a shortage of satellite capacity faced by cable television and other industries, FCC said that the decision would open the way for investment of more than $2 billion by the eight companies. This was their first chance to compete directly in the long-distance field with AT&T, instead of tying their local networks to the Bell System. Already operating their own satellite networks were three companies operating eight commercial communications satellites: Western Union Telegraph Company with three, RCA-American Communications, Inc., with two, and Comsat General Corporation with three leased entirely to AT&T and General Telephone & Electronics (GTE). Also Satellite Business Systems had finally launched its *Sbs* in November, making nine.

All four current owners would expand operations under the new policy: AT&T and GTE as well as Hughes Communications and Southern Pacific Communications would build their own systems for the first time. Continental Telephone Corporation and partner Fairchild Industries would enter the field through purchase of 50% of WU's Space Communications Corporation. (*NY Times*, Dec 5/80, D-1; *W Post*, Dec 5/80, E-2)

December 6: NASA launched *Intelsat 5A F2*, first of a new communications satellite series, from ESMC at Cape Canaveral, Fla., at 6:31 p.m. EST on an Atlas Centaur, into a transfer orbit with 35,950-kilometer apogee, 166.8-kilometer perigee, and 23.75° inclination. ComSatCorp fired the kick motor December 8 to put the craft into near-geosynchronous orbit at 15°E for tests. By mid-1981 the communications satellite would be on station at 338.5°E. (NASA MOR 0-491-203-80-01 [postlaunch] Dec 29/80)

—NASA issued a press kit describing the spacecraft, which weighed 1,928 kilograms (4,250 pounds) at launch. Built by Ford Aerospace using system components developed by firms in France, the United Kingdom, West Germany, Japan, and Italy, it had a capacity of 12,000 voice circuits and 2 television channels, almost double the capability of earlier Intelsats. Cost of the launch was about $76.6 million, including $34 million for the spacecraft and $42 million for the Atlas Centaur and launch services. INTELSAT, with headquarters in Washington, D.C., would reimburse NASA for costs of the vehicle and launch services, under an agreement signed in May. (NASA Release 80-179)

December 8: The *Washington Post* reported that two Florida launches had lit up evening skies with brilliant colors and a streak of light that prompted calls to authorities from as far away as Nashville, Tenn.

In the second of four tests to see whether ionized clouds blocked communications among aircraft, satellites, and ground stations, a U.S. Air Force rocket from Eglin Air Force Base in the Florida panhandle sprayed the ionosphere 116 miles above the Gulf of Mexico with 106 pounds of barium Sunday, December 6, creating a pink, green, and purple haze monitored by scientists on the ground and in airplanes. One aircraft was positioned so that the barium cloud passed between it and an experimental satellite in orbit 25,000 miles up. About 30 minutes later, the *Intelsat 5A F2*, largest communications satellite ever built, roared into orbit with the rocket trail familiar to Space Coast residents. (*W Post*, Dec 8/80, 4)

December 9: The *Washington Post* reported that Dr. Paul MacCready had completed a round of test flights of his solar-powered airplane Solar Challenger to prepare it for a Paris-to-London flight in June 1981. In six days of tests at the air park in Marana, Ariz., the Challenger had not achieved a planned 63-mile flight over the desert [see December 4]. Trouble with the propeller pitch control and related equipment continued, and MacCready said that he wanted to consider some changes before resuming the tests. The plane's 47-foot wingspan and stabilizer carried 16,000 solar cells to gather sunlight and convert it to power for the 2.7-hp motor that turned the propeller. (*W Post*, Dec 9/80, A-20)

• Responding to press reports on the Ariane, ESA issued a statement on its program of four flight tests, the second of which failed when the first stage malfunctioned. ESA had identified the trouble and taken steps to rectify it.

Test 3 would now take place in June 1981 and test 4 in the autumn of that year, a timetable ESA said was compatible with its commitments to put scientific and communications satellites into orbit in late 1981 and 1982. Financing arranged at the outset, which included 20% for contingencies, would cover the additional studies and tests needed. (ESA Info 31)

December 10: Press reports said that the three cosmonauts launched November 27 in *Soyuz T3* on a repair mission to the three-year-old space station *Salyut 6* had returned safely from their 13-day flight December 10 at 12:26 p.m. Moscow time. Landing was in Kazakhstan in Soviet central Asia. Leonid Kizim, Oleg Makarov, and Gennady Strekalov were in perfect condition, Tass said. This was the sixth manned mission by the Soviet Union this year and the first three-person crew orbited since 1971, when three cosmonauts died during reentry after a valve blew on *Soyuz 11*.

A new guidance system on *Soyuz T3* took over after liftoff and guided it to smooth docking with *Salyut 6*. The spacecraft, third of an improved version of the Soyuz (mainstay of the Soviet space program since 1967), carried solar batteries, an on-board computer, improved maneuvering rockets, and improvements in cabin comfort for the cosmonauts. The crew had performed repairs and maintenance on *Salyut 6* telemetry, refueling systems, and temperature controls. (*W Post*, Dec 10/80, A-2; Dec 11/80, A-13; *NY Times*, Dec 11/80, A-23)

December 11: ARC reported that its Earth-resources survey aircraft (U-2) was helping the U.S. Forest Service, National Park Service, and California Department of Forestry fight fires by providing real-time infrared imaging of smoke-obscured landscapes. The images, used for the first time October 2 during a fire at Kings Canyon National Park in the Sierra Nevada where thick smoke blocked aerial viewing, gave the size, shape, direction of burn, and hot spots of the fire. Crews had to hike four hours each way to get to some areas.

Steep terrain would endanger firefighters and equipment if the fire perimeter was unknown.

Flying at 21-kilometer altitude (about 65,000 feet), the plane used a Daedalus multispectral scanner with a Fairchild charge-coupled linear-array scanner to send infrared (IR) images directly to ARC, which transferred the hard copy of processed information immediately to U.S. Geological Survey maps of the area. Within 10 minutes, fire control headquarters would receive a telecopy for use in deploying manpower and equipment. The U-2 could photograph a fire for up to 5 hours and transmit anywhere within 500 kilometers (300 miles) of ARC, located near San Francisco, covering virtually all forested lands in California. (ARC Release 80-90)

• NASA announced development of a new lightweight flame-resistant material subject only to charring even at 800°F (426°C): polyimide resilient foam, a product of International Harvester's solar division at San Diego, under contract to JSC. Use of the new foam, available next year, would reduce hazards for buses, trains, and automobiles as well as planes.

Between 1965 and 1978, fires occurred in 20% of all passenger air-carrier accidents and caused 2,727 deaths, 469 of them (17%) attributed to effects of fire or smoke. Airlines and builders of commercial planes had sought improved materials since the 1960s; in the late 1960s, materials developed by NASA for Apollo and Skylab were made available to the industry, which chose not to use them because of cost, scarcity, and lack of durability. (NASA Release 80-185)

• INTELSAT said that the full launch sequence for *Intelsat 5A F2*, world's largest and most advanced commercial communications satellite, was completed successfully December 10 when the craft unfolded its antennas upon command from the Washington, D.C., control center relayed through a ground station at Fucino, Italy.

Launched December 6 on an Atlas Centaur into a highly elliptical orbit, the satellite went into near-circular orbit when the apogee motor was fired December 8. For the next two days the control center staff had been activating it into operational configuration, unfurling its giant 51-foot (15.6-meter) solar arrays and locking its sensors on the Earth, spinning up the momentum wheel to stabilize it facing Earth's surface. Final operation was antenna deployment.

Intelsat 5A F2 would now drift in equatorial orbit to its station as primary Atlantic Ocean communications satellite by May 1981, when it would begin serving as communications link between the western hemisphere and Europe, the Middle East, and Africa. (INTELSAT Release 80-29-I)

December 12: NASA reported that GSFC scientists had developed a high-precision radioastronomy system to study movements of Earth's crust. A technique known as Very Long Baseline Interferometry (VLBI) used ground antennas to observe fixed extragalactic sources, usually quasars. Arrival of the quasar signal at the different points at different times could serve to calculate geometrically the distance between the stations with a high degree of accuracy.

The VLBI technique had been one means used by NASA with other federal agencies to study movement and deformation of Earth's crust, including how and why earthquakes occur. A team representing GSFC; the Haystack observatory at Westford, Mass.; MIT at Cambridge; and JPL, Pasadena, Calif., had refined the technique for ultraprecise geodesy using fixed or mobile radioastronomy antennas 4 to 64 meters (13 to 210 feet) in diameter to measure Earth and polar rotation with precision better than 10 centimeters (4 inches), and detect Earth movement preceding large earthquakes. Such movement might occur so slowly and over so wide a region as to be undetectable by conventional means. The project had used fixed stations in California and Massachusetts and at Green Bank, W.Va., and Ft. Davis, Tex., as well as in Sweden, West Germany, and England. JPL was also working the system into a mobile station to measure movement in the Western United States. (NASA Release 80-187)

• NASA said that the Shuttle integrated flight system was in its second week of tests in the VAB at KSC. Electrical and mechanical interfaces between the elements and between the individual Shuttle systems were under extensive test the past week, including umbilical connections between launcher and orbiter, external-tank tumble system, and inertial-measurement unit. Interface tests began at 2:00 a.m. December 4 and had continued around the clock since that time. The integrated test began early December 10; flight simulations with prime and back-up crews would begin December 14. (NASA Release 80-190; KSC Release 261-80)

• NASA announced signing of an agreement in Jakarta December 9 by Dr. Stanley I. Weiss, associate administrator for space transportation operations, and Drs Suryadi, Indonesia's director general of posts and telecommunications, for NASA launch of two Indonesian communications satellites. Satellites Palapa B-1 and Palapa B-2 in geosynchronous orbit would offer voice, video, telephone, and high-speed data service to member states of the Association of Southeast Asian Nations (ASEAN) including, besides Indonesia, the Philippines, Thailand, Malaysia, and Singapore. NASA would launch B-1 between January 1983 and January 1984, depending on Shuttle availability, and B-2 between January and March 1984; it had launched earlier versions of Palapa in 1976-77. (NASA Release 80-183)

December 16: NASA reported that it was test firing Shuttle main engines with spalled (pitted or flaked) bearings and cracked turbine blades, to show that the liquid-fuel engines could tolerate less-than-perfect conditions and still perform Shuttle missions successfully. Firing began this week at NSTL and at Rockwell's Rocketdyne Division in California. The bearings and blades were parts of the engine's high-pressure oxidizer pump: in more than 153 tests on

23 pumps, totaling more than 34,000 seconds of operation, only five instances of spalling on the bearings occurred, detected in inspections after the tests. In each instance, operation of engine and pump was satisfactory.

Since procedures for chilling before operation were improved, 6 pumps had gone through 25 tests (7,500 seconds of operation) with zero spalling. Although engine runs had produced some cracked turbine blades, such cracks had caused no failures or engine malfunctions in more than 98,000 seconds of testing. NASA had instituted the tests for added assurance of successful performance even with cracked blades or spalled bearings in the Shuttle engines. Testing was under the direction of MSFC. (NASA Release 80-191)

• DFRC reported that on December 16 Dr. Robert A. Frosch visited it for the first time as NASA administrator, holding an all-hands meeting in the auditorium for an overview of NASA status and a farewell speech. Center director Isaac T. Gillam IV gave Frosch a montage of photographs of DFRC research aircraft. After the meeting, Frosch briefed local reporters on Shuttle status. (FRC *X-Press*, Dec 19/80, 4)

December 18: KSC reported that the Shuttle interface tests were coming to an end. This first major checkout of the integrated flight system was to close with a series of four simulations using prime and back-up crews of the first launch to validate computer programs that would serve on-board flight systems during the first STS mission in 1981; the last two simulations were scheduled for December 18.

Tile work and processing of gap fillers was continuing, with only a small amount of gap-filler work to be completed after the Shuttle moved to Pad A of Launch Complex 39. At the pad, filling of the liquid-oxygen storage tank was to be complete December 17, as would insertion and removal of dummy payloads to test the service structure. Tests of *UTC Liberty* retrieving solid-fuel rocket casings from the ocean would continue through December 19, and sister ship *UTC Freedom* would begin sea trials later. (KSC Release 268-80)

The *Washington Star* carried a UPI report that astronauts Richard Truly and Joe Engle had put Columbia through its third rehearsal of the week December 18 "as slick as silk," improving chances of launch March 14. (*W Star*, Dec 19/80, A-5)

• NASA announced that rollout of orbiter Columbia to the launch pad would occur no earlier than December 29 at KSC. The move was postponed from December 26 because of time lost in VAB processing, intensity of crew work, and a two-day holiday vacation. Gap-filler closure rate was averaging 275 per day and would not constrain the rollout data, NASA said. (NASA Release 80-195)

• INTELSAT announced that its board of governors had decided to purchase three more Intelsat 5A satellites in addition to the nine already on hand for the Intelsat 5 series, the latter to be launched by the end of 1982. Launching of the 5A series would begin in 1984; basically similar to Intelsat 5, they would have increased reliability and 25% more communications capacity, handling 15,000 telephone calls compared to 12,000. (INTELSAT Release 80-30-I)

December 19: LaRC announced successful demonstration of the world's first gas laser powered directly by sunlight. Conventional laser systems required intermediate energy conversion to achieve lasing: LaRC's device without conversion components reduced system size, weight, complexity, and cost. Researchers J.H. Lee and W.R. Weaver directed light from a solar simulator onto a quartz tube filled with gaseous iodide; the light excited the iodide, causing lasing and emission of a 5-W burst of concentrated light waves.

NASA plans for lasers included use of a space-based system powered by sunlight to direct a laser beam at remote space operations; at the operations site, the laser would change to conventional energy such as electricity or heat. A laser might propel a special space engine to provide economical transfer of payloads in orbit. (LaRC Release 80-96; NASA Release 80-196)

• NASA noted that *Pioneer 6* had completed 15 years of circling the Sun and returning solar data, longest operating life attained by an interplanetary spacecraft. Original Pioneer specifications had called for a working life of six months.

Pioneer 6 was first to measure the interplanetary medium in detail, sometimes over a half-billion-mile distance. It measured the Sun's corona, returned data on solar storms, and measured a comet's tail. It acquired data on solar cosmic rays, the solar wind, and the solar magnetic field, all three of which extend far beyond the orbit of Jupiter.

Launched in December 1965, the 140-pound (64-kilogram) drum-shaped TRW-built craft was 35 inches (89 centimeters) high and 37 inches (94 centimeters) in diameter, covered with solar cells, and carried three booms 120° apart. With *Pioneer 7, Pioneer 8,* and *Pioneer 9,* its sister craft, it constituted a network of solar weather stations circling the Sun millions of miles apart. All current Pioneers (*6* through *11*, and the Pioneer orbiter at Venus) were still operating; mission manager Richard Fimmel said that *Pioneer 6* was so good "that we may get another 10 years out of it." (NASA Release 80-194)

December 23: KSC reported final preparations under way for moving the orbiter Columbia from VAB to pad A, Launch Complex 39, within the week. Mating Columbia in the VAB to its external propellant tank and solid-fuel rocket boosters November 24 was followed by tests of ground-support connections for checkout, fueling, and launch, and of the entire flight system. December 23 should see completion of the installation and checkout of ordnance (any explosive devices for parting components like the boosters and external tank from the vehicle in flight).

Gap-filler work needed before rollout would be complete by December 27;

the crawler-transporter would take its place under the mobile launch platform December 28. Senior NASA managers would review the VAB tests and pad A status before rollout to make sure no constraints existed. (KSC Release 275-80)

December 24: NASA said that ARC had begun a study of the effect on airline pilots of irregular work schedules and sleep patterns and frequent crossing of time zones. Studies of animals and humans showed that reduced performance, short-term memory lapses, loss of attentiveness and alertness, and fatigue were results of "circadian desynchronosis" (jet lag), the disturbance of 24-hour biological rhythms, especially sleep cycles. Previous research was on shift workers, truckers, ship crews, and railroad engineers, but little on airline crews.

A workshop last August for airline, research, and FAA personnel agreed on pilot fatigue as a problem but could not agree on its magnitude. A group of life scientists checked reports from NASA's safety reporting system for events possibly related to fatigue; another group reviewed scientific literature to prepare a bibliography on jet lag in lay terms and distribute it to the aviation community. ARC would also do a field study on dietary, sleep, rest, and drug-use patterns of commercial airline crews and study altered sleep and nutrition patterns in its simulation facilities. (NASA Release 80-197)

December 29: Dr. Alan M. Lovelace, NASA's deputy administrator, submitted his resignation effective this date, but agreed to be appointed agency associate administrator and general manager. Named deputy administrator by President Ford in June 1976, Lovelace had been associate administrator for the Office of Aeronautics and Space Technology (OAST) since September 1974. In his new post he would continue the basic management he did as deputy administrator and be acting administrator during the absence of departing administrator Dr. Robert A. Frosch from January 20 until appointment of a new administrator and confirmation by the Senate. This arrangement, agreed to by both President Carter's and President-elect Reagan's staffs, would give NASA maximum continuity of management. (NASA Release 80-200)

• Bolted nose up to crawler-transporter, Shuttle orbiter Columbia arrived at its KSC launch pad for final tests before launch into space in 1981. The transporter made the 3.5-mile trip over a rocky road at 1 mph or less, completing the operation about 8:00 p.m. Dr. Robert A. Frosch, NASA administrator, told a "shivering crowd" that turned out to watch the journey that "we are now at the threshold of a new capability to investigate the universe."

Richard G. Smith, KSC director, and George Page, Shuttle launch director, said that test firings, simulated countdowns, and other work at the pad would probably delay liftoff to the end of March or early April. Navy Cdr. John W. Young, who had gone into space four times and would command the first flight, told reporters that delays in the program resulted from the concern for safety: more than a year went into attaching, replacing, and strengthening thermal tiles designed to protect the Shuttle astronauts from the heat of reentry. (*B Sun*, Dec 30/80, 4)

January

January 7: Ames Research Center (ARC) announced the completion of a flight program to evaluate the quiet short-haul research aircraft (QSRA). Twenty-two visiting pilots representing 16 organizations made 2 flights each in the modified deHavilland Buffalo (C-8A) with a new wing design and 4 Lycoming YF-102 engines mounted on the wing to provide propulsive lift. NASA offered the evaluation program to introduce QSRA technology to potential users, obtain feedback on the future of the program, and get an independent critique. Participating pilots and engineers represented ARC, Dryden Flight Research Center (DRFC), and Langley Research Center (LaRC), as well as the U.S. Navy, Marine Corps, and Air Force, the Federal Aviation Administration (FAA), and companies including Boeing, McDonnell Douglas, Lockheed, deHavilland, Grumman, United Airlines, U.S. Air, Ransome Airlines, and the Airline Pilots Association (APA). (ARC Release 81-01)

January 8: NASA officially approved the continuation of *Voyager 2*'s journey to encounter Uranus in 1986 after a Saturn flyby this summer. The Uranus encounter in January 1986 (a first close-up look at that planet, seventh from the Sun and twice as far from it as Saturn) would produce measurements and photographs as the spacecraft passed on its way to a possible encounter with Neptune.

NASA's decision to maintain *Voyager 2*'s present trajectory depended on *Voyager 1*'s November 1980 close approach to Titan and Saturn's ring system. Successful so far in its scientific aims, NASA judged the health of the *Voyager 2* spacecraft and instruments sufficient to complete a 5-year journey to Uranus and a productive flyby of that planet. (NASA Release 81-3)

January 13: NASA said that a new instrument it developed for the Environmental Protection Agency (EPA) had measured, for the first time, ozone concentration and distribution in a column of atmosphere. Ozone is a component of photochemical smog possibly hazardous to health; previous instruments could analyze its presence only in the area immediately surrounding an aircraft. The ultraviolet differential-absorption lidar, called UV-DIAL, analyzed light of different wavelengths—one absorbed by ozone, the other not—to define the amount and location of ozone between aircraft and ground. Lidar (light-intensification detection and ranging) is similar to radar but uses electromagnetic waves of much shorter length. (NASA Release 81-7)

January 15: Outgoing NASA Administrator Dr. Robert A. Frosch held a press conference on the agency's 1982 budget proposed by President Reagan in the amount of $6.7 billion, an overall increase of 21% ($1.2 billion) over FY81. "Given the inflation rate, the budget reflects real growth of about 9% over FY 1981. . . [not] as much as I would like to have seen, given NASA's extremely tight budgets over the past decade." The major emphasis would be on completing the development of operational capability for the Shuttle.

This budget would also include "a balanced effort in other areas of the space program and in aeronautics," Frosch said, mentioning the Venus-orbiting imaging radar (VOIR); a geological applications program (GAP); research using the triagency flight program NOSS (National Oceanic Satellite System); an upper-atmosphere research satellite (UARS) experiment defining the optimum spacecraft design to improve understanding of the stratosphere and mesosphere; and a numerical aerodynamic simulator (NAS) of airflow over three-dimensional aerodynamic surfaces, with major impact on design of aircraft and large-scale computers. The budget was "good, but not as good as it should be if we are to revitalize NASA," Frosch said. (NASA Text, press conf, Jan 15/81)

• In an accompanying statement, Frosch reviewed the situation of the inertial upper stage (IUS) to be used on the Shuttle for launching spacecraft into outer space from Shuttle orbit. Within resources offered by the 1981 and 1982 budgets, the best alternative seemed to be modifying the Centaur instead of proceeding with a three-stage IUS, in order to have "that very powerful combination available for first launches in 1985. No other alternative upper stage is available on a reasonable schedule or with comparable costs. Therefore, NASA will expand discussions with the Air Force on the best means for providing upper stages. . . [and continue with] the two-stage IUS, which both we and the Air Force are counting on." (NASA Release 81-14)

January 16: NASA announced the selection of the Association of Universities for Research in Astronomy (AURA), a consortium of 14 universities, for final negotiation of a contract to establish, operate, and maintain a science institute for the 13.1-meters (43-foot) Space Telescope scheduled for launch on the Shuttle early in 1985.

The space telescope science institute, making scientific investigations using the telescope for at least 15 years, would be located on the Homewood campus of Johns Hopkins University in Baltimore. The estimated contractor cost for an initial 5-year contract would be $24 million. Additional funding would be needed later for a guest-observer and archival-research program. The contract had options for three 5-year extensions. The institute would receive data sent from the telescope via the Tracking and Data Relay Satellite System (TDRSS) and NASA's communications network through the Goddard Space Flight Center (GSFC), where the institute would operate a space telescope support center. Investigations would be able to ask GSFC to point the spacecraft at any desired field-of-view. The 2.4-meter (96-inch, mirror in the telescope could image 350 times the volume of space now visible from Earth. (NASA Release 81-12; MSFC Release 81-11; *Nature*, Jan 29/81, 339)

January 17: NASA reported success in the last Shuttle main-engine test (static firing 12); engine 3 shut down as planned at 235 seconds, engines 1 and 2 shut down at 624.5 seconds. All major objectives were satisfied, including gimbaling and POGO pulsing; loading liquid oxygen (LOX) with the anti-geyser line removed; shutting down engines 1 and 2 using a flight high-pressure oxygen turbopump overspeed-prevention sequence; and completing a full-duration run using flight nozzles. Completion of this test ended the main propulsion test (MPT) constraint on the Space Transportation System STS-1. The test facility would be phased down until full power-level tests scheduled to take place in the spring of 1982. (*NASA Dly Actv Rept*, Jan 21/81; NASA Release 81-16; MSFC Release 81-8)

January 26: The government of Spain delivered a note to the U.S. embassy in Madrid agreeing to use of the naval base at Rota as a contingency landing site for the Shuttle. This completed action on contingency landing-site negotiations, as NASA had already reached agreement with Japan. (*NASA Dly Actv Rept*, Jan 28/81)

January 30: Johnson Space Center's (JSC) *Space News Roundup* said that a conference sponsored by NASA and the American Institute of Aeronautics and Astronautics (AIAA), attended by representatives of major U.S. industries, heard briefings on systems developed for the space program that were applicable to Earth-based activities. Representatives of Dow Chemical, Exxon, ITT, Johnson & Johnson, Teledyne, 3M, Xerox, and numerous other corporations learned about pharmaceutical production in Earth-orbiting laboratories, life-support systems designed for space suits, and an electromechanical alternative to conventional hydraulic actuators.

Bryan Erb of JSC's Earth-resources division described the use of satellite observations to predict crop growth or locate mineral deposits or oil sources. From 1974 to 1978 JSC had managed the Large-Area Crop-Inventory Experiment (LACIE), showing how sensors on an orbiting platform could read and relay to Earth the characteristic signatures of Earth features used by scientists and engineers to make mathematical models on a worldwide basis. The AgRISTARS (agricultural resources inventory survey through aerospace remote sensing) project was carrying the measurements further, reading out thermal conditions, predicting soil moisture, and analyzing crops in the visual (as compared to infrared) spectrum. Erb said a worldwide remote-sensing system should be available within the next 20 years for managing Earth resources.

Another innovation would be to work in space with living cells and proteins to develop products for fighting disease. Products like beta cells, enzymes, and immunoglobulins produced by kidney cells were already available in hospitals, but at astronomical cost. JSC's Dennis Morrison said that on the ground this kind of work was limited to a microbiological level; working in space with larger amounts would mean a 20 to 50% improvement. Pituitary, kidney, and pancreas cells would be among candidates for spaceflight, even though weight limitations would delay early commercial processing. (JSC *Space News Roundup*, Jan 30/81, 4)

During January: NASA reported Orbiting Astronomical Observatory *Oao 3* (Copernicus), the heaviest and most complex observatory ever launched by the agency and instrumental in discovery of the first black hole (Cyg X-1), had finished its career at the end of 1980 after 8.5 years of operation. Launched from Kennedy Space Center (KSC) August 21, 1972, with a life expectancy of 1 year, its performance was "astonishing," said GSFC engineers and scientists.

Orbiting at an altitude of 740 kilometers (460 miles), *Oao 3* used its supersensitive ultraviolet telescope, largest ever put into orbit, to view the heavens "with a precision and clarity never before possible," producing spectral readings invisible to ground-based observatories because of the obscuring effects of Earth's atmosphere. The telescope was capable of pointing accuracy equivalent to seeing a volleyball from a distance of 400 miles. During its lifetime, *Oao 3* served more than 160 investigators from the United States and 13 foreign countries in observing more than 450 unique objects.

Formal scientific investigations using *Oao 3* ended December 31, 1980, but a series of engineering tests would continue into mid-February, when NASA would terminate contact with the spacecraft. GSFC engineers were not sure whether it would orient itself permanently toward the Sun, begin a permanent orbital tumble, or combine the two. (NASA Release 81-10; *Goddard News*, Jan 5/81, 1)

February

February 2: Insulation that separated from the Space Shuttle's huge external fuel tank would delay the long-awaited launch to a time "no earlier than the week of April 5," NASA announced. Columbia's maiden flight was already more than two years behind its original schedule because of technical probable causing a series of postponents. The new difficulty was discovered in preflight tests at Cape Canaveral in which over a half-million gallons of supercold liquid hydrogen and liquid oxygen were pumped into the fuel tank for the first time.

The new delay was "the first substantial" problem encountered since July 1980 and was not related to earlier problems with the Shuttle's ceramic-tile insulation. During tanking tests, two areas on the external tank—one about 7×8 feet, the other about 4×4 feet—became debonded. The loose insulation would have to be rebonded before launch. (*NASA Dly Actv Rpt*, Jan 28/81; NASA Releases 81-15, 81-25; *W Post*, Feb 3/81, A-7; *W Star*, Feb 3/81, A-8)

February 2: The European Space Agency (ESA) reported on the May 23, 1980, failure of Ariane flight L02. The cause was "clearly identified" as inherent instability in one of the four launch-vehicle engines. All external causes had been excluded, and the manufacturer was able to reproduce the failure at a single-engine test stand. Devices for fuel injection in the combustion chamber provided unstable despite positive tests during development. The fault, "unfortunately a very common phenomenon with liquid-fuel rocket engines," had occurred in "most rocket programmes... notably in the American programmes."

ESA said that it had abandoned the injector in its present form and was working on modifications. The report concluded with a tentative launch schedule to be confirmed after the modifications were validated. (ESA Info Bltn, Jan 28/81 for release Feb 2/81)

February 9: LaRC reported on a meeting of representatives from industry and six NASA centers to review the agency's large space antenna program. Shuttle flights in the mid-1980s would include models of several antenna concepts: the large antennas designed for communications and other Earth-oriented applications, as well as for purely scientific studies of the solar system and the universe, would be transported into space folded into the Shuttle's cargo bay and deployed in Earth orbit. Previous work concentrated on the structural and material requirements of each concept; the meeting would identify work still needed on system technology, ground testing, and technical resources to complete development. (LaRC Release 81-9)

February 10: The National Oceanic and Atmospheric Administration (NOAA) was undertaking the first mass shift of satellites at 22,300 miles altitude in space, moving three meteorological satellites to new areas to improve their product and to prevent possible collision of one of them in its present crowded location, the Department of Commerce (DOC) reported.

NOAA would move *Goes 4* (the geostationary operational environmental satellite launched in September 1980) from 98°W to 135°W as backup for failing *Goes 3*; NOAA would not move *Goes 3* while it continued to function, but would put *Goes 4* as near as possible without its interfering with communications.

On January 29, NOAA moved a third meteorological satellite, *Goes 2*, from 105°W to 107°W to reduce the danger of collision with other craft or space debris; this satellite served primarily to relay weatherfax charts to ground stations. NOAA had to operate two geostationary satellites at all times: "Goes East" for the eastern United States and Canada and for most of the Atlantic, and "Goes West" for the western United States and Canada, for Alaska, and for the Pacific westward to Hawaii.

On January 29, NOAA also boosted its 7-year old *Sms 1* into a 22,600 mile high orbit, where it would remain indefinitely. After NASA's launch of a seventh geostationary satellite, planned for March, NOAA would move *Sms 2* from its station at 75°W to a nearby location on standby. (NOAA Release 81-16)

February 11: Japan reported that its National Space Development Agency successfully launched the first N-2 vehicle from Tanegashima carrying the 21st Japanese satellite—the engineering test satellite *Ets 4* (Kiku 3)—into a transfer orbit with 36,000-kilometer apogee, 230-kilometer perigee, and 10.5-hour period. The 650-kilogram satellite would monitor vehicle performance. Japan would launch seven N-2s between August 1981 and February 1986 to meteorological and communications satellites and aeronautical experiments. Although used for five years, the N-1 did not have the power to carry big geostationary spacecraft into orbit. (FBIS, *Kyodo* in English, Feb 11/81; *NASA Dly Actv Rpt*, Feb 12/81)

February 20: Columbia, flagship of U.S. Space Shuttles, "proved that at long last it is ready to carry astronauts into orbit," said the *Washington Star*, describing "a successful and spectacular firing of its three powerful engines."

At the end of the practice countdown, 8:45 a.m. EST, the three engines at the base of the delta-wing spaceship "flashed to life, spewing torrents of almost invisible flame, steam, and smoke over the launch pad" and sending a thunderclap of sound across KSC. "All engines are up and running," the control center announced. The world's most sophisticated rocket machine had generated 1.1 million pounds of thrust for 20 seconds, while the 122-foot-tall orbiter with fuel tank and boosters remained fixed to the pad by eight 3-foot steel bolts. In actual launch, explosive charges would sever the bolts, releasing the orbiter, and the solid-fuel boosters would help lift it to orbit.

During the final countdown, 526,000 gallons of fuel were pumped into the external fuel tank. Technical, weather, and procedural difficulties had postponed the firing, a first test of all shuttle systems combined, three times this week. Minor problems had delayed today's test another hour.

The *Washington Post* said that a labor walkout at KSC immediately after the 8:45 a.m. firing might threaten the April 7 date set for the actual launch of Columbia. About 800 aerospace workers, members of the International Association of Machinists employed by Boeing in spaceport support work, had struck in a pay dispute. Richard Smith, KSC director, said that the strike might jeopardize remaining operations; however, he noted that the union had a legal right to strike because its contract with Boeing had expired some time ago.

Columbia crew members John Young and Robert Crippen, who had waited out 2½ years of delays, viewed the test firing from the air; Young in a Shuttle training jet at 4,000-foot altitude, and Crippen in an identical craft about 1,900 feet higher. (*W Star*, Feb 20/81, A-1; *W Post*, Feb 21/81, A-7)

February 21: NASA launched Comstar-D, last of a series of four domestic communications satellites built by Hughes Aircraft for Comsat General, from KSC at 6:23 p.m. EST on an Atlas Centaur into a geosynchronous transfer orbit. The 6.1-mile (20-foot) high cylinder called *Comstar 4* in orbit, weighing 1,516 kilograms (3,342 pounds) at launch, had 12 transponders (channels), each capable of relaying 1,500 two-way voice circuits (overall capability of 18,000 simultaneous high-quality two-way phone transmissions). A postlaunch report said the apogee motor firing February 23 was successful. (NASA Release 81-27; NASA MOR-O-491-201-81-04 [prelaunch summary] Feb 10–12/81, [prelaunch] Feb 17/81, [postlaunch] June 17/81; *NASA Dly Actv Rpt*, Feb 24/81, Feb 25/81; ComSat Gnl Release 81-6; *D/SD*, Feb 25/81, 286; Feb 26/81, 294; *A/D*, Feb 26/81, 292; *Spacewarn*, Mar 31/81, 2)

• FBIS reported the launch at 9:30 a.m. local time of Astro-A, a scientific experimental satellite, by the University of Tokyo's Institute of Space and Aeronautical Science. The launch from Kagoshima had been postponed twice, from February 18 to 19 and again to February 21, because of rain. NASA's Space Tracking and Data Network (STDN) supported both this launch and that of *Comsat 4.*

Called Hinotori (fire bird) in orbit, the new satellite was Japan's 22d object to orbit and its 7th scientific satellite. It was the heaviest (190 kilograms) ever launched on the MU-3S rocket. In an elliptical orbit with 695-kilometer apogee, 568-kilometer perigee, and 37-minute period, Hinotori would study X-rays, gamma rays, and other aspects of solar flares. Its data would be of particular value because the Solar Max satellite launched by the United States in February 1980 on a similar mission was having instrument trouble. (FBIS, *Kyodo* in English, Feb 21/81; *NASA Dly Actv Rpt*, Feb 23/81)

February 26: ESA announced that it had "rejected" NASA's decision to cancel the U.S. spacecraft that would have been part of the joint International Solar-Polar Mission (ISPM). NASA told a meeting of the two organizations in New York that the cancellation resulted from budget cuts imposed by the Office of Management and Budget (OMB) in preparing the Reagan administration's budget proposal. ESA responded that canceling the satellite without consultation was a unilateral breach of a memorandum of understanding between the agencies and was unacceptable. ESA asked that NASA restore the program to its original level, noting that unilateral actions of this kind would be detrimental to future space cooperation between the United States and Europe. ESA said that, when its science-program committee decided to pursue ISPM in 1979, they chose that mission over a number of purely European missions because of the value ESA put on transatlantic cooperation.

Because of NASA's decision, European scientists from 17 institutions who supplied experiments for the NASA spacecraft would not be able to fly them. The experiments, "in an advanced stage of development" with more than half of the costs committed, ESA said, would be lost with no corresponding scientific return. ESA's director general immediately asked all of its member states to protest, through their ambassadors in Washington, the decision taken by NASA. Timing was crucial, because Congress would consider the federal budget in March. (ESA Inf 2)

February 27: DFRC reported on a dress rehearsal of Shuttle first-mission landing and postlanding activities on the dry lake bed at Edwards Air Force Base, Calif. The crew that would act as recovery convoy used an orbiter mock-up, fitted with interfaces for ground connections, to practice postlanding safety and servicing procedures: simulated activities included testing for the presence of toxic or explosive vapors and gases and cooling the orbiter by circulating freon through its pipes and cool air through its ducts. To simulate the landing, a NASA T-38 jet descended along the planned flight path from 40,000 feet up, while test manager Deke Slayton kept in touch with the recovery convoy and with the flight director, Don Puddy, at JSC.

Meanwhile, astronauts John Young and Robert Crippen at JSC completed a full-scale flight rehearsal, going through the 54.5-hour mission in a computer-operated simulator. Flight directors monitored the mock mission as if it were the real thing. (DFRC Release 81-8; *W Star*, Feb 27/81, A-9)

During February: Nature magazine reported that the Franco-Soviet mission to Halley's comet in 1986 entailed "a substantial cutback" for a planned joint mission to Venus in 1984. Assignment of two of the original four Venus probes to Halley was a reminder that Soviet space-program resources, though vast, "are not infinite."

Pravda had published several articles aimed at putting the Soviet effort in a favorable light; the Communist party congress would be asked next week to approve another 5-year plan including space exploration. However, the Soviet Union had never revealed the costs of the program. *Nature* said hints of increasing financial constraints had appeared recently: no further Intercosmos flights were in view after those with Mongolia and Romania, and Bulgaria had been offered two unmanned probes instead of a manned flight to replace the failed trip of its cosmonaut to the orbiting *Salyut 6*. (*Nature*, Feb 26/81, 741)

March

March 5: The Japanese government accepted a U.S. proposal to use the U.S. Air Forces' Kadena Airbase on Okinawa Island as an emergency landing area for the Space Shuttle orbiter Columbia, the Foreign Broadcast Information Service (FBIS) reported. Tokyo *Kyodo* said NASA was arranging sites for emergency landings at six airports, three domestic and three abroad. The agreement with Japan covered only four test flights; other flights would need further negotiations. Officials of Japan's foreign and defense ministries would discuss safety measures because nearby Naha airport was in constant use for both civil and military flights. (FBIS, Tokyo *Kyodo* in English, Mar 5/81)

March 9: The International Telecommunications Satellite Organization (INTELSAT) reported that it had signed an agreement with the International Maritime Satellite Organization (INMARSAT) to provide satellite communications services to ships. INTELSAT would put at the service of INMARSAT three of its satellites to be launched between mid-1981 and mid-1982: two Intelsat Vs over the Indian Ocean, one over the Atlantic.

The maritime communications subsystems (MCS), each with a capacity of 30 voice channels plus data, would operate for up to seven years and would bring more than $100 million (U.S.) to INTELSAT. In addition to the MCS, each Intelsat V could carry up to 12,000 simultaneous international telephone calls and two television channels. (INTELSAT Release 81-1-1)

March 10: Dr. Alan Lovelace, NASA's acting administrator, held a briefing on the agency's FY82 amended budget, which he said "eliminates or defers all FY81 and FY82 new program initiatives in space science, aeronautics, and applications." At a press conference January 15, he had discussed the budget for NASA proposed by the previous administration, just over $6.7 billion for FY82. The revised budget would reduce NASA funds by $604 million to a new total of $6.122 billion. The revisions preserved Space Shuttle test-flight schedules and research and development; allowed continued production of a four-orbiter fleet on the present schedule, which "meets the critical needs for both civil and military missions"; and kept the option for a fifth orbiter.

However, the funding would delete the solar-polar spacecraft; cut space and aeronautical technology development; delete construction-of-facilities projects; and eliminate 840 civil-service positions. It would defer the VOIR and the gamma-ray observatory launch from 1986 to 1988; cancel NOSS, a three-agency project; end the technology transfer program; and cancel funding for energy-technology activities, a geological applications program, and a search-and-rescue mission.

Aeronautics programs canceled or deferred included efforts in vertical/sidewise takeoff and landing (V/STOL) systems, supersonic cruise research, the variable-cycle engine, and the proposed numerical aerodynamic simulator. A initiative in large, composite primary aircraft structures was eliminated.

Other programs affected were materials processing in space, AgRISTARS, instrumentation for an upper-atmosphere research satellite, and the Spacelab flight schedule.

Lovelace said that adjustments in FY81 figures would reflect impact of decisions on the FY82 budget: an increase of $60 million in 1981 Space Shuttle changes and upgrading would "provide added schedule confidence" in Shuttle development and testing and in production of orbiter vehicles. The amended budget reflected NASA's decision announced in January to discontinue the three-stage version of an inertial upper stage and to modify the Centaur upper stage instead. The modified stage would allow NASA to fly the Galileo mission to Jupiter on a single launch in 1985 and could be used for a restructured solar-polar mission in 1986 and VOIR in 1988. (NASA Text, Mar 10/81)

March 12: The Soviet Union announced the launch of *Soyuz T-4* at 10 p.m. Moscow time to link with the orbiting space complex *Salyut 6-Progress 12*. *Salyut 6*, in space since September 29, 1977, had docked January 26 with cargo craft *Progress 12*, which refueled it automatically on ground command and used its engine to raise the orbit.

Soyuz T-4 carried as commander Col. Vladimir Kovalenok, veteran of *Soyuz 25* that failed to dock with *Salyut 6* in October 1977 and of *Soyuz 29*, which docked there for 140 days in June 1978. Also on the T-4 flight was Viktor Savinykh as flight engineer. (FBIS, Tass in English, Mar 12/81)

—Tass said March 13 that the *Soyuz T-4* had docked with the *Salyut 6-Progress 12* complex March 12 at 11:33 p.m. Moscow time and the cosmonauts had transferred into the space station, being the 15th crew to occupy it in the 3½ years. They would check on-board systems and equipment, do maintenance, and replace instrumentation as necessary. (FBIS, Tass in English, Mar 13/81)

March 16: ESA reported that it had successfully tested injectors for the five Ariane engines to be used in the L03 flight, now scheduled for the latter part of June. The L03 vehicle could carry a tech capsule to monitor equipment and environment; a second flight model of the Meteosat 2 aimed at putting ESA into the Earth-observation field; and an India communications satellite known as Apple (Ariane passenger-payload experiment) at Kourou, French Guiana. (ESA Info 3)

March 17: NASA announced the selection of scientific instruments to be flown on the Gamma-Ray Observatory scheduled for launch from the Space Shuttle in 1988. Produced from the most energetic processes in the universe, gamma rays were the most direct source of knowledge about these processes.

Gamma rays to be measured by the observatory would begin at 100,000 electron volts (100 Kev) and continue up to several hundred million electron volts (100 Mev or more).

The instruments chosen were a transient-event monitor to detect short intense bursts of gamma rays of unknown origin and localize them to determine their distribution in the galaxy; a high-energy gamma-ray telescope that could measure the energy spectra and arrival directions of the highest-energy gamma rays it finds; an imaging Compton telescope to obtain gamma-ray maps of the celestial sphere at medium energies; and a low-energy gamma-ray spectrometer to look for evidence of nucleosynthesis in supernovas.

The observatory, with a planned 2-year lifetime would be one of the largest every orbited, weighing 23,000 pounds (10,432-kilograms) and measuring 25 feet (7.6 meters) in length and 12.5 feet (3.8 meters) in diameter. (NASA Release 81-40)

March 22: The Soviet Union launched *Soyuz 39* from the Baykonur cosmodrome at 5:59 p.m. Moscow time to link with the orbiting *Salyut 6/ Soyuz T-4* complex. Tass said that the *Progress 12* cargo ship had undocked March 19 after being filled with discarded equipment to replace the supplies it brought and on March 20 had entered the atmosphere over the Pacific where it "ceased to exist."

The crew of *Soyuz 39* were veteran cosmonaut Vladimir Dzhanibekov as commander and the first citizen of Mongolia to fly in space, Jugderdemidyn Gurragcha, as researcher and "101st spaceman of the world." They would join Vladimir Kovalenok and Viktor Savinykh already aboard the orbiting complex.

Tass said that the launch commemorated the 60th anniversary of the revolution of the Mongolian People's Republic, 10th nation to participate in manned spaceflight. United Press International (UPI) said that it was in honor of the 20th anniversary of launching Yuri Gagarin, first man into space, on April 12, 1961. (FBIS, Tass in English, Mar 22/81; UPI, in *W Star*, May 23/81, A-8)

March 23: Digital techniques would cope with "the coming world telecommunications explosion" and cut the cost of overseas transmissions as well, said INTELSAT Director General Santiago Astrain in his keynote address to the fifth international conference on satellite communications in Genoa, Italy.

In the first use of the giant new *Intelsat V* (launched December 6, 1980, from Cape Canaveral into geostationary orbit 22,300 miles up), the speech was heard simultaneously in three countries. The telecast also marked INTELSAT's first use of the 14/11 GHz frequency band. Receiving stations were two small 3-meter antennas at Genoa; a 10-meter torus antenna at COMSAT laboratories in Clarksburg, Md.; and 19-meter antenna at Goonhilly, England. (INTELSAT Release 81-5-1)

March 24: Biggest and best customer of the Space Shuttle, developed and operated by a civilian agency, would be the Department of Defense (DOD), said the *Washington Star* in one of a series of articles on the Shuttle program. At least 21 of 75 spaceflights planned before 1986 would be military missions, and neither NASA nor DOD would say what the flights were for. DOD had contributed millions of dollars to the Shuttle program in hardware and personnel, including a multibillion-dollar facility at Vandenberg Air Force Base for launches into polar orbit.

Although the Shuttle would serve both civilian and military purposes, the two sides showed differing degrees of confidence: current boosters had reached orbit only 90% of the time, 10% dumping expensive satellites into the sea. "We have yet to achieve routine access to space," said Lt. Gen. Richard C. Henry, commander of the U.S. Air Force's Space Division. Shuttle reliability should be "as close to 100% as you can get." Most NASA missions slated for the 1980s and beyond could not be flown without the huge cargo bay of the Shuttle. The military, however, would keep its Atlas and Titan expendable boosters just in case. Space, said Henry, was the high ground, "crucial for collecting and disseminating information, for reducing the confusion of battle, even for improving combat efficiency. . . . Everything we put up is supportive of our national security, but nothing is combative." DOD, he added, had "made commitments far in excess of any civil users." (*W Star*, Mar 24/81, A-8)

March 26: Japan's National Space Development Agency conducted, for the first time, a successful 30-second firing test of its huge H-1 liquid-fuel rocket. Japan's LE5 engine fueled with liquid oxygen and hydrogen would serve as the second stage of H-1, which was scheduled to launch a 500-ton satellite into orbit in February 1986. Japan was now the fourth country to have a liquid-hydrogen engine; in addition to the United States, ESA, and China. (FBIS, Tokyo *Kyodo* in English, Mar 26/81)

March 30: Shuttle launch director George Page said that success of the two final fueling tests cleared the way for launch April 10, but official announcement would await a flight-readiness review at KSC. Page said examination of the silo-like tank revealed "a few foam cracks" readily fixed with spray-on foam.

The launch-preparation schedule now in progress could indicate an April 9 launch, but Page wanted to give his teams a day off before the launch took place. Inquiry into the accidental death of a launchpad worker would not delay the liftoff, Page said, but the board would probably recommend revising safety procedures. (*W Star*, Mar 30/81 A-5)

March 31: NASA Headquarters held a press briefing on scientific results of *Voyager I*'s Saturn encounter in 1980. On hand were project scientists Dr. Edward C. Stone, California Institute of Technology (CalTech); imaging-team leader Dr. Bradford Smith, University of Arizona; and project manager E.K. Davis, JPL. Initial results included discovery of a ring system vastly more complex than imagined and a thick nitrogen atmosphere around Titan, Saturn's major moon.

Voyager 1 took 17,500 photographs of Saturn and its satellites between August 22 and December 15, 1980. The closest approach was November 12—126,000 kilometers (78,000 miles) from Saturn's cloud tops. From the spacecraft, as from Earth, the atmosphere of Saturn looked grossly similar to Jupiter's, with alternating light and dark zones, circulating storm regions, and other distinguishable cloud markings.

Unlike Jupiter, however, Saturn's markings were blurred by thick haze above the visible cloud tops; the haze layer at Jupiter was not as optically dense as Saturn's. Wind speeds were substantially higher than on Jupiter and did not appear closely tied to belt-zone boundaries. Highest winds, blowing eastward at the equator, were four times stronger than on Jupiter; velocity decreased to near-zero at about 40° latitude north and south.

Saturn's atmosphere consisted mostly of hydrogen, helium accounting for only 11% of atmospheric mass above the clouds compared to 19% at Jupiter. The difference was consistent with separation by gravity of helium and hydrogen in Saturn's interior and could explain the excess energy radiated by Saturn over that received from the Sun.

Voyager 1 found that the A, B, and C rings visible from Earth consisted of hundreds of small ringlets, a few of them elliptical; the classical gaps also contained ringlets. Intertwining ("braiding") of the rings was not explainable, although it might stem from electrostatic charging of their dust-sized particles. *Voyager 1* discovered three new satellites, photographed the D and E rings, and confirmed the existence (2.8 Saturn radii from planet center) of a new ring postulated on the basis of *Pioneer 11* findings.

The flyby observed all of Saturn's known satellites except Phoebe: Mimas, Enceladus, Tethys, Dione, and Rhea, all appeared roughly spherical and composed mainly of water ice. Titan was the most interesting from an Earth viewpoint because of its atmosphere, similar to what would have evolved on Earth had it formed at Titan's distance from the Sun. Previously considered the largest satellite in the solar system, Titan was found to be slightly smaller than the largest satellite of Jupiter (Ganymede). Both are larger than the planet Mercury. Titan's atmosphere consisted mostly of nitrogen, the main constituent of Earth's atmosphere; pressure near the surface was 60% greater than Earth's. The surface was not visible in photographs from *Voyager 1* because of the haze layer, though the southern hemisphere was slightly brighter than the northern, possibly a seasonal effect. Titan's density seemed about twice that of water ice, indicating that it, like Ganymede, was made of equal amounts of rock and ice.

Voyager 1 was now headed out of the solar system, and its platform instruments were turned off December 19. Most fields-and-particles instruments on *Voyager 1* were still monitoring the solar wind and its changes with distance and time; exact location of the heliopause (outer edge of the solar wind) was unknown, but might be reached around 1990. *Voyager 2* would reach Saturn in August 1981 and proceed on a trajectory to Uranus. (NASA Releases 81-41, 81-44)

April

April 10: Nine minutes before launch time, NASA grounded the Space Shuttle Columbia until April 12, because one of five computers in its nose was failing to communicate properly with the other four. The decision to scrub the launch came after a three-hour delay from the original 6:50 a.m. liftoff time; a fuel-cell warning light showed in the cockpit just 16 minutes beforehand. No sooner was that problem solved than a second one appeared, when the program in the backup computer did not match that of the four primary computers controlling the ship. (*W Star,* Apr 10/81, A–1)

April 12: NASA launched Space Shuttle Columbia, designated STS-1, from pad A of KSC's launch complex 39 at 3 seconds after 7 a.m. EST. All launch facilities, systems, and support equipment performed as designed; NASA said that damage to the launch pad was less than predicted. The solid-fuel rocket boosters (SRBs) jettisoned after burnout fell within the predicted impact "footprint" in the Atlantic about 14 nautical miles northeast of KSC, splashing down 7 minutes and 100 seconds after liftoff. All the SRB parts were recovered for reuse except two of the six parachutes.

The external tank separated at 8 minutes and 58 seconds into the flight and began to break up at about a 280,000,-foot altitude without tumbling as planned. A tumble system built into the tank to prevent skipping during reentry (and keep debris within a preplanned area) did not work. The Indian Ocean tracking ship, *USNS Arnold,* said that the tank-debris footprint was larger than expected.

Orbit-maneuvering system (OMS) firings (OMS-1 and OMS-2) put Columbia into an orbit with 133.7-nautical-mile apogee, 132.7-nautical-mile perigee, and 40.3° inclination. Ascent went as planned, with all events, through payload-bay door opening, occurring normally. (NASA MOR M-989-81-01 [postlaunch] May 12/81)

April 13: Press reports on the Space Shuttle Columbia's launch noted the loss of some insulating tiles from engine-pod coverings visible, television viewers from an aft-facing cockpit window when astronaut Robert Crippen opened the payload-bay doors to dissipate heat into space as a way of cooling the orbiter. The areas lacking tiles, nine on the right-hand engine pod and four to six on the left-hand pod, had undergone the greatest stress during blastoff and ascent. Astronaut John Young relayed the view to Earth so flight directors could estimate the damage.

The two astronauts evinced so little concern about the missing tiles that, during a six-minute telecast late on Monday, neither mentioned the subject. As flight directors wanted to know whether the underside of the fuselage was intact, Deputy Operations Director Eugene F. Kranz announced that supersecret U.S. Air Force cameras in Hawaii and Florida would photograph the orbiter in an attempt to discover further areas of damage. His statement hinted at the highly classified capability of DOD cameras: photographing areas lacking tiles of a moving craft 170 miles up would be like reading license plates in a Moscow parking lot from orbit, the *Washington Post* commented.

The fuselage's underside housed Shuttle electronics and hydraulics systems that would navigate the craft on its return; move the elevons, keeping it on course during the last 1,000 miles; and lower the landing gear. Should loss of tiles expose the surface to reentry heat that could burn through the fuselage and the underlying systems, the orbiter without its landing gear lowered would have to crash-land at more than 200 mph. If photography showed underside tiles missing, Kranz said the crew would handle the reentry "to avoid a possible catastrophe," not specifying the alternatives. Officials said that the areas known to be missing tiles were not critical to reentry; all visible edges of tail and wings appeared intact, suggesting that tiles were lost during the stress of launch only on the engine pods. (*W Post*, Apr 13/81, A-1, A-20, *WSJ*, Apr 13/81 3; *NYTimes*, Apr 13/81, 1; *W Star*, Apr 13/81, A-1)

April 14: The Shuttle orbiter Columbia came to a "flawless" landing on a dry lake bed in the Mojave desert at Edwards Air Force Base, California, at 1:21 p.m. EST before a crowd that included NASA employees, 20,000 VIPs, and about 250,000 spectators who had camped out all night to watch Columbia's return. Millions of people around the world also watched the return on television.

The astronauts got a wakeup call from mission control about 4 a.m. on their 30th orbit, with a special message for Robert Crippen: "You've waited 12 years for this. If you don't wake up, you'll miss the whole thing." Before eating breakfast, the crew took time to check flight systems, guidance and navigation instruments, and the 44 reaction-control thrusters used during reentry. On 36th orbit, the crew received "final go" for deorbit firing. Columbia's payload-bay doors were closed four hours before the scheduled landing time, and the astronauts put on their pressurized space suits in case of emergency.

Over the Indian Ocean at 12:22 p.m., an hour before landing and while out of contact with any tracking stations, Commander John Young turned Columbia tail-first and fired two on-board maneuvering rockets to brake the spacecraft; then, turned it nose-first again, tilting it slightly to permit full exposure of underside insulation. Reentry into the atmosphere at more than 17,000 mph took place at 12:48 p.m., 400,000 feet over the Pacific at Wake Island. The few tiles missing from tail areas after liftoff did not affect reentry at heats up to 2750°F. The 80-ton 122-foot long vehicle landed at 215 mph, twice the usual jet speed.

As Columbia's wheels touched down, flight-control chief Don Puddy at Houston told his jubilant team to "Prepare for exhilaration," allowing them about 15 seconds of celebration before resuming their jobs. For the first time, a splashdown or landing did not immediately end a manned spaceflight. "Welcome home, Columbia," Houston greeted the craft landing on the center line of the California runway. "Do you want us to take it up to the hangar, Joe?" Young radioed, and mission control responded "We're going to dust it off first."

A NASA official said that Columbia would probably begin its return flight to Cape Canaveral in seven or eight days, riding piggyback on its Boeing 747 carrier. An "optimistic" estimate was that the orbiter would fly again under its own power in less than six months, on a four-day flight from which it might be able to "turn around" and be ready to fly again in four months. (*NYTimes*, Apr 15/81, 1, 21; *W Post*, Apr 15/81, A-1; *W Star*, Apr 15/81, A-1; *WSJ*, Apr 15/81, 2)

April 15: NASA officials said that the Space Shuttle Columbia was "in excellent condition" after its flight and should be able to make at least 100 round trips into orbit. Technicians were hooking up ground power links and monitoring systems, photographing the tiles, and preparing to purge the fuel tanks and to install a shroud over the tail section for the flight back to Florida. Postflight servicing was running about 12 hours behind schedule. (*W Star*, Apr 16/81, A-1)

April 16: NASA reported that the Shuttle orbiter Columbia would not be ready by April 21 for ferrying back to KSC. A first postlanding check at DFRC indicated that no tiles were missing other than those noted before; later, however, two from in front of the windshield appeared to be missing, and gouges were evident on the tile surface from nose to aft fuselage. Gap fillers, thermal-barrier seals, and ablators were reported to "look good," and technicians said that they could still read the stenciling on the tiles "with no shrinkage to speak of." (*NASA Dly Actv Rpt*, Apr 16/81, 2)

April 17: The *New York Times* said that launch pad 39A at KSC, earlier reported to have been seriously damaged by Columbia's blastoff, suffered "very minimal" damage, according to a KSC damage-assessment team. Wayne C. Ranow, an assistant to pad-site manager Tip Tallone, supplied a preliminary list of items damaged and added that just a few more seconds of "hang time" before the Shuttle cleared the pad would have caused much more damage. NASA spokesman Hugh Harris said KSC had expected "a lot more damage than that;" although it would take two weeks to restore the pad this time, "we will learn from the experience and change some things" to avoid delays in the program. The impact of the 6.6 million pounds of thrust was "similar to what we saw with Apollo," Harris said. (*NYTimes*, Apr 17/81, A-26)

• ARC reported the effects of weightlessness on physiological processes shown in 14 U.S. experiments carried on unmanned Soviet satellite *Cosmos*

1129 in 1979. This was the only U.S. opportunity for biological research in space since 1975. The Vostok spacecraft sent into elliptical orbit and recovered within the Soviet Union 18½ days later was like those of two previous Cosmos missions in which the United States had participated in 1975 and 1977. Use of Cosmos vehicles was inexpensive for the United States because the Soviet Union paid for spacecraft, launch, and support activities; 40 scientists from 18 U.S. universities and research organizations shared in the mission.

The U.S. experimenters found changes in enzymes and in animal bone strength, growth rate, and mineral content, like the changes experienced by astronauts and cosmonauts; the results would help explain some of the problems of weightlessness. The Soviet Union provided 37 white rats and 60 fertile quail eggs, shared by the experimenters; U.S. scientists provided carrot-tissue cultures and plantlets and carrot slices inoculated with tumor-forming bacteria. One of two control groups of white rats kept in Moscow lived in ordinary cages and ate the flight diet; the other, called "synchronous control," was housed in an identical spacecraft on the ground and subjected to vibration and gravity forces like those of launch and reentry, experiencing whatever changes in environment the orbiting Cosmos transmitted to earth. The only difference between the synchronous control group and the mammals in flight was the weightlessness.

After the Cosmos flight, the animals were recovered immediately, before they could readapt to Earth gravity, and a recovery team set up a mobile lab at the landing site to autopsy about a fifth of the rats. The rest were flown to Moscow, where some were autopsied after 6 days of readaptation to gravity, and the rest after 29 days. The Cosmos rats showed a 20% deficiency in bone mineral content compared to the synchronous-control subjects. In the rats readapting to normal gravity, some changes reversed within a few days; others took longer to return to normal.

Under normal conditions, the total amount of bone in an adult human or animal remains constant, with bone continually resorbed and replaced by newly formed bone. In spaceflight, production of new bone seems to slow down, but resorption continues, resulting in net loss of bone and a decrease in strength. The greatest change is in weight-bearing bones, but even those not bearing weight (as jaw bones) show changes in mineral content and the cells forming new bone.

The experiments included the first attempt to breed animals in space—mating the rats and examining how embryos developed in a weightless state. This experiment did not succeed, however, and no litters were produced; the control group, to the surprise of Soviet and U.S. scientists, showed the same results. The scientists were still seeking a reason for the failure. The quail eggs provided no information on embryo development because the incubator failed on the 13th day of flight. The plants showed no ill effects; carrot embryos and plant tumors grew in space just as on the ground, suggesting that spaceflight had no effect on carrot tissue. (ARC Release 81-21)

April 21: NASA said that the most likely date for ferrying the Space Shuttle orbiter Columbia back to KSC would be April 25 for the flight to Tinker Air Force Base in Oklahoma and April 26 for the flight from Tinker to KSC. Delays in deservicing were "mainly due to first-time-thru problems," the agency said, referring to the lack of interface between Columbia and the mate/demate device "because of the unavailability of OV-2" which had not been checked out with the new ground-servicing equipment "for form, fit and function." NASA noted that the three-day stretch in the schedule had covered leaks in quick-disconnect systems, new position of the work stand, the "unexpected OV-102 configuration (engine-bell placement that no longer fitted into the mate/demate device), and changes in operational maintenance instructions.

A NASA press release pointed out that deservicing the orbiter involved "removal or containment of hazardous propellants such as toxic hypergolics and cryogenics," inspecting its systems (including the thermal protection system), and raising the orbiter, with its 17-piece tailcone in place, to a stand where it could be fastened to its 747 carrier. Reviewing events, *Aviation Week Space Technology* said that ground personnel wearing protective suits had trouble connecting hoses to orbiter interfaces for off-loading propellants and purging systems because of limited space; operations were complicated by wind, rain, and lightning, with a series of four power losses in service facility, each requiring a two-hour minimum to power up again by following a checklist. (*NASA Dly Actv Rpt*, Apr 21/81; NASA Release 81-50; DFRC Release 81-18; *AvWk*, Apr 27/81, 30–31)

April 23: President Reagan announced the nomination of business executive James Montgomery Beggs as administrator and Dr. Hans Mark as deputy administrator of NASA. If confirmed, Beggs (who was executive vice president and a director of General Dynamics Corporation, which he had joined in January 1974), would be the sixth person to head the civilian space agency, succeeding Dr. Robert A. Frosch.

Beggs had been associate administrator in the Office of Advanced Research and Technology (OART) at NASA in 1968–69, leaving to become undersecretary at the Department of Transportation (DOT). Mark, who became secretary of the Air Force in July 1979 the being undersecretary since 1977, was formerly director of NASA's ARC. (NASA Release 81-51; MSFC Release 81-50; *NYTimes*, Apr 24/81, A-12; *W Post*, Apr 25/81 A-4)

• John Young and Robert Crippen, the crew of Columbia's maiden flight, told of their experience at at 75-minute JSC press conference carried on closed-circuit television to NASA Headquarters and other centers. They said that the orbiter was an incomparable flying machine, surprisingly easy to control, and that the mission was "what NASA calls nominal, although I think you're going to have to call it phenomenal," Young reported. Neither crewman expressed concern over the loss of tiles from the aft end of the vehicle, detected shortly after launch. Young said that he was impressed by the fact that the metal under the tiles did not heat up during reentry as much as expected: he said "a lot" of the thermal tiles on the topside could probably be eliminated in future missions, lowering spacecraft weight and increasing the limit on payload weight, now set at 65,000 pounds.

Young said that he went immediately upon landing to look at the underside of the orbiter, which had encountered the most heat. "People had been telling us it was impossible that some of these tiles wouldn't fall off. Well, none of them fell off, and those tiles went through some of the roughest ascent and reentry you can imagine." "Nothing failed. Statistically, I didn't think that was possible," Crippen added. "We've been working 3 years to learn how to handle catastrophes, and all we did the whole time was sit back and enjoy it."

The cruise was not perfect, the astronauts agreed: the craft was cold to the point of discomfort some of the time, and the toilet shut down near the end of the flight. The crew kept getting tangled in communications lines, and Columbia "landed long" instead of at its prescribed touchdown spot. Young said the chill could be avoided by putting interior temperature sensors nearer to the crew than to heat-emitting electronic gear. Cordless microphones would solve the problem of tangled cords, and engineers were already working on the toilet program. Young said that he had landed Columbia farther down the 7-mile long runway than he was asked in order to test the Shuttle's wings and tail for lift; he said that the lift he got at landing was "remarkable." "We hardly used our brakes. I tell you that was quite a performance, taking 99 tons out of orbit and getting it back down all in one piece."

A reporter asked Crippen if his pulse rate of 130 at liftoff, compared to Young's 90, meant that he was more excited. "You betchum I was excited," he replied. "What you don't understand is, I was excited too," Young added. "I just can't make it go any faster." (Young is 50, seven years older than Crippen.)

The mission was so successful that Columbia might fly again as early as September 23, with a third test in December and a final test in April 1982. With that schedule, NASA might begin operational flights carrying cargo into space as early as September 1982. Young said they had been given 135 flight objectives and had completed all 135. "You really should be proud of this vehicle," he told the JSC audience. (NASA Text, postflight brfg, Apr 23/81; *NYTimes*, Apr 24/81, A-12; *W Post*, Apr 24/81, A-6; *W Star*, Apr 24/81, A-12; *B Sun*, Apr 24/81, A-6)

April 27: NASA announced that it would consolidate two major field installations as of October 1, 1981: DFRC would become an operational element and component of ARC, and Wallops Flight Center (WFC) would become an operational element and component of GSFC. DFRC and WFC would retain their identity under the overall management of ARC and GSFC, respectively. (NASA anno, Apr 27/81; NASA Release 81-54)

April 27: Marshall Space Flight Center (MSFC) reported that *Heao 2*, NASA's second high-energy astronomy observatory (Heao), had expended its control-gas supply and ended its mission. One of a family of three "highly successful" scientific satellites managed by MSFC, *Heao 2* (like its predecessor, *Heao 1*) had performed twice as long as its predicted design life; a third observatory was still operating.

Launched November 13, 1978, *Heao 2* carried the world's largest focusing X-ray telescope and an array of astronomical instruments; it had provided data on X-ray output of normal stars, content of supernova remnants, distribution of mass in galaxies, and the origin of the extragalactic X-ray background. MSFC said that participating astronomers would need years to analyze all the data received. Unable to maintain attitude after exhausting its control fuel April 25, the spacecraft was powered down April 26. Reentry and burnup would probably occur early in 1982. (MSFC Release 81-52; NASA Release 81-56)

April 28: Shuttle orbiter Columbia on its 747 carrier landed at the Shuttle landing facility runway at KSC at 11:24 a.m. EDT. Demating began in preparation for moving it into the processing facility for 72 hours of troubleshooting.

CBS-TV News said hundreds of employees and their families were on hand for the arrival; reporter Bruce Hall said that, although the orbiter's condition was "excellent," a number of NASA officials did not expect the next launch to take place before 1982. Jules Bergman of ABC-TV said that work on the orbiter would include installing a miniature remote-control arm to deploy satellites and retrieve them on future missions. The second flight, STS-2, would test the arm only. NASA's current target date was said to be mid-October, though much work remained to be done on the reusable boosters and the launch pad. (*NASA Dly Actv Rpt*, Apr 29/81; DOD RadioTv Rpts, Apr 29/81)

• NASA's acting administrator, Dr. Alan M. Lovelace, signed a memorandum of understanding with Hans-Hilger Haunschild of the Federal Republic of Germany's (FRG) ministry for research and technology on FRG use of the STS (Shuttle), with NASA furnishing launch and support services on a reimbursable basis. NASA said that the Federal Republic had "long been a supporter" of STS and had contributed 40% to ESA's development of Spacelab, soon to be a Shuttle payload with laboratory facilities like those on Earth but adapted for zero gravity.

The Federal Republic of Germany had already paid NASA for two reimbursable Spacelab missions: D-1, materials processing and life-sciences experiments, and D-4, astrophysics experiments; it also planned to launch an X-ray satellite (Rosat) from the Shuttle in 1986. In addition, private and scientific organizations in West Germany had reserved 25 small self-contained payloads for eventual shuttle flight on a space-available basis. (NASA Release 81-58)

May

May 8: NASA announced that the National Science Teachers Association (NSTA), chosen last summer to run a nationwide student competition to develop payloads to fly on the Shuttle, had picked from 191 semifinal entries 10 finalists to attend a conference at KSC on preparing their experiments for payload assignment.

Finalists and their teacher-advisers would view KSC preparations for Columbia's second flight, now scheduled for October; the finalists and their teachers as well as their schools would receive special medallions.

The winners and their experiments were Wendy A. Angelo of New York, use of biofeedback to help Shuttle crew members relax or sleep; Aaron K. Gillette, Florida, growth of common sponges in zero gravity; Pritchett A. Harris, Pennsylvania, simulating planetary atmosphere; Karla R. Hauersperger, North Carolina, space-travel effect on chromium in the human body; Michelle A. Issel, Connecticut, formation of crystals from supersaturated solution in weightlessness; Amy M. Kusske, California, space-travel effect on lipoprotein profiles; Dave D. Madura, Indiana, space-travel effect on human cell division; Todd E. Nelson, Minnesota, insects in zero-g; D. Scott Thomas, Pennsylvania, convection in zero-g; Daniel J. Weber, New York, effect of weightlessness on arthritis in rats. (NASA Release 81-59)

May 14: The Soviet Union launched from Baykonur the *Soyuz 40* spacecraft crewed by Leonid Popov, who in 1980 achieved a world space-endurance record of 185 days with fellow cosmonaut Valery Ryumin, and Dumitru Prunariu of Romania's air force. Tass said the ship would dock with orbiting space station *Salyut 6*, occupied since March 14 by Vladimir Kovalenok and Viktor Savinykh.

This flight, ninth in the Intercosmos program of launching a Soviet cosmonaut with one from another country, would complete the first round that began in March 1978 with representatives from Bulgaria, East Germany, Poland, Cuba, Hungary, Vietnam, Czechoslovakia, and Mongolia. (*W Star*, May 15/81, A-16)

May 15: NASA launched the U.S. Navy's improved Transit navigational satellite *Nova 1* at 2:07 a.m. from the Western Space and Missile Center (WSMC) on a Scout vehicle into a polar transfer orbit with 935-kilometer apogee, 353-kilometer perigee, 90.16° inclination, and 97.67-minute period. The solar panels deployed, and the payload was in a housekeeping mode. A multiple-burn spacecraft motor fired on later orbit would raise the 368-pound spacecraft's altitude to about 600 nautical miles.

This 102d launch of a Scout was the ninth success in a row. NASA provided the launch under a June 1962 agreement with DOD to reimburse NASA for the cost of Scout vehicles, Western Test Range (WTR) launch services, and mission support, as required. So far, NASA had launched 15 Transit satellites and 3 Transit improvement program satellites, of which 5 were currently operating. The Navy would reimburse NASA about $7.6 million for services and hardware provided for the program ($1.825 million for launch-vehicle hardware; $0.950 million for WTR launch services and mission support; $4.825 million for FY81 support services). (NASA MOR 0-490-603-81-01 [prelaunch] May 13/81; *NASA Dly Actv Rpt*, May 18/81; *SF*, Oct 81, 274)

• NASA announced that it would launch the next Shuttle flight (STS-2) on September 30, if turnaround procedures went smoothly. JSC spokesman Robert Dotts said that the thermal-protection system "exceeded our expectations" and that the amount of repair needed would not affect turnaround time. Only 10 or 12 of the foamed-glass tiles protecting Columbia's fuselage during reentry would need replacement. Inch-deep gouges all over the surface of the Shuttle mostly occurred during takeoff. NASA cautioned that the orbiter would be undergoing turnaround for the first time, and unforeseen problems could affect the flight schedule. (NASA Release 81-65; MSFC Release 81-61; *W Post*, May 16/81, A-2)

May 19: Some 40 astronauts were on hand at the White House as President Reagan awarded John Young and Robert Crippen, the crew of Space Shuttle Columbia's first flight, the Distinguished Service Medal. Young also received a Space Medal of Honor for his five spaceflights in two decades as an astronaut.

The guest list of 160 included present and former space officials and astronauts, including six of the original Mercury seven: Alan B. Shepard, first American in space; John H. Glenn, Jr., first American to orbit the Earth; L. Gordon Cooper, M. Scott Carpenter, Walter M. Schirra, and Donald K. Slayton. (Virgil L. Grissom, the seventh, had died 14 years ago in a launch-pad fire.) The group included the crew of *Apollo 8* that orbited the Moon at Christmas in 1968: Frank Borman, James A. Lovell, Jr., and William A. Anders. Also on hand were the *Apollo 11* moon walkers, Neil A. Armstrong and Edwin E. Aldrin, Jr., and the third pilot on their mission, Michael Collins. This was the first time so many former astronauts from the Mercury, Gemini, Apollo, and Skylab projects had come together. They did so at the invitation of the president to honor the reusable Shuttle, most recent U.S. space effort, and the men who flew it into orbit for the first time last month.

The president described the Shuttle as "the world's first true space transportation system," saying it would affect American life in both subtle and dramatic ways, "bringing energy and excitement to our national reserve." The Columbia crewmen presented the president and vice president with American flags they had carried on the Shuttle's first flight. They also gave the president a gold spaceflight jacket with the presidential seal, and Reagan responded: "You won't mind if I only wear this in Earth's atmosphere."

Reagan also awarded the presidential citizen's medal to Dr. Alan M. Lovelace, acting head of NASA, who had been in charge of the Shuttle's first flight. Lovelace was the fourth recipient of the medal, established in 1969. (Text, WhHs remarks, May 19/81; NASA Releases 81-70, 81-71 *NYTimes*, May 20/81, A-22, *W Post*, May 20/81, A-2; *W Star*, May 20/81, A-3)

May 22: After a series of delays, NASA launched GOES-E, fifth of a series of geostationary operational environmental satellites funded by NOAA, from the Eastern Space and Missile Center (ESMC) at 6:29 p.m. EDT on a Delta into a transfer orbit with 49,768-kilometer apogee, 192-kilometer perigee, 921-minute period, and 24.1° inclination. The craft would move into synchronous orbit at 85°W by the first week of June for testing.

The Hughes-built 875-pound satellite, *Goes 5* in orbit, carried a new visible-infrared radiometric atmospheric sounder (VAS)—modified from the original visible-infrared spin-scan radiometer (VISSR) first carried by *Goes 4* in September 1980—to provide not only visual imagery of Earth surface and cloud cover and infrared sea-surface temperature but also temperatures and amount, distribution, and movement of water vapor at various altitudes.

Goes 5 would ultimately replace an older craft at 75°W, now serving as "Goes East" to monitor the eastern United States and Canada, Central America, South America, and much of the Atlantic Ocean. (NASA MOR E-612-81-03 [prelaunch] Apr 28/81, [postlaunch] July 23/85; NASA wkly SSR, GSFC, May 28/81; *D/SD*, May 29/81, 156; *AvWk*, June 15/81, 53; *Spacewarn* SPX-332, June 30/81)

May 23: NASA launched the world's largest telecommunications satellite, *Intelsat V-2*, from Cape Canaveral on an Atlas Centaur at 6:42 p.m. EDT into a highly elliptical transfer orbit with 35,960-kilometer apogee, 172-kilometer perigee, 633.9-minute period, and 24.1° inclination. Originally scheduled for May 21, the launch was delayed by computer problems in the rocket's main safety-control system.

The huge communications satellite, weighing more than 2 tons, was second in a new series of nine international communications satellites the first having been launched December 9, 1980, as an on-orbit spare for the Atlantic network, which would eventually consist of four satellites. The first five Intelsat Vs would be launched by Atlas Centaur; the next three, by Europe's Ariane booster. Average estimated cost of an Atlas Centaur launch was $42 million; that of an Ariane launch was $27 million. Overall cost of the Intelsat V program was $680 million, or some $76 million for each mission; estimated average cost of each satellite was $34 million.

Intelsat V-2, after coming on station at 355°E for a month of testing, would be operational by July at 335.5°E, handling communications between the Americas and Europe, the Middle East, and Africa. It could transmit 12,000 telephone calls simultaneously in addition to two television color channels, having twice the capacity of Intelsat IV-As previously launched by NASA for INTELSAT. The 106-nation organization jointly owned and operated 12 satellites over the Atlantic, Pacific, and Indian oceans in order to handle two-thirds of the world's overseas communications, from telegrams and telephone calls to television and data.

In 1984, INTELSAT would begin a series of three improved Intelsat V-As capable of 15,000 simultaneous telephone calls and two television channels; 1986 would inaugurate Intelsat VIs, each handling more than 40,000 simultaneous telephone calls and two television channels and designed for launch by either the Ariane or the Space Shuttle. (NASA MOR-491-203-81-02 [prelaunch] May 20/81, [postlaunch] June 17/81; NASA Release 81-60; INTELSAT Release 81-10-1; *W Post*, May 24/81, A-3, *D/SD*, May 27/81, 140; *A/D*, May 28/81, 151; *Spacewarn SPX-332, June 30/81)*

May 26: NASA announced the establishment of two new divisions within the Office of Space Transportation Systems and the disestablishment of the Expendable Equipment Division. L.M. Weeks, NASA Headquarters deputy associate administrator for space transportation systems, said the change would direct increased attention and impetus to the widebody Centaur program recently approved by NASA.

A new Upper Stage Division would manage the widebody Centaur, the inertial Upper stage (IUS), the spinning solid upper stage (SSUS), and the solar-electric propulsion system (SEPS) proposed for use on the Galileo and solar-polar missions. Frank van Rensselaer, director of the former Expendable Equipment Division, would direct the new upper Stage Division. Jerry Fitts would direct a new Solid Rocket Booster and External Tank (SRB/ET) Division. (NASA anno May 26/81)

• Press reports said that two the cosmonauts who occupied orbiting space station *Salyut 6* for 75 days had returned safely at 4:38 p.m. Moscow time in *Soyuz T-4* to a landing site in Kazakhstan. Col. Vladimir Kovalenok, flight commander, and flight engineer Viktor Savinykh had two sets of visitors during their mission: Vladimir Dzhanibekov and Mongolian cosmonaut Jugderdemidyn Gurragcha of *Soyuz 39* in March and Leonid Popov and Romanian cosmonaut Dumitru Prunariu of *Soyuz 40*, just a week ago.

The *New York Times* said that this was the final mission for *Salyut 6*, which would probably be abandoned. Launched in 1977, it had been the base for nearly four years of record-setting tests of human endurance. Last week, Popov said that the Soviet Union would also retire the old-model two-person Soyuz spacecraft used for the past 14 years in favor of the Soyuz-T, a three-man version more maneuverable and sophisticated, with four successful flights, including the one just ended. (*NYTimes*, May 27/81, A-1; *W Post*, May 27/81, A-14)

During May: The National Aeronautic Association (NAA) reported unofficial records set by Columbia's first flight, pending review for world certification. As the official U.S. certification authority for aerospace records since 1905 and sole U.S. representative of the Federal Aeronautique International (FAI), NAA gave the following figures: duration, 54 hours, 20 minutes, 52 seconds; maximum altitude, 209 kilometers; distance, 1,144,709 kilometers; mass carried into orbit, 95,201 kilograms; payload mass to altitude, 4624 kilograms. NAA said that Columbia was "the world's first and only *aerospacecraft*. . .capable of operating in space or in the atmosphere."

NAA had awarded the Voyager mission team represented by Dr. Edward C. Stone the Collier Trophy, oldest U.S. aviation award, for space exploration achievement peaking in the close examination of Saturn after a comparable visit to Jupiter the previous years. Established in 1911 and first presented to Glenn Curtiss for development of a seaplane, the Collier Trophy was awarded yearly for achievement demonstrated by actual use. (NAA newsletter, May 1981)

June

June 1: NASA said that the principal investigators for the plasma-wave instruments on the Jet Propulsion Laboratory (JPL)-managed *Voyager 2*, heading for rendezvous with Saturn in August 1981, discovered that the spacecraft had encountered the magnetic tail of Jupiter almost two years after leaving that planet, confirming a theory that the huge magnetosphere might extend all the way to Saturn.

Dr. Frederick L. Scarf, scientist at TRW Inc., and his colleagues, Dr. Donald Gurnett and Dr. William Kurth of the University of Iowa, found plasma-wave phenomena from February 1981 identical to those of July and August 1979, when *Voyager 2* had left Jupiter but was still in that planet's magnetosphere. Scarf had published in 1979 in the *Journal of Geophysical Research* his idea that Jupiter's magnetotail might reach as far as Saturn and that the rare alignment of outer planets that permitted the successive Jupiter-Saturn encounters might put *Voyager 2* and Saturn simultaneously into Jupiter's far-flung influence.

Inside the Jovian tail, Saturn could experience unusual conditions observable by the Voyager when it arrived in August. The next Saturn encounter might differ widely from the two previous. (NASA Release 81-73)

June 2: MSFC said that NASA's third high-energy astronomy observatory, *Heao 3*, used the last of its attitude-control thruster gas and was powered down, completing a mission begun in September 1979 to study pulsars, quasars, exploding galaxies, and black holes in space, whose high energy output could not be studied with Earth-based telescopes due to atmospheric interference. With 20 months of operation in orbit, *Heao 3* was the third of its type to perform for more than twice its design lifetime. It would reenter and burn up later this year. (MSFC Release 81-69; NASA Release 81-77)

• Lewis Research Center (LeRC) said that it had awarded four contracts totaling more than $7 million for design and development of a modified Centaur launch vehicle and components to be used as a Shuttle upper stage.

A $1.545 million contract with Teledyne Industries called for five digital computer units and nine remote multiplex units. A $1.593 million contract with Honeywell was for three inertial-measurement groups, part of an automatic navigation and guidance system. A $3.412 million contract with General Dynamics was for design and development of two modified Centaur vehicles. A $.933 million contract with United Technologies Corporation would cover building four RL10-3-3A rocket engines, two of which would provide primary thrust for one Centaur. Work under these contracts would con tinue through September 1981; they were all to support the Galileo mission to Jupiter, scheduled for launch in 1985, and the international solar-polar mission in 1986.

The Centaur for these missions would resemble the one used over the past 15 years as an upper stage for Atlas and Titan boosters on Mariner missions to Mars and Venus, Pioneer missions to Jupiter and Venus, Viking and Voyager missions, and the cooperative Helios missions with West Germany. It had carried low Earth-orbit missions for NASA, such as the Heao series and commercial and military geosynchronous satellites. (LeRC Release 81-26; NASA Release 81-75)

• DFRC said that its newly refurbished Canberra bomber would be the test airplane for an atmospheric-turbulence measurement program to gather data on sudden wind changes creating abrupt and uneven pressures on different areas of an aircraft. Engineers would use the information to improve aircraft design and operation, with special attention to approach and takeoff during strong winds and unstable atmospheric conditions.

Project engineers chose the B-57B because of its ability to withstand high g forces; its wings were extremely rigid and strong enough to recover from upsets during severe turbulence. Its cockpit held two crewmen, so that a meteorologist could fly as observer during the tests. Wen Painter, project manager for the program, said that scientists do not fully understand wind-shear phenomena and expect the flight tests to produce valuable data.

The B-57B would fly at Edwards Air Force Base, Denver, Oklahoma City, Huntsville, Cape Canaveral, and Wallops Island, all of which exhibited distinctive types of turbulence. Other NASA centers participating in the study would be ARC, LaRC, and MSFC. (DFRC Release 81-21)

June 10: NASA's *Atmosphere Explorer 5* reentered Earth's atmosphere after 31,268 orbits and more than 5½ years of service. Launched from KSC November 20, 1975, the 720-kilogram (1,587-pound) *AE-5* carried 15 highly specialized instruments to gather data on Earth's near-space environment. It was the first spacecraft using on-board propulsion to make large orbit changes and to use a central computer to make all data acquired immediately accessible to members of investigator teams at terminals in their own facilities.

The last signal from *AE-5* came over Hawaii, and no signal was received when it was due over Ascension Island. Trajectory of the descent was across the Pacific, Central America, and toward the Atlantic; the North American Air Defense Command (NORAD) confirmed reentry into the atmosphere over the Caribbean east of Nicaragua at 9:57 a.m. EDT. (NASA Release 81-86)

June 11: The Soviet Union's space program must develop a low-cost transport vehicle like the U.S. Space shuttle, according to Konstantin P. Feoktistov, one of the three cosmonauts who orbited the Earth six times in *Vostok 1* in 1964. Feoktistov, now a professor of technical sciences doing research for the Soviet space program, did not specifically mention the successful flight of Columbia in April but called for solution of technological problems in space travel such as cheap lightweight batteries. The *New York Times* quoted from *Pravda*, the official Communist Party newspaper, the first official acknowledgment by the Soviet Union that it would like to have a shuttle-like vehicle for manned space flights.

Tass said June 19 that *Cosmos 1267* had docked with the empty *Salyut 6* with the mission of testing systems "of the design of future spacecraft and for training in the methods of assembly of orbital complexes of a big size and weight." The *Washington Post* said that the linkup was "the precursor of a very large space complex that U.S. sources expect to have military uses." (*NYTimes*, June 11 81, A-18; *W Post*, June 20/81, A-9; FBIS, Tass in English, June 91/81)

June 12: NASA signed an agreement with the West German firm Messerschmitt-Bölkow-Blom (MBB) covering the first flight of shuttle-pallet satellite SPAS-01 scheduled for orbit on STS-5, the first operational Shuttle flight, in September 1982. This would be the first payload deployed and retrieved by the Shuttle's Canadian-built remote-manipulator system (RMS).

The 1,814-kilogram (4,000-pound) payload would operate inside the payload bay and would also be a free flyer when deployed, using an on-board stabilization and control system. NASA would use it to test RMS capabilities during the five-day mission, with a 70-mm camera on the payload to record deployment, free flight, retrieval, and reberthing. MBB would conduct materials-processing experiments while the payload was in the shuttle bay.

The agreement was signed for NASA by Dr. Stanley I. Weiss, associate administrator for space transportation operations, and for MBB by Dr. Johannes Schubert and Dr. Peter C. Bittner, general manager and commercial director of MBB's space division. The pact would cover KSC and JSC launch services as well as NASA's use of the payload for RMS testing. (NASA Release 81-80)

June 15: NASA said that investigators at GSFC and the University of Maryland had discovered a natural infrared laser on Mars, a find that could help detect new planets in the universe and require rewrites of books on general physics of the planetary atmosphere. Members of the team were Dr. Michael J. Mumma, Dr. David Buhl, Dr. Gordon Chin, Dr. Drake Deming, Fred Espenak, and Dr. Theodore Kostiuk, all of GSFC, and Dr. David Zipoy of the University of Maryland. The discovery was reported in *Science* magazine.

Optical lasers since their 50-year-ago invention had proved extremely useful not only in scientific laboratories but also in everyday life; for example, as price scanners in supermarkets. However, the investigators said, no naturally occurring laser had ever been reported, although "the extreme variety of physical and chemical environments of extraterrestrial objects. . .argue[d] that natural lasers must exist."

In theory, "natural" lasers would occur whenever atoms or molecules were stimulated to release photons in transition from higher to lower energy states. A Goddard-developed device (an infrared heterodyne spectrometer) used with the McMath solar telescope at Kitt Peak National Observatory in Arizona had detected such a process in the Mars atmosphere (made up almost entirely of cabon dioxide) between January and April 1980. The new device let the scientists confirm occurrence of a molecular-population inversion, necessary for lasing.

The natural laser on Mars, identical in principle to man-made lasers with commercial, scientific, and military applications, had a total continuous power output of more than a million megawatts, equivalent to that generated by a thousand large hydroelectric-power projects; in fact, the Mars laser generated more than five times the total power output of the United States. The investigators said orbiting satellites might eventually be able to extract power from the natural laser and beam it wherever needed. (NASA Release 81-78)

June 16: NASA announced that Perkin-Elmer Corporation's Danbury, Connecticut, facility had finished shaping and polishing the 94-inch (2.4-meter) diameter primary mirror for the space telescope, main optical component of the telescope assembly. Launched on the Shuttle early in 1985, the 12-ton unmanned telescope would orbit at 600 kilometers (370 miles) above the interfering haze of Earth's atmosphere. It would be able to see objects 50 times fainter than observable from Earth telescopes, observing about 350 times more volume of space and 7 times further into space than now possible, up to 14 billion light-years. To make full use of this undistorted view of space, telescope parts had to be much more accurate than those in Earth telescopes. The mirror exhibited a deviation at any point on its surface of less than one millionth of an inch from an ideally perfect surface.

Manufacture of the mirror blank began in October 1977 at Corning Glass Works, which delivered it to Perkin-Elmer in December 1978. The blank was made of a Corning product called ultra-low-expansion glass, which has extremely low thermal expansion properties. Optical fabrication began with rough grinding of front and back surfaces of the blank, followed in August 1980 by fine polishing of the front surface, using a computer-controlled polisher. The next stage of fabrication would be the application to the polished surface of two uniform extremely thin coatings, one a reflective layer of pure aluminum, the other a protective layer of magnesium fluoride to prevent oxidation of the aluminum. Coating would take place at Perkin-Elmer in the world's largest vacuum chamber, which operates at a vacuum very near that of space. After coating, the mirror would be installed in the optical telescope and aligned to the secondary mirror, focal plane, scientific instruments, and guidance sensors. The completed optical telescope would then be integrated into a support-systems module, a major element of the space telescope, under construction by Lockheed.

The space telescope project was managed by MSFC. (NASA Release 81-82)

June 17: MSFC awarded a $400,000 contract to McDonnell Douglas as the follow-up of an initial study of ideas for manned platforms in space. MSFC was the lead NASA center for the study of space platforms designed to carry payloads of science experiments left in orbit by the Shuttle, which would return from time to time to replace equipment in orbit. As a structure grew, temporary manned modules would be added, with the objective of a permanent structure where scientists and technicians would do research for extended periods of time. The McDonnell Douglas study would be completed in about 10 months. (MSFC Release 81-68)

June 18: ESA successfully launched its Ariane rocket from Kourou, French Guiana, at 2:33 p.m. local time, carrying Indian-built comsat *Apple* and ESA's own *Meteosat 2* into an orbit with 36,206-kilometer apogee and 201-kilometer perigee and "breaking a quarter-century two-power monopoly on space achievements," as the *Washington Post* and *Washington Star* agreed.

Michel Bignier, ESA's director of space and transport systems, said "space is no longer the exclusive preserve of a few powerful nations but now belongs to all of humanity." Pierre Morel, director general of the Centre National d'Etudes Spatiales (CNES), said the third Ariane launch "opens the way to European commercial exploitation of space." ESA had hoped for a third of the 180 to 200 satellite launches scheduled for the next decade; Ariane had firm contracts for 7 launches through 1985 and options for another 14.

Ariane's second launch in May 1980 had ended in failure when the rocket burst into flames moments after leaving the pad. The first test in December 1979 had been successful, but that rocket carried no satellites. The $1.6 billion Ariane program was funded by 10 nations, with France (contributing about 64%) and West Germany (about 20%) as major participants. (ESA Info 10, 11, 12; *W Post*, June 20/81, A-9; *W Star*, June 20/81, D-2; *Nature*, June 25/81, 604)

June 19: NASA Headquarters released an official report on the investigation of the March 19, 1981, accident at KSC that killed two employees of Rockwell International, who went into the Shuttle's aft compartment while it was filled with gaseous nitrogen. It had been determined that an all-clear signal was given too soon.

Primary findings by an investigative board headed by Charles D. Gay, KSC director of expendable-vehicle operations, were that test procedures lacked adequate steps to clear a vehicle or pad for hazardous operations, or to partially or completely reopen the vehicle or pad for resumption of normal work; also, that a breakdown occurred in the operational command/coordination process. The report of more than 400 pages included 19 pages of findings, observations, and recommendations to prevent similar accidents in future. (NASA Release 81-85; *W Post*, June 20/81, A-5)

• NASA said that astronaut Alan L. Bean, fourth man to set foot on the Moon, would resign effective June 26 to devote full time to his career as a painter. Bean, selected in the third group of astronauts in the fall of 1963, flew on the second moon-landing mission, *Apollo 12*, in November 1969, exploring the Ocean of Storms with Charles (Pete) Conrad, Jr., as Richard F. Gordon circled in the command module. He captained the second Skylab mission in July–September 1973 and was backup spacecraft commander for the 1975 U.S.-USSR Apollo-Soyuz mission. He noted that in his 18 years as astronaut he had seen sights no artist had ever viewed firsthand, and he hoped to record his experiences through his art.

Bean's time in space—1,671 hours 45 minutes—made him first among active U.S. astronauts and fourth of all in total spaceflight time. He was currently head of astronaut-candidate operations and training. His resignation would leave in the corps only one of the 12 U.S. astronauts who had walked on the Moon: John Young, chief of the astronaut office and commander of shuttle Columbia's first flight last April. (NASA Release 81-87)

June 23: A U.S. Air Force launch team from WSMC, Vandenberg Air Force Base, California, launched NOAA-C under NASA direction from WSMC at 6:53 a.m EDT on an Atlas F into a polar orbit with 863-kilometer apogee, 845-kilometer perigee, 101.9-minute period, and 98.9° inclination. The 371-centimeter-high spacecraft, 188 centimeters in diameter weighing 723 kilograms in orbit, was fourth of eight advanced weather satellites to be launched in the Tiros-N series to measure Earth-atmosphere temperature and humidity, sea-surface temperature, and proton-electron flux near the Earth.

Designated *NOAA 7* in orbit, the spacecraft with a two-year design life carried the most versatile scanning radiometer ever launched, gathering visual and infrared images and other measurements in five spectral channels. (Two earlier craft in the series carried four-channel radiometers: *NOAA 6* was still operational, but *Tiros N* was turned off February 21 after operating for twice its design life.) *NOAA 7* also carried a joint U.S. Air Force-NASA instrument to monitor in the spacecraft vicinity any environmental contamination from its propulsion systems; such contamination could degrade performance of future instruments planned for launch on similiar satellites.

Successful launch of *NOAA 7* meant that two polar-orbiting satellites would circle the Earth, viewing virtually all of its surface at least twice each 24 hours. NOAA routinely used data and imagery from the polar orbiters as well as from two geostationary spacecraft it was operating. *NOAA 6* and *NOAA 7* would transmit unprocessed sensor data in real time to ground stations in more than 120 nations, while passing overhead. Four more satellites in this series would be launched through 1985 on a call-up basis to ensure uninterrupted data flow.

NOAA 7, built by RCA Astro-Electronics, under contract to GSFC, industry interface for NOAA, cost about $15 million to build and $7.5 million to launch. (NASA MOR E-615-81-03 prelaunch summary, June 2/81; [prelaunch]

June 9/81; NASA Release 81-76; NASA wkly SSR, June 25/81; *NASA Dly Actv Rpt*, June 24, 30/81; SPX-332)

• The House of Representatives passed NASA's authorization bill by a vote of 404-13. The amount, the same that appeared in the amended budget request, was $6.122 billion for research and development, construction of facilities, and research and program management. One amendment was adopted, reducing the authorization for aeronautical research and technology by $11.2 million. (*CR*, June 23/81, D773; *NASA Dly Actv Rpt*, June 24/81)

June 25: The Senate confirmed appointment of James M. Beggs as administrator of NASA. (*CR*, June 25/81, D797)

July

July 2: Dr. Alan M. Lovelace, acting adminsitrator, left the agency July 11 to become corporate vice president for science and engineering at General Dynamics Corporation, St. Louis, Mo., in charge of research, engineering, advanced product and program development, and development and implementation of corporate engineering and research policy. NASA's new chief, James M. Beggs, who began his new job July 9, had been executive vice president for aerospace at General Dynamics.

Lovelace had been acting administrator of NASA since the departure of Dr. Robert A. Frosch in January 1981; he had actually retired as deputy administrator in December 1980 but at Frosch's request had agreed to remain through the first flight of the space shuttle Columbia and appointment of a new administrator. Lovelace had entered federal service in 1954 with the U.S. Air Force at Wright-Patterson Air Force Base, Ohio, and became director there in 1967. He went to Andrews Air Force Base in 1972 as director of science and technology for the U.S. Air Force Systems Command and in 1973 became acting deputy assistant secretary of the Air Force for research and development. He came to NASA in 1974 as associate administrator, Office of Aeronautics and Space Technology (OAST) and was appointed deputy administrator of NASA in June 1976 by President Ford.

Lovelace recently received the Presidential Citizens Medal for his work on developing the Space Shuttle. (NASA anno, July 2/81; NASA Release 81-88; *NYTimes*, July 6/81, D–6)

July 7: A 122-pound Colorado pilot, Stephen Ptacek, steered Dr. Paul MacCready's Solar Challenger (a 210-pound aircraft made of lightweight DuPont synthetics and powered solely by 16,000 photovoltaic cells on its 47-foot wingspan) across the English Channel from Cormeilles-en-Vexin 25 miles northwest of Paris to a Royal Air Force base at Manston on England's southeast coast, a 5½-hour flight of 165 miles at an average speed of 30 mph and a cruising altitude of 11,000 feet. Other planes had flown on solar power, but Challenger was the only one to do so without storage batteries. The project was largely financed by DuPont, maker of the Lucite windscreen, Mylar sheathing, and Kevlar-fiber struts.

MacCready said that his solar plane was no serious alternative for air travel, but the flight was to highlight "irrational" dependence on fossil fuels. He had built the first human powered aircraft, Gossamer Condor, which flew in 1977, winning the $100,000 Kremer prize and earning the Condor a place beside the Wright flyer in the National Air and Space Museum. He had also made the Gossamer Albatross, which flew the Channel in 1979 under human legpower, winning a $213,000 prize and a Royal Aeronautical Society trophy. (*NYTimes*, June 9/81, C-1; July 8/81, A-1; July 12, 22E; *W Post*, July 8/81, A-20; *W Star*, July 8/81, A-2; *AvWk*, July 13/81, 21; *Nswk*, July 20/81, 50; *Time*, July 20/81, 45)

July 8: The Senate confirmed the appointment as NASA deputy administrator of Dr. Hans Mark, former secretary of the Air Force and former director of NASA's ARC. Mark, a physicist and nuclear engineer, became diretor of ARC in February 1969 and undersecretary of the Air Force in 1977. He had been secretary of the Air Force from July 1979 until 1981.

Mark had taught at Boston University, Massachusetts Institute of Technology (MIT), the University of California, and Stanford University. He was chairman of the nuclear engineering department at Berkeley from 1964 to 1969, administering its research reactor. (NASA spl anno, July 9/81; NASA Release 81-51)

July 10: NASA reported "encouraging initial results" from a two-month experiment that it conducted jointly with the FAA, National Center for Atmospheric Research, and Northwest Airlines. An instrument on *Nimbus 7*, called total ozone-mapping spectrometer, sent GSFC experimenters data on the total ozone profile in the atmosphere. Within three hours the GSFC scientists relayed the data, processed to indicate upper-air patterns and meteorological activity, such as rapidly moving fronts, to Northwest Airlines meteorologists in Minnesota for use in forecasting.

Knowing the location of the fronts could help in avoiding them, both because they were associated with clear-air turbulence and because ozone encountered by airlines at high altitudes had caused shortness of breath as well as eye, nose, and throat irritation among airline passengers. Further research would lead to deduction of troposphere heights from total-ozone data for comparison with satellite temperature-sounding data. (NASA Release 81-90)

• NASA reported that Dr. Jack L. Kerrebrock, former head of MIT's department of aeronautics and astronautics, had become associate administrator at NASA Headquarters for aeronautics and astronautics, effective July 1, replacing Dr. James J. Kramer, who retired in October 1979.

Before accepting the NASA Headquarters position, Kerrebrock had been a member of the U.S. Air Force scientific advisory board, the National Research Council's aeronautics and space engineering board, and the NASA Advisory Committee. He had directed MIT's gas-turbine laboratory from 1968 to 1978. He received his Ph.D. from CalTech in 1956; from 1951 to 1953 he was a researcher in aeronautics at the Lewis laboratory of NASA's predecessor, the National Advisory Committee for Aeronautics (NACA). (NASA Release 81-91)

July 23: Press reports said that a Texas-based firm called the Percheron project was preparing to launch the first U.S. privately owned space rocket into a 50-mile suborbital flight from Matagorda Island northeast of Corpus Christi.

Backers of the project, named for a breed of large French draft horses, hoped to launch their rocket powered by kerosene and liquid oxygen at the end of July, but had run into trouble with the FAA, which said they must seek waiver of air-traffic rules preventing "nonconventional" use of U.S. air space above 12,500 feet. An FAA spokesman said that an application for waiver could take more than two weeks to resolve and could end by restricting Percheron to a flight no higher than 14,500 feet and no further out to sea than the three-mile limit over which FAA had jurisdiction. A flight would also call for extensive coordination with the Coast Guard to protect shipping and oil rigs in the area.

Percheron was the idea of Gary C. Hudson, a "self-taught engineer" seeking to head a company pioneering corporate space ventures. In 1979 he met a fellow enthusiast, Houston developer David Hannah, described as "a disciple of Dr. Gerard K. O'Neill," the Princeton physics professor famous for his ideas about the commercial and social possibilities of space colonies. Hannah, a supporter of the U.S. space program, had developed a slide show on commercial uses of a cheap, privately owned space vehicle; to launch Percheron, he raised $1.2 million from a number of investors including an oilman and rancher who owned part of Matagorda Island.

Hudson rounded up a crew of engineers, scientists, and technicians, some from NASA's JPL, others from private aerospace firms. So much information and so many plans were available that production of Percheron took only six months from final design. The 55-foot single-engine rocket used in clusters might one day orbit a 5,000-pound geosynchronous payload with a conical module able to withstand reentry heat and return reusable components to Earth. (*W Star*, July 23/81, A-1; July 28/81, A-7; *W Post*, July 29/81, A-1)

July 26: Space shuttle Columbia was still awaiting its trip to KSC's Vehicle Assembly Building (VAB) because of a delay in the orbiter integrated test that had been scheduled for July 23. The test had to wait until technicians finished wiring the remote manipulator's system for emergency jettison of its $100 million Canada-built "bionic arm." That system would have to be retested before the major integrated test could begin, probably not before August 9. The delay would not affect launch date of STS-2, NASA said. (MSFC Release 81-90, 81-91; NASA Release 81-109; *W Star*, July 27/81, A-2)

July 27: MSFC reported the arrival from Europe of a jumbo jet carrying equipment to prepare Spacelab, the ESA reusable scientific research facility, for flight on the shuttle beginning in 1983.

The gear for electrical ground support and mechanical servicing arrived at KSC after formal acceptance in early July by representatives of MSFC, which was responsible for monitoring Spacelab design and development and would manage the first three Spacelab missions. (MSFC Release 81-92)

• LaRC said that it was studying a possible "assembly line in space" that would allow astronauts to build large platforms or antennas in Earth orbit from the shuttle. A mobile work station would position a pair of pressure-suited astronauts so that they could move horizontally and vertically within a prescribed area to set up structures too large or complex to fold up and transport inside the shuttle. The work station would be located inside the orbiter's cargo bay or would be a free-flyer operating near the shuttle.

LaRC was testing a large-scale model to detect possible problems in space and identify ways to improve astronaut productivity: foot restraints to leave hands free, for instance, and electrically operated work platforms. (LaRC Release 81-50; NASA Release 81-104; MSFC Release 81-93)

July 30: The NASA centers which were directed in April to merge reported the steps being taken to complete the action, approved by the agency's new administrator, James M. Beggs.

As of October 1, DFRC, Edwards, Calif., would become a directorate of ARC, Mountain View, Calif., reporting to ARC director C.A. Syvertson; it would retain its name and its "essential identity" but would function as an operational element of ARC. Aeronautical research at the two locations would be integrated and staff functions for the two centers would be combined. Several ARC projects, such as the quiet short-hand research aircraft (QSRA) and the tilt-rotor research aircraft would be moved to DFRC over the 30-month consolidation period.

WFC in Virginia would become an operating element of GSFC at Greenbelt, Md., responsible for suborbital projects and operations. WFC's applied sciences directorate would be a new instrument-systems division of GSFC's applications directorate. GSFC's management operations directorate would absorb WFC's technical support and administrative directorates, except for electronic and mechanical shops. (NASA Release 81-107; WFC Release 81-9)

August

August 3: NASA launched Dynamics Explorer A and B from the WSMC at 2:56 a.m. PDT (5:56 a.m. EDT) on a Delta into polar orbits with 24,945-kilometer(15,500-mile) and 1300-kilometer(808-mile) apogees, 675 kilometer(420-mile) and 306-kilometer(190-mile) perigees, 90° inclination, and 409 and 97.5-minute periods. The orbits, lower than predicted, were still suitable for the full scientific mission. Launch had been delayed three successive days by command-system discrepanies, high winds at the launch site, and problems with a tracking aircraft.

Called *DE-1* and *DE-2* in orbit, the satellites would study the interaction of solar energy with near-Earth space, simultaneously acquiring data on auroras (northern lights) produced by solar energy entering Earth's magnetic field and their effect on radio transmission and basic weather patterns. (NASA Releases 81-95, 81-114; NASA MOR S-850-81-03 [prelaunch] July 28/81, [postlaunch] Aug 7/81; *W Star*, Aug 4/81, D-5)

August 5: Press reports said that test firing of a rocket built by Space Services Inc. (SSI) seeking to be the first private company to launch satellites for profit, ended with an explosion on the launching pad while 18 of its crew watched.

The 53-foot Percheron [see July 23] broke into four major parts, costing the firm more than $1.2 million and delaying the project at least six months. Flight plans had called for the rocket to climb to 14,500-feet and drop into the Gulf of Mexico about three miles from the site. (*NY Times*, Aug 6/81, B-7, *W Star*, Aug 6/81, A-8)

August 6: NASA launched FltSatCom-E for the Naval Electronic Systems Command at 4:16 a.m. EDT from KSC on an Atlas Centaur into a transfer orbit with 35,790-kilometer apogee, 166.7-kilometer perigee, and 26.6° inclination, and turned the craft after it separated from the Centaur over the U.S Air Force Space Division.

Designated *FltSatCom 5* in orbit, the TRW-built DOD communications satellite with a five-year design life would join four similar craft now in geostationary orbit 22,300 miles over the equator at different locations around the Earth, forming a worldwise system to provide two-way communications between naval aircraft, ships, submarines, ground stations, Strategic Air Command elements, and presidential command networks. *FltSatCom 5* would serve over the eastern Pacific. DOD would reimburse NASA for Atlas Centaur and launch services. LeRC had management responsibility for development and operation of the Atlas Centaur; KSC was responsible for checkout and launch. (NASA Releases 81-32, 81-93; NASA MOR 0-491-202-81-05 [prelaunch] Aug 4/81; *D/SD,* Aug 7/81, 211)

August 7: The Soviet Union launched an Intercosmos-Bulgaria 3000 satellite into an orbit with 906-kilometer apogee, 825-kilometer perigee, 81.2° inclination, and 101.9-minute period. A Tass report said that the satellite would study ionsopheric plasma and high-energy charged-particle flux, magnetic fields, and upper-atmosphere glow in the ultraviolet and visible bands of spectrum. The Soviet Union and Bulgaria cooperated on the design of the craft and would continue to work together in data processing and analysis. (FBIS, Tass in English, Aug 7/81)

August 8: WFC reported the launch of a coordinated balloon, plane, and rocket experiment to study electric fields in thunderstorms. Five vehicles simultaneously measured the fields from troposphere to ionosphere for a number of firsts: first multiple flight of electric-field devices, first simultaneous direct observations of ionosphere lightning, and first measures of lightning waveforms in the stratosphere. (WFC Release 81-11)

August 10: During the early-morning move of space shuttle Columbia from it KSC hangar to the VAB, a forklift "accidentally banged into" the spacecraft, damaging two tiles on the left elevon, according to KSC spokesman Rocky Raab. Engineers and technicians were expected to replace the tiles by nightfall so that raising Columbia and bolting it to its mobile launcher could proceed. The three-times-delayed rollout began at 3:54 a.m EDT and took 26 minutes to cover the quarter-mile distance. (*NY Times*, Aug 11/81, C-3)

August 18: NASA declared successful the *Landsat 3* project launched March 5, 1978, still in operation three years later. Its multispectral scanner (MSS) acquired more than 200,000 images worldwide and the return-beam vidicon (RBV) acquired more than 175,000. The project completed two full years of data acquisition and processing for LACIE, and was continuing the same for AgRISTARS. Some equipment was no longer operative, but MSS operations were judged successful, and some foreign stations were still receiving RBV data in real time. (NASA MOR F-641-78-03 [postlaunch] Aug 18/81)

August 19: NASA announced that it had postponed to August 31 Columbia's move to KSC's launch complex 39A, scheduled for August 26, but did not say what effect the delay would have on the September 30 launch date. A nine-day preflight test series that began August 17 would culminate in simulated liftoffs and descent from orbit to landing.

MSFC later reported that the launch date for STS-2 would be reset to October 9 because of "a number of small problems" and a need to prevent crew fatigue. A loss of five days in the VAB was caused by delays in interface tests and misalignment of Shuttle and external-tank connections. The thunderstorm season would also account for some lost time. (NASA Releases 81-123, 81-135; MSFC Release 81-107)

August 25–31: Press coverage of the *Voyager 2* encounter with Saturn came from JPL, Pasadena, Calif. New NASA Administrator James M. Beggs told reporters that the mission was "one of the really great scientific achievements of our age." Under questioning, Beggs said that he could not promise any new planetary missions in the near future. The *New York Times* said that the encounter meant "farewell to American planetary exploration for at least five years," alluding to the expected encounter with Uranus in January 1986.

The 1,800-pound *Voyager 2*, having arrived within Saturn's magnetic field early August 25 after a four-year 1.2 billion-mile journey, was sending back data and pictures "as perplexing as they are dazzling," the *New York Times* said. The craft photographed four of Saturn's moons in greater detail than before, sent data on the thousands of strands in Saturn's rings, and dived behind the planet for a close approach and a gravity-assisted push toward arrival at Uranus in 4½ years. So far, it had found no new moons of Saturn, which had been one of its aims.

When *Voyager 2* reappeared, JPL engineers reported that its camera platform was stuck, affecting three scientific sensors as well as the two television cameras. Chief project scientist Dr. Edward C. Stone said *Voyager 2* "basically completed" all of its observations before the malfunction: "We were fortunate that the troubles didn't happen a few hours earlier," he told a news conference.

Signals needed 1 hour and 27 minutes to travel to Earth. Controllers picked up the signals again at 3 a.m. EDT after Voyager had been out of touch with Earth for 2 hours and 20 minutes; the cameras were showing black space, indicating that the platform was pointing away from Saturn. The platform could be rotated in two dimensions, and controllers countermanded the original program so that the swivel could operate in high torque and expel or destroy whatever foreign object was making the platform stick. A similar problem with *Voyager 1* in 1978 was solved by manipulation of the swivel, after records showed a tiny piece of plastic had been left in a gearbox during construction.

Further reports Thursday, August 27, said that the platform (which had been jammed for 17 hours) was working again but not perfectly. Project Director Esker K. Davis said that it was moving sluggishly in low gear; the plan was to keep moving it, but it took three hours just to send a command and get back a signal that the spacecraft responded. Stone said that his main objective was to recover use of the platform for the voyage to Uranus. Project scientists had turned the cameras off when the platform stuck and would not turn them on again until the problem was solved.

Loss of about 600 pictures of Saturn's rings and darkside, as well as infrared and ultraviolet measurements of clouds and atmosphere, did not mean that the mission had failed, Stone said, calling it "a 200 percent success." Thousands of photos stored on Voyager's tape recorders were still pouring back to Earth, showing sights never seen before. Dr. Arthur L. Lane's telescope aimed at a distant star to catch it blinking on and off as *Voyager 2* passed through Saturn's rings was so successful that he said it would take years to map the rings, 45,000 miles of which were shown by his telescope.

Early on Friday, August 28, flight directors restarted one of the five blacked-out cameras to photograph "a rapidly receding Saturn" from *Voyager 2*'s location already 2 million miles beyond the planet. The platform had responsed by rotating 40° on command in exactly the proper time. NASA would photograph Saturn's outermost moon Phoebe next week when Voyager crossed its orbit: Phoebe, rotating in a direction opposite to that of the other 16 moons, might be a burned-out comet nucleus captured by Saturn.(NASA MOR S-802-77-01/02, July 16/81, *WSJ*, Aug 24/81, 15; *NY Times*, Aug 14/81, A-13; Aug 26/81, A-1; Aug 27/81, A-1; Aug 28/81, B-5; Aug 29/81, A-9; Aug 30/81, F-1; Aug 31/81, B-6; *W Post*, Aug 25/81, A-2; Aug 26/81, A-3; Aug 27/81, A-1; Aug 28/81, A-1, Aug 29/81, A-3; Aug 30/81, A-5; Aug 31/81, A-5; *Science*, Sept 11/81, 1236; *Dscvr*, Sept 81, 79)

August 26: The *Washington Post* said that a USSR satellite that fell into the sea off the coast of China August 23 might have "lost its way to the Moon." The Soviet foreign ministry said that *Cosmos 434* was not nuclear-powered and posed no danger of nuclear contamination: the *Washington Post* said that the Soviet Union seemed eager to allay any fears of radioactive debris like that *Cosmos 954* strewed over Canada's "sparsely inhabited" Northwest Territories in January 1978. The Soviets said that the reentered craft was an "experimental lunar cabin." This description tallied with a long-held belief that *Cosmos 434* was relic of an unsuccessful manned lunar mission planned in the 1960s by the Soviet Union to rival the U.S. Apollo program, which had put 12 men on the Moon by the time it ended in 1972.

Between November 1970 and August 1971, the Soviet Union had launched four unmanned satellites that performed complex maneuvers in Earth orbit simulating those of a lunar-landing mission. A two-volume book on the Soviet space program published in 1979 by the American Astronautical Society said that the satellites (*Cosmos 379, Cosmos 382, Cosmos 398*, and *Cosmos 434*) seemed to be practicing acceleration toward the Moon, braking into lunar orbit, landing on the Moon, and returning to Earth. The Soviet Union never disclosed the purpose of the satellites, but U.S. analysts believed them to be flight tests of a propulsion unit for manned lunar spacecraft. As the 50th anniversary of the 1917 Bolshevik revolution neared, observers thought it likely that the Soviet Union would mark 1967 by putting a man on the Moon; in 1968; the year before the first U.S. moon landing, Soviet cosmonauts were saying that, when the Americans reached the Moon, Russians would be there to greet them.

The Soviet program apparently had a series of setbacks that "cooled the leadership's enthusiasm," the *Washington Post* said. In June 1969 the first attempt to launch the G rocket (a giant new booster like the U.S. Saturn 5) was said to have ended in a mammoth explosion demolishing the launch complex. It also apparently exploded in the early stages of flight during two other tests, in the summer of 1971 and on November 24, 1972. (*W Post*, Aug 30/81, A-25)

September

September 1: Press reports described the rollout of space shuttle Columbia on its eight-tread mobile launching platform from KSC's VAB to launch pad 39A, a 3.5-mile trip that took about seven hours.

New launch date was October 9, only 39 days from rollout; however, Columbia had sat on its pad for 104 days before its first flight, and launch director George F. Page said that all the usual tests should be completed in time. The new schedule allowed for weather delays or new technical problems. The launch pad was modified after last April's ignition caused shockwaves that buckled struts on the spaceship and endangered other parts; Columbia had "several hundred" of its 31,000 heat-resistant tiles replaced. It would carry a new fuel tank—the only expendable part of the Shuttle assembly—and two new solid-fuel booster rockets to be retrieved from the ocean shortly after liftoff.

KSC officials had closed two viewing sites for the next launch because of exhaust fallout. Dr. Albert Koller, chief of environmental management for KSC, said that the fallout problem was a surprise: acid drops in an exhaust cloud produced by STS-1's boosters had spotted vegetation up to four miles north of the site, but apparently did not harm animals in the area. Hydrochloric acid drops from the cloud might cause reddening and burning of unprotected skin.

NASA hoped eventually to send a shuttle back into space within two or three weeks of its previous mission, but Page said "we're a long way from that ultimate goal." (*NY Times*, Sept 1/81, C-3; *W Post*, Sept 1/81, A-4)

September 7: ESA announced that Drs. Claude Nicollier and Wubbo Ockels, two ESA payload specialists in astronaut training at JSC since July 1980, had completed training and were now officially European mission specialists. Ockels would rejoin the crew readying the first Spacelab mission in Europe, at MSFC and at JSC; Nicollier would stay at JSC to continue training as mission specialist for future missions carrying European payloads. The third ESA representative, Dr. Ulf Merbold, had been working with the European experiments selected for first Spacelab flight and would remain as European payload specialist.

The two U.S. candidates for the Spacelab crew, Drs. Michael Lampton and Byron Lichtenberg, had been in a hiatus from training because of delays in the launch date. One each of the U.S. and ESA candidates would be chosen to fly; the others would provide ground support. (MSFC Release 81-119; FSA Info 20)

September 14: GSFC said the two Dynamic Explorers DE-1 and *DE-2* launched August 3 would soon be fully operational. Designed for simultaneous observation of solar-energy effects on Earth's environment, the two craft failed to achieve planned orbit because of Delta-stage misfire but should carry out their major scientific objectives. (NASA Release 81-147)

September 15: LaRC said that it was conducting, under contract with McDonnell Douglas Corporation, a test program on widebody commercial DC-10 aircraft to measure the effect on fuel efficiency of winglets, small structures attached to the tips of airplane wings perpendicular to the wing surfaces. Winglets would reduce fuel-consuming drag by lessening the effect of vortices, turbulent air swirls forming during flight at tips of all aircraft wings.

Developed by aeronautical designer Dr. Richard T. Whitcomb, recently retired from LaRC, the concept had been tested on several types of small aircraft but not on a plane as large as the DC-10. Winglets were already in use on the Gates Learjet 55 and Grumman's Gulfstream III. Wind-tunnel tests showed a drop of about 3% in fuel use, which would mean an annual saving per plane of about 250,000 gallons of fuel, now priced at more than $1 a gallon.

LaRC said that it was also working on the prevention of stall and spin in light aircraft by using the canard, a miniature wing sprouting from an aircraft's nose area, first used by the Wright brothers at the turn of the century but neglected since then because of patent and flight-handling considerations. LaRC found that home-built airplane kits that used the canard to increase fuel efficiency also had impressive records of stall-spin safety. Tests of a model in LaRC's spin tunnel showed that with proper loading the plane was "virtually impossible to spin." Current tests would document the plane's aerodynamic efficiency without trying to improve it. Although the canard did reduce a pilot's area of vision in takeoff and landing, the tunnel data should show whether it could be relocated without sacrificing its safety features.

NASA's aircraft energy-efficiency program was seeking ways to reduce fuel consumption and improve safety. Four NASA centers were focused on aeronautical research: LaRC, LeRC, ARC, and DFRC. (NASA Releases 81-145, 81-155; LaRC Releases 81-68, 81-75)

• NASA officials began a "tanking exercise" of the Shuttle on its KSC launch pad to see if newly installed water-pressure systems would prevent recurrence of shockwaves produced by booster exhaust during the April 12 liftoff. The *New York Times* quoted officials as saying that shockwave reduction was "mandatory" before Columbia could head for space again. Columbia, already erected on the pad for its second mission, contained a payload of five experiments and a 50-foot mechanical arm put aboard in June when the cargo bay was "closed out," the *New York Times* said. NASA might remove a package of scientific experiments rather than risk damaging it during liftoff. (*NY Times*, Sept 15/81, C-2)

—MSFC said September 8 that the Shuttle's external tank was "successfully filled with liquid propellants" in a cryo-loading test at KSC designed to check out ground and vehicle systems. The success was "a major milestone" toward the second Shuttle flight, now scheduled for October 9. (MSFC Release 81-117)

September 20: The People's Republic of China (PRC) launched 3 experiments in space physics on a single rocket, making a total of 11 manmade Earth satellites sent into space by that country since 1970. FBIS quoted PRC press service Xinhua in reviewing the successful series that began April 24, 1970. Previous reports had said the Great March 3 rocket would use a liquid hydrogen and oxygen mixture "slightly less powerful than the European Ariane system," in which the People's Republic had "shown close interest." Both the rocket and its payload were "wholly Chinese manufactured." (FBIS, Xinhua in English, Sept 20/81; Hong Kong AFP in English, Sept 14/81; Paris AFP in English, Sept 10/81)

September 22: LaRC said that it was advancing aviation technology that could "revolutionize commuter flying in the 1990s" by making 20- to 60-passenger turboprops sturdier, faster, and able to travel farther than current commuter aircraft. Rising interest in such aircraft stemmed from high oil prices and airline deregulation, creating "greater demand than supply" for small planes that had to be more cost-effective than large ones because of their smaller capacity and short-haul operations.

LaRC and NASA's other lead centers for aeronautics (ARC, DFRC, and LeRC) were developing advanced aerodynamics, propulsion, materials, and control and guidance systems to provide technological data considered too high-risk or beyond the resources of industry to produce (LaRC Release 81-69; NASA Release 81-131)

September 22–25: Accidental spillage of a caustic oxidizer being pumped into the shuttle damaged the spacecraft surface, unglued nearly 300 of its thermal tiles and forced postponement of the October 9 launch date. Between two and three gallons of nitrogen tetroxide spurted from a malfunctioning connector about 1:15 a.m. and dissolved the bonding agent that fastened the tiles to Columbia's skin. [See December 14] No one was on the launch pad except the specially clothed technicians, and no injuries were reported. About 67 tiles came loose in the hands of technicians mopping up the spill; launch director George Page said the tiles themselves were not damaged, but the vehicle skin would have to be decontaminated and dried, and each tile would have be waterproofed and retested.

NASA warned that the shuttle might have to be moved back into the VAB, separated from its external tank, and moved again into the orbiter-processing facility to see if any propellant had leaked inside. The *Washington Post* said September 24 that inspection of the orbiter's nose showed contamination of the reactor-control system containing thrusters to govern pitch and roll of the vehicle during atmospheric reentry. The oxidizer, when it encountered water, turned into nitric acid, highly corrosive to copper wire and other materials. Moving the ship back to its hangar for repair would delay launch "in excess of a month," Page said.

September 25 NASA said that management had decided to repair Columbia on its launch pad, making a move to the VAB unnecessary. (*W Post*, Sept 23/81, A-17; Sept 24/81, A-28; NASA Release 81-154)

September 24: NASA launched SBS-B from the Eastern Space and Missile Center (ESMC) on a Delta at 7:09 p.m. EDT into a transfer orbit. Owned by Satellite Business Systems, Inc. (a consortium of IBM, Comsat General, and Aetna Insurance Company), the Hughes-built cylinder was second of four commercial communications satellites planned for launch by NASA at a fixed cost to SBS Inc. of $22 million. Called SBS 2 in orbit, the spin-stabilized communications satellite 660 centimeters high and 216 centimeters in diameter weighed 555 kilograms on station. It would be the first to offer routine commercial service in the K-band, 12–14 GHz. (NASA Release 81-130; NASA MOR 0-492-213-81-02 [prelaunch] Sept 21/81, [postlaunch] Jan 27/82; *NASA Dly Actv Rpt*, Sept 25/81, 2)

September 29: NASA Administrator James M. Beggs announced the reorganization of Headquarters effective November 9 "to assure proper delegation of authority to all line managers, set forth a clear distinction between line and staff, and a simplification of field centers' reporting lines." The change would combine the Office of Space Science and Office of Space and Terrestrial Applications into an Office of Space Science and Applications. It would set up an Office of Management to handle some functions now under the NASA comptroller and some now under the Office of Management Operations and to support program offices in managing research and development and institutional resources.

Associate administrators in the program offices would be NASA's major line officers through whom center directors would report to Headquarters. JPL and GSFC would report to the associate administrator for Space Science and Applications. ARC, LaRC, and LeRC would report to associate administrator for Aeronautics and Space Technology; JSC, KSC, MSFC, and the National Space Technology Laboratories (NSTL), to the associate administrator for STS. Remaining program offices would be Space Transportation Operations and Space Tracking and Data Systems.

The administrator's staff would include chief engineer, comptroller, procurement, equal opportunity, external relations, general counsel, inspector general, legislative affairs, associate deputy administrator, and assistants to the administrator. A reorganization working group led by NASA's general counsel S. Neil Hosenball would work out functional and personnel changes; a reorganization steering committee led by Dr. Hans Mark, deputy administrator, would review the plans and recommend a complete reorganization package to the administrator. (NASA Release 81-156)

• The external tank (ET) for the third shuttle flight (ET-3) left the Michoud Assembly Facility in New Orleans on a NASA barge for KSC. Unlike those used in the first two flights, this tank would be light brown, the natural color of the insulation sprayed on the tank's exterior. The white paint on the first two tanks weighed about 600 pounds. Since the tank went almost all the way to orbit, elimination of the paint would add nearly 600 pounds payload besides saving several thousand of dollars in handling and would not affect the tank's fire-retardant or water-repellent qualities. (MSFC Release 81-122)

• *Pravda*, the official Communist Party newspaper, marked the fourth anniversary of orbital laboratory *Salyut 6* with a report of planned space activity. A "lull" was being used for an overhaul of the ground-control center in the Crimea. Employees were on long-awaited vacations, and a skeleton staff was monitoring *Salyut 6*, orbiting without a crew since May 26.

After orbiting for nearly two months of unspecified tests, a Cosmos craft launched April 25 had linked with the Salyut in June to form a 34-ton complex. A flight-test manager said that the complex would help in designing future space stations and was being monitored to see how such a heavy system behaved in space. Since docking with the Salyut the Cosmos had used its engines twice to raise the orbit of the complex. (*NY Times* Oct 7/81, B-11)

During September: William F. Lilly, named NASA comptroller in 1973 and the only person so far to hold that position, announced that he would retire in October after 37 years of service to the federal government, the last 21 with NASA. (NASA Release 81-148; Sp anno Sept 22/81)

—Isaac T. Gillam IV, director of DFRC since June 1978, would become special assistant to the NASA administrator October 1, detailed to the White House Office of Science and Technology Policy to participate in a space-policy review. (NASA Release 81-151; DFRC Release 81-30; NASA anno Sept 15/81)

—Abraham D. Spinak, acting director of Wallops Flight Facility, would leave government service in December after nearly 33 years with NASA and NACA, its predecessor, which he joined in 1948. He had actually retired September 1, 1980, but stayed on to help in the consolidation with GSFC. (WFC Release 81-14)

—Edwin C. Kilgore, associate administrator for management operations at Headquarters, would retire in October after 37 years of service with NASA and NACA. After graduation from Virginia Polytechnic Institute in 1944, he went to work at Langley, joined Headquarters in 1970, and was named deputy associate administrator for center operationas in 1974. As head of management operations, he had been in charge of agencywide institutional management. (NASA Release 81-139; LaRC Release 81-67)

—Ann P. Bradley, deputy associate administrator for management operations, who had been acting associate administrator and acting executive officer at NASA Headquarters pending the retirement of E.C. Kilgore, would return to her duties in management operations with the appointment of A.B. Virkler Legate to the office of the administrator as NASA's executive officer. Legate had been associate deputy undersecretary for intergovernmental relations at the Department of Labor since February 1971: he had previously been a congressional special assistant and executive secretary of DOT from 1969 to 1977. He had also been a congressional administrative assistant. (NASA Spl anno, Aug 28/81, Sept 21/81)

October

October 1: NASA appointed Maj. Gen. James A. Abrahamson, deputy chief of staff for systems at Air Force Systems Command headquarters, Andrews Air Force Base, as associate administrator for the Office of Space Transportation Systems. Abrahamson, former test pilot and manager of the development program for U.S. Air Force's F-16 fighter, would succeed John F. Yardley, who left NASA in May to become president of McDonnell Douglas Astronautics Corporation.

In 1979, Abrahamson was one of five on a special panel selected by NASA to assess STS management; he began his job at Andrews in July 1980. He had been an astronaut in the Air Forces's Manned Orbiting Laboratory (MOL) program from August 1967 until the program was canceled in June 1969. He then served on the staff of the National Aeronautics and Space Council in the Executive Office of the President. A command pilot with more than 3,000 flying hours in jet and conventional fighter aircraft, he was promoted to major general May 1, 1978. (NASA Release 81-159; NASA anno Oct 2/81; *NY Times*, Oct 3/81, 15)

October 2: Astronomers at three major U.S. observatories found a vast region of empty space so large that 2,000 galaxies the size of the Milky Way could fit into it. The void, about 400 million light years from Earth's solar system, seemed to be growing as galaxies near its boundaries gravitated together.

A survey of the large-scale structure of the universe by telescopes at Mt. Hopkins, Arizona, Kitt Peak, and Mt. Palomar showed enormous gaps in three directions near the constellation Bootes. The cosmological principle, basis of modern theories about the universe, assumed that distribution of matter and motion in all directions of space was homogeneous; the new finding would challenge that principle (*W Post*, Oct 2/81; *NY Times*, Oct 2/81, A-1)

October 6: NASA launched a 90-pound solar mesosphere explorer from WSMC, Vandenberg Air Force Base, at 7:27 a.m. EDT on a two-stage Delta into a polar orbit at an altitude between 535 and 550 kilometers with 95-minute period and 97.4° inclination. The satellite, carrying five sensors to monitor atmospheric constituents between 19 and 50 miles up, would study conversion of molecular oxygen to ozone, a layer protecting Earth against ultraviolet radiation and possibly being depleted by refrigerant chlorofluorocarbons. The University of Colorado Laboratory for Atmospheric and Space Physics developed the instruments and would manage the mission under contract to JPL.

Riding piggyback atop the Delta was a smaller craft built by amateur radio operators at the University of Surrey in England. *Uosat* (University of Surrey satellite) was ninth in a series of Oscar (orbiting satellite carrying amateur radio) satellites launched as a second payload on U.S. rockets. Using a voice synthesizer, it could broadcast ionosphere data to amateur receivers. (NASA Release 81-106; NASA MOR S-887-81-01 [prelaunch] Sept 17/81, [postlaunch] Oct 16/81; *NY Times*, Oct 7/81, B-11)

• ARC announced that John A. Manke, famed test pilot, would head a new directorate of flight research after consolidation of ARC and DFRC, effective October 1.

Manke, who made the first supersonic flight of a lifting body and the first landing of a lifting body on a hard-surface runway, had joined DFRC as a research engineer in 1962 and later became a research pilot, testing advanced designs like the wingless craft that were forerunners of the Shuttle. He was project pilot on the X-24B and also flew the M-2, HL-10, and X-24A lifting bodies. Most recently he had been director of flight operations and support at DFRC, where he would remain responsible for on-site management as well as for aircraft operations at both centers. (ARC Release 81-32)

October 7: The *Washington Post* said that NASA was faced with cutting so much money from its budgets for the next three years that it was considering abandoning the Voyager, now on its way from Saturn to a flyby of Uranus in 1986 and Neptune in 1989.

Turning off Voyager's radios would save $222 million (the amount needed to keep NASA scientists and engineers on the job and to operate the Deep Space Network antennas in California, Australia, and Spain) over the next eight years. OMB had ordered NASA to cut $367 million from its FY82 budget and $1 billion each from FY83 and FY84. As NASA could not take money from the Space Shuttle, it would have to save money in other ways.

It had already bowed out of an international mission to Halley's comet and now must choose from among three other programs: the Galileo mission to Jupiter in 1987, the large Space Telescope to be orbited in 1985, or the Voyager trips to Uranus and Neptune. Killing both Voyager and Galileo would save about $520 million. The only other way for NASA to save a large amount of money would be an indefinite delay in building a fourth shuttle, the Discovery, estimated to cost $1.2 billion and due for delivery in 1985. (*W Post*, Oct 7/81, A-4)

October 8: NASA postponed the second Shuttle launch to November 4 because of tile damage caused by an oxidizer spill September 22. Tile replacement was "proceeding well," and measures had been taken to prevent further spillage.

Science magazine described the "minor problems" causing previous postponements: tests that took longer than expected and various handling mishaps. The Shuttle's complexity would "resist attempts to operate with aircraft-like efficiency," the article said. NASA had already decided to trim its Shuttle flights by 30% over the next three years, from 44 missions to 28: it had less money to spend on flying its own satellites and science experiments, as it had to pay for Shuttle modifications and construction of more orbiters.

The delicate instruments planned for the second flight had almost been delayed to a later mission by the discovery that pressures from the solid-fuel boosters against the KSC module launch pad could damage the experiments: the shock had been 2.4 pounds per square inch, not the expected 0.6, enough to buckle a strut supporting a fuel tank near the cabin. If the tank had been jarred enough to leak or malfunction, the first-flight crew would not have been able to orient the Shuttle properly for landing. NASA engineers devised a system of nylon water troughs to disperse the shock and redesigned the launch platform to allow jet watersprays to dissipate the pressure. (NASA Release 81-160; *W Post*, Oct 9/81, A-15; *Science*, Oct 9/81, 160)

October 20: NASA declared the mission of the stratospheric aerosol and gas experiment (SAGE) launched February 18, 1979, successful. SAGE, designed for a 1-year life in orbit, was the second of two small applications-explorer missions built to provide a global data base on ozone and aerosols in the atmosphere.

Like its predecessor, the heat-capacity mapping mission (HCMM), the SAGE spacecraft was built by Boeing. It carried an instrument designed by LaRC that met or exceeded all design specifications, despite power-subsystem problems. Before battery capacity dropped in June 1979, SAGE had acquired 96% of all possible events; since then, about 82%.

SAGE obtained the first global measurements accurate within 1%, more than 12,000 between 78°S and 78°N, to define mass aerosol loading of the stratosphere and its seasonal variations. Worldwide ground-truth measurements validated the accuracy of its measurements from space of vertical profiles of aerosol extinction and of ozone and nitrogen dioxide concentration.

SAGE also detected and tracked at least five volcanic-eruption plumes that had penetrated the stratosphere, one every six months: La Soufriere in May 1979, Sierra Negra in November 1979, Mt. St. Helens in May 1980, Ulawun in October 1980, and Aloid in May 1981. The volcanic data were the first clear instance of gas-to-particle conversion in the stratosphere and of using volcanic aerosols to track global circulation. (NASA MOR E-659-79-01 [postlaunch] Oct 20/81)

October 22: NASA said that the third shuttle flight, now scheduled after January 1982, would carry the first biology experiment specifically designed for the Shuttle: the effect of gravity on formation in plants of lignin, the woody substance giving plants structural stability. Monitoring growth in the microgravity environment of space should show how wood is formed. The plants should grow upward in response to the presence of artificial sunlight, but root development was unpredictable. (NASA Release 81-166; ARC Release 81-56)

October 27: NASA consideration of a "mixed fleet" to augment Shuttle missions by using an unmanned vehicle developed from recoverable shuttle components led to issuance in September by MSFC of a request for proposals asking for definition of such a vehicle, to be called SRB-X. Boeing Aerospace and Martin Marietta Aerospace were the two contractors responding. MSFC had management responsibility for the SRB-X study because it had been in charge of Shuttle propulsion and was the lead center for design, development, and testing of all NASA propulsion systems. (MSFC Release 81-135)

October 28: NASA announced that it would shut down on December 1 its three 26-meter (85-foot) tracking antennas operated by the Deep Space Network at Canberra (Australia), Madrid (Spain), and Goldstone (California), because of reductions in the agency's budget. The stations would operate the 64-meter (210-foot) and 34-meter (112-foot) deep-space antennas as in the past. Loss of the 26-meter antennas would mean a 30% reduction in tracking and data-acquisition and support for NASA's planetary spacecraft: the network was currently supporting *Voyager 1* and *Voyager 2*, *Helios 1*, the *Viking 1* lander on Mars, and *Pioneers 6* through *12*.

Shutting down the three antennas would save about $7.2 million per year, beginning in FY83; termination would eliminate 110 positions, 51 in Spain, 26 in Australia, and 33 at Goldstone. The stations in Spain and Australia were operated by government agencies of those countries, which would reduce staff by reassignment and attrition; the Goldstone station was operated by Bendix Field Engineering Corporation, which would also reduce staff by reassignment and attrition. JPL managed the Deep Space Network for NASA's Office of Space Tracking and Data Systems. (NASA Release 81-171)

November

November 1-12: NASA reported that its $2 million quick-fix shock-prevention water system was hooked up November 1 during a countdown "notable for its smoothness," the *Washington Post* said. Designed hastily over the past five months, the shock-absorber system would flush 400,000 gallons of water in 35 seconds into the Shuttle's exhaust. Food for the journey was loaded aboard the spacecraft, and the next task would be loading chemicals for the ship's electric and environmental systems.

Liftoff had been scheduled for 7:30 a.m. EDT on November 4, but officials called off the countdown at 9:35 a.m., when rising oil pressures in the Shuttle's power generators, apparently caused by waxy contaminants, threatened to impair control of the hydraulic system that moved aerodynamic surfaces, such as the elevons, landing gear, and rudder and body flaps, and swiveled the nozzles on the Shuttle's three main rocket engines. L. Michael Weeks, acting associate administrator for STS, said that the engineers would have to analyze the trouble, correct it, and lay out a plan for resuming countdown; the delay would be "approximately one week."

NASA was considering two courses of action: changing the oil and the filters in the auxiliary power units or replacing them with backup units. Engineers at KSC or JSC were not sure which course would take longer; neither, however, would mean hauling Columbia with its attached fuel tank and booster rockets back from the launch pad into the processing hangar for reworking.

The launch team had noticed the lubrication problem while the countdown was halted to grapple with other problems. Pressure in the liquid-oxygen chamber of the external tank had dropped below the limit for launch, and a similar glitch occurred in three smaller tanks feeding the electricity-producing fuel cells inside the Shuttle. Flight controllers decided that they could live with the pressure drops and instructed the control computers to ignore the warning signals. Two of the computers accepted the instruction but "logic got hung up in the system" leading to the third computer, which stopped the clock governing countdown at T minus 31 seconds. This was the point at which Columbia's on-board computers were supposed to take over control of all remaining steps in the countdown, but—having detected a problem—they refused to continue.

Controllers at the Cape and at mission control in Houston called up data displays to locate the trouble, and Shuttle operations director George F. Page finally announced that there would be no launch. Astronauts Col. Joe H. Engle and Capt. Richard H. Truly, who emerged from the Shuttle about an

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hour after the launch was scrubbed, seemed to take the delay "in stride," the *New York Times* said.

What persuaded controllers to call off the launch was the finding that oil pressure for two of the units had stabilized at 100 pounds per square inch, about 40 over normal. Neil B. Hutchinson, a flight director at JSC, said that contaminants in the oil had previously clogged Shuttle filters, which resembled the oil filter in an automobile. However, replacing a filter along with the lubricant it was supposed to keep clean would take far more time than in an automobile. If the auxiliary power units now in the Shuttle were to be used, technicians would have to drain the present oil, change filters, and flush the system before the flight could proceed. This had never been done on the launch pad; engineers would have to go ahead without knowing how long it would take. NASA spokesman Charles Redmond noted that General Motors found out about such problems "at the proving grounds, behind high screens, while we're doing it in public."

Either changing filters and lubricant or completely replacing the two power units would be time-consuming because the units deep inside the ship would be difficult to reach. The power-unit fuel hydrazine, suspected of gumming up the works by interacting with the lubricating oil, was highly toxic, and the location of the power units would have to be purged with nitrogen. The nitrogen, which also could be fatal, would have to be purged in its turn.

The next procedure was the flushing and reservicing of the auxiliary power-unit (APU) gearboxes and installation of new filters. Tests to see what would happen if the APU was operated with a clogged filter (using the oil and filter removed from Columbia) showed that the filter would clear after about 10 minutes of operation, as the temperature increased. Launch was reset for November 12.

A second countdown to launch November 12 was delayed 2 hours and 40 minutes by trouble in the cockpit electronics. Engineers discovered November 11 that a 15-pound device, called multiplexer-demultiplexer (MUX/DEMUX), that collected information from all over the spacecraft about its condition to display both on video terminals for the astronauts and on the ground for analysis by engineers, was not working properly; it was quickly replaced with a substitute that did not work as well as the original. Officials sent for two of the instruments from the Challenger orbiter, still unfinished at Rockwell's Palmdale plant, to be flown to KSC and installed on Columbia. One went into Columbia's cockpit; the other would be carried as a spare. Countdown was at a built-in hold designed for emergencies such as the one that had occurred; it would resume early November 12 with the loading of 3-million gallons of supercold liquid oxygen and hydrogen fuel into the external tank, delaying launch until at least 10 a.m. The latest delays would cost NASA more than $26 million; every day of delay, including the eight in this last series, cost $3 million. The MUX/DEMUX delay cost an extra $2 million from handling, overtime, travel costs, and additional launch and landing tracking report.

Launch of the second mission finally occurred at 10:10 a.m. EST November

12. About 2½ hours into the mission, during the third orbit, fuel cell one showed a voltage drop; by the sixth orbit, it was so erratic that the astronauts were told to turn it off and use one of the other two. The faulty cell failed when one of the lines feeding hydrogen into it caused a water buildup that spilled onto an electrically charged manifold, breaking down the water into a potentially explosive mixture of gaseous hydrogen and oxygen. The failure took flight directors by surprise, as the cells had been used in 25 manned U.S. spacecraft since 1965 and had never before failed in flight. Hutchinson noted that "the good thing about this" was that the Shuttle could sustain a fuel-cell failure and continue operations. At 10 p.m. November 12, one of the standby cells was producing 7.5 kilowatts of electricity, and the other, 8.5, enough to do nearly everything except run all five instruments while the Shuttle arm was in operation. If the two good cells continued satisfactory, the flight would proceed as scheduled and return November 16 to Edwards Air Force Base in California; if either showed signs of weakening, the crew would return November 13 or 14. (*W Post*, Nov 2/81, A-3; Nov 6/81, A-9; Nov 13/81, A-1; *NY Times*, Nov 5/81, A-1; NASA MOR M-989-81-02 [postlaunch] Dec 17/81)

November 13-15: President Reagan became the first incumbent chief executive to visit JSC's mission-control center during a flight, when he came on the second day of STS-2's flight to sit in the capsule communicator chair and talk briefly to the astronauts. After his conversation, the president had a short talk with the Engle and Truly families and left for a dinner in Houston. Two days later, November 15, JSC played host to Vice President Bush at breakfast with the STS-1 and STS-2 crews at the recreation center. This was the first back-to-back visit to JSC of the two highest U.S. officials.

The *New York Times* said that workers were already ahead of schedule November 13 in a 3- to 4-week cleanup of the launch compound at Cape Canaveral. A shock-absorber water-trough system worked "better than expected," said Merrill Oakley, design engineer on the launch pad, cutting shockwaves to a fifth of the first launch's intensity. After a washdown and system checks, Oakley said all that remained was replacement of some bricks that blew out of a flame trench and painting.

The STS-2 crew flew to Ellington Air Force Base, in Texas shortly after landing the Columbia at Edwards Air Force Base ending "a troubled but scientifically rewarding 54-hour mission," the *New York Times* said. Welcomed on their 9:50 p.m. arrival in Texas by about 400 JSC employees, the astronauts breakfasted the next morning with Bush, JSC director Chris Kraft, and the first shuttle crewmen John W. Young and Robert L. Crippen among the 23 guests. Although Bush said "the people here at the NASA complex are a national treasure," he said that he could not promise any easing of budget constraints on the agency.

Preparations were already under way for the third shuttle flight, now scheduled for March 1982. Damage to the launch pad from the second mission was "minimal and superficial," Oakley said. (Public Papers of the President; *W Post*, Nov 14/81, A-7; *NY Times*, Nov 15/81, 35; Nov 16/81, A-1, A-19; JSC *Sp NRdP*, Nov 20/81, 1)

November 20: NASA launched RCA *Satcom 4* from the ESMC on a Delta at 8:37 p.m. EST into a transfer orbit with 19,356-kilometer apogee, 100-kilometer perigee, and 25.5° inclination. The objective of the commercial communications satellite was to transmit video programs to cable television (CATV) systems throughout the United States. The 500-kilogram box-shaped craft, fourth in a series of large 24-transponder communications satellites, managed by a subsidiary of RCA, carried a payload-assist module (PAM) to put it into geosynchronous orbit at 132°W, joining three other RCA satellites providing television, voice, and high-speed data to all 50 states and Puerto Rico. More than 4,000 Earth stations had direct access to these spacecraft.

GSFC had project-management responsibility for the launch vehicle; RCA Americom, which managed the Satcom program, including spacecraft acquisition and tracking, telemetry, and command systems, would reimburse NASA $22 million for the launch and launch support. (NASA Release 81-172; NASA MOR 0-492-206-81-04 [prelaunch] Nov 18/81, [postlaunch] Jan 27/82)

• NASA announced that it had completed plans for the reorganization of its Office of Space Science and Office of Space and Terrestrial Applications into a new Office of Space Science and Applications to take over responsibilities of the former offices, except for the technology utilization program, which would go to the government and industry affairs division of the Office of External Relations.

Andrew J. Stofan, formerly acting associate administrator for space science, would be acting associate administrator of the new group; Samuel W. Keller, formerly deputy associate adminstrator for space and terrestrial applications, would be deputy associate administrator. (NASA Release 81-182)

• *Science* magazine said that Congress was in a "stir" because the administration planned to let a U.S. company sell materials for an advanced communications satellite to an Arab consortium that included the Palestine Liberation Organization (PLO).

Ford Aerospace would sell satellite parts to the French firm Aerospatiale, which was under contract to build three communications satellites for a group called Arabsat, composed of 22 governments, among them Libya, Syria, South Yemen, and the PLO. Libya has been "an avowed enemy" of the United States. The $135 million contract would cover satellites similar to but less sophisticated than the one Ford Aerospace was building for global communications system INTELSAT: Arabsat would offer 8,000 simultaneous two-way telephone conversations and one television channel. These services would cost less if bought directly from INTELSAT, but the Arab group apparently preferred to operate its own system.

The matter came up November 3 during hearings before the Senate Foreign

Affairs Committee, when Secretary of Defense Caspar Weinberger said that he knew nothing about the deal; the next day, Secretary of State Alexander Haig also said that he knew nothing about it. The Arms Export Control Act required State Department approval of exports of high-tech items, even those having no direct military application. (*Science*, Nov 20/81, 891)

• NASA reported that it would join a sounding-rocket program with Canada's National Research Council to study a cleft or wedge-shaped opening over the Northwest Territories (N.W.T.) in Earth's magnetic field. From November 25 to December 21, researchers would launch five rockets carrying experiments into the cleft region to record effects ranging from disrupted communications to pipeline corrosion and long-term weather patterns. Ground-station equipment would be installed at the launch site, Cape Parry, N.W.T., and at Sachs Harbor about 200 kilometers (124 miles) north.

Data from the project, called CENTAUR (cleft energetics, transport, and ultraviolet radiation), would define mechanisms causing particle acceleration in the cleft and would aid in studying ion flow, auroral arcs, and plasma instabilities. WFC would manage launch and tracking and acquisition of experiment data. (NASA Release 81-180; WFC Release 81-18)

• DFRC said that it was readying Shuttle orbiter Columbia for its return to KSC on its Boeing 747 carrier plane. DFRC was deservicing the orbiter after its 54-hour second flight, draining liquid oxygen and hydrogen fuels, removing pyrotechnic devices, and purging toxic chemical and fuel cells used in the propulsion systems. DFRC would attach a tailcone to the orbiter covering its three main engines and two orbital-maneuvering engines.

The ferry flight would take two days, with a refueling and overnight stop at Bergstrom Air Force Base near Austin, Texas, or Dyess Air Force Base near Abilene. Donald K. (Deke) Slayton, manager of the orbital flight tests, would accompany Columbia back to KSC. (NASA Release 81-181; ARC Release 81-34)

• The Soviet Union launched India's satellite *Bhaskara 2* into an orbit with 557-kilometer apogee, 514-kilometer perigee, 95.2-minute period, and 50.7° inclination. It carried television and microwave radiometers to study Earth's natural resources. Tass said that India and USSR stations were receiving data. (FBIS, Tass in English, Nov 20/81)

November 27: Newsreview, published by the Air Force Systems Command, told of a special "bake job" done for NASA by Patrick Air Force Base, Fla., in its Civil Engineering Squadron's fabrication-branch shop. Ovens there, normally used to harden, soften, or anneal metals, were large enough to treat 75 to 80 thermal tiles from Shuttle orbiter Columbia damaged by a nitrogen tetroxide spill. The heat treatment at 1,100–1,400°F took about 16 hours to burn off contaminant and bonding material. Checking for toxic vapors caused by the heat disclosed none. (AFSC *Newsreview*, Nov 27/81, 8)

During November: Administrator James M. Beggs appointed Philip E. Culbertson associate deputy administrator with revised duties, serving as senior staff adviser and directing formulation of NASA policy, strategy, and planning of a facility to constitute permanent U.S. presence in space. Culbertson had served for two years as assistant for space transportation systems.

—Robert F. Allnutt, associate deputy administrator since mid-1978, would assume new duties as deputy general counsel for policy review, studying the long-term development of NASA and its relationship to other federal agencies as well as contractual arrangements with future users of the Space Shuttle. (NASA anno, Nov 18/81; NASA Release 81-178, 81-179)

—NASA named C. Thomas Newman comptroller to succeed Wiliam E. Lilly, who retired in October. Thomas F. Campbell would replace Newman as deputy comptroller. (NASA anno Nov 25/81)

—Frank J. Malina, cofounder of JPL and of the Aerojet General Corporation, died November 9 at his home in Paris. He had moved there to work with the United Nations Educational, Scientific and Cultural Organization (UNESCO) after retiring in 1947 as an officer of Aeroject and JPL. He had worked for Theodore von Karmann as a researcher for Guggenheim Aeronautical Laboratory, CalTech, leading to creation of the CalTech rocket-research project in 1936 that later became JPL, which made the first successful U.S. satellites in the 1950s.

—William Pickering, who followed Malina as JPL director from 1954 to 1976, said that inventions that made present-day rockets possible went back to work done at JPL under Malina. A leader in developing jet-assisted takeoff (JATO) rockets used in World War II and co-developer of the WAC Corporal, first U.S. successul stratosphere rocket, Malina had in 1942 joined von Karmann to form Aerojet General, first U.S. manufacturer of rocket engines. He left UNESCO in 1953 to start a studio as a graphic artist, working in a form he invented called "kinetic art." (*LA Times*, Nov 11/81; *LA Star News*, Nov 11/81)

December

December 1: NASA said that it had picked Jack R. Lousma and C. Gordon Fullerton as commander and pilot for the third flight of Shuttle orbiter Columbia. The backup crew would be Thomas K. Mattingly II and Henry W. Hartsfield, Jr.

Lousma, a colonel in the U.S. Marine Corps, was mission pilot on *Skylab 3*, logging more than 1,427 hours in space as he and his crew accomplished 150% of their assigned goals. Fullerton, a colonel in the U.S. Air Force, piloted the Shuttle Enterprise on its first, third, and fifth flights in the approach-and-landing tests in 1977. The third Columbia flight, a seven-day and three hour mission of 116 orbits set for March 1982, would carry a payload (OSS-1) developed by NASA's Office of Space Scinece and would further test the remote manipulator arm for inserting future payloads into space. (NASA Release 81-187)

December 4: ESA handed over to NASA in Bremen the first flight unit of Spacelab, built for use on the shuttle. Just a year after delivery of the engineering model, NASA received all the systems—first main components of standard equipment, platforms, ground facilities, and spare parts—to be used on the first Spacelab flight September 1983. It would transfer to NASA in May 1982 experiments for the first Spacelab payload.

An industrial consortium with ERNO as prime contractor had carried out development since January 1980. The contract, worth 301.3 million deutschmarks (DM) at 1980 levels, had increased to 380 million DM at 1981 levels. NASA would receive the components of a second Spacelab flight unit, ordered throughout ESA to be identical with the first, in 15 batches, starting in 1982. (ESA Info 28; NASA Release 81-193; MSFC Release 81-145)

December 7: NASA's Office of Space and Terrestrial Applications (OSTA) announced its selection of 9 experimental and 10 theoretical teams to participate in the upper-atmosphere research satellite (UARS) program designed to provide data on energy input, chemical composition, and dynamics of Earth's stratosphere and mesosphere. Interest in this area had increased with the realization of potential damage to the ozone layer from high-flying aircraft and from chemicals in aerosol sprays, refrigeration, air-conditioning, and foam-blowing operations.

The experimental teams would develop instruments for direct measurement of upper-atmosphere winds, solar-ultraviolet radiation, energetic-particle interaction with the upper atmosphere, and variation of chemical content with altitude. Theoretical teams would develop upper-atmosphere models to be used with new acquired data for assessing the impact of man's activities on the delicate processes in the stratosphere and for improving understanding of upper-atmosphere chemistry and dynamics. (NASA Release 81-190)

December 8: MSFC said that the Spacelab 1 payload crew was in Japan for a week, practicing the use of instruments scheduled to fly on the first mission in 1983. A NASA-sponsored package, SEPAC (space experiments with particle accelerators), would study the interaction of Earth's magnetosphere with the upper atmosphere. Professor Tatsuzo Obayashi of the University of Tokyo would be the principal investigator.

Before leaving Japan December 15, the crew would be trained on the actual flight hardware at Japan's National Space Development Agency. The crew—civilian scientists called payload specialists and two NASA mission-specialist astronauts—were Drs. Byron Lichtenberg and Michael Lampton of the United States, Dr. Ulf Merbold of West Germany, Dr. Wubbo Ockels of the Netherlands, and NASA mission specialists Drs. Owen Garriott and Robert Parker. Two payload specialists would actually fly on the mission with the mission specialists; the other two would support the mission on the ground. (MSFC Release 81-146)

—NASA said that one of Japan's major newspapers, *Asahi Shibmun*, had signed an agreement to fly a "getaway special" experiment on the Shuttle, possibly in late 1982, using the weightlessness of space to make pure artificial snow crystals directly from a gaseous substance while the Shuttle was in orbit.

A Japanese physicist, the late Dr. Ukichiro Nakaya, had made the first artificial snow-crystal experiments in 1936. The Shuttle experiment, a first try at creating artificial snow in a weightless environment, would contribute significantly to crystallography, especially growth of semiconductor crystals or other items from a vapor source. The idea, suggested by two Japanese students, was chosen for 17,000 suggestions by the newspaper's readers.

To date NASA had accepted 321 getaway specials—privately funded experimental payloads—for flight on the Shuttle on a space-available basis, beginning with the fifth mission in 1982. (NASA Release 81-191)

December 10: ARC reported the first NASA-piloted test flight of its "flying research facility," a helicopter-type aircraft equipped with fixed wings and jet engines, over San Francisco Bay at speeds of up to 120 knots (138 mph) for 45 minutes. Warren Hall of ARC piloted the flight; copilot was Lt. Col. Bob Merrill, deputy director of U.S. Army flight tests at Edwards Air Force Base.

Designed for studying advanced rotor systems in actual flight, the craft had the highly reliable type of rotor used on presidential helicopters. The wings and engines provided the lift needed in studying rotors too small to support the research aircraft alone. A second rotor-systems research aircraft (RSRA) had been flown at ARC in the basic-helicopter configuration.

Located at ARC, the two aircraft constituted a national facility for in-flight verification of rotor-system technology; they could be flown as helicopters or equipped with the fixed wings and auxiliary jet engines to enhance test capability. The two craft, built by the Sikorsky Division of United Technologies for LaRC and the Army's technology lab at Moffett Field, California, were transferred to ARC in 1979 for the joint NASA-Army research program. (ARC Release 81-67; NASA Release 81-194)

• MSFC reported a milestone in the development of the Space Telescope. Perkin-Elmer Corporation, contractor for design and production of the optical asembly, finished putting an aluminum coating 3 millionths of an inch thick on the 94-inch primary mirror, an 1,800-pound polished glass blank. Engineers from the firm and from MSFC verified that the coating adhered to the mirror and exhibited the proper reflectivity. The telescope would use two mirrors to focus light from stellar objects onto a group of instruments at the rear of the telescope assembly. Launched from the Shuttle into Earth orbit in the mid-1980s, the Space Telescope should allow astronomers to see seven times deeper into space than is now possible with ground-based telescopes. (MSFC Releae 81-148)

• NASA declared the mission of *Voyager 1* and *Voyager 2* successful. Launched September 5 and August 20, 1977, each of the spacecraft had traveled more than 2.4 billion kilometers during the past four years and had conducted scientific investigations at seven major bodies of the solar system. They had made comparative studies of the Jupiter and Saturn systems, including their satellites, rings, and fields and particles environments. They had also measured characteristics of the interplanetary medium from Earth to Saturn. Achievements included:

—acquiring more than 62,000 images from the outer solar system

—discovering rings around Jupiter and unusual braiding, spokes, ringlets, and shepherding satellites in the rings of Saturn; new satellites of Jupiter and Saturn; lightning on Jupiter; eight active volcanoes on Io; and new sources of radio emissions in the Jupiter and Saturn systems

—measuring atmospheric composition, temperature, pressure, and dynamics, magnetospheres; and particle environments of Jupiter, Saturn, and Titan. (NASA MOR S-802-77-01/02 [postlaunch] Dec 10/81)

December 14: NASA issued a final report on investigation of the leak of nitrogen tetroxide oxidizer at KSC September 22. A four-person committee chaired by KSC's Wiley Williams said that the cause of the leak was failure of a quick-disconnect fitting in which iron nitrate from the oxidizer had accumulated between interior components, allowing escape to the outside.

Between 15 and 20 gallons of oxidizer escaped, some diverted away from the orbiter surface by a catch system, but "a significant quanity" flowed over the outside of the orbiter and its thermal-protection system. About 370 tiles had to be removed. Oxidizer also got into the forward module of the reaction-control system, damaging thermal blankets and electrical wiring.

Close tolerance in the interior components, allowing the binding to take place, was a design failure point unrecognized before the accident. As the same fittings would be used for the second Shuttle launch, the committee recommended taking several steps before loading hypergolic propellant again:

—adding more values to the system to permit isolation of the quick-disconnect fittings

—modifying the catch system and adding protective aprons to guard against a large leak

—changing procedures to eliminate use of the quick-disconnect fitting as a shutoff valve

—expanding emergency procedures and conditioning the servicing team to expect similar failures

—sealing possible entry paths into the orbiter during loading, or purging internal compartments with inert gaseous nitrogen.

Although the committee limited its investigation to this one incident, it recommended review of its report to identify other fluids used around the orbiter that could cause damage if spilled. (NASA Release 81-73)

December 15: NASA launched *Intelsat 5-C F3* from ESMC at 6:35 p.m. EST on an Atlas-Centaur into a highly elliptical transfer orbit with 35,953-kilometer apogee, 165.8-kilometer perigee, and 23.7° inclination. Firing of the apogee motor by INTELSAT would put it in geostationary orbit at 15°E for tests by Telespazio at Fucino, Italy. It would later become the primary Atlantic communications satellite at 335.5°E, replacing *Intelsat 5 F1*, which would move to an Indian Ocean location at 62°E to begin service next March after launch of another communications satellite as a spare.

The two-ton *F3*, capable of 12,000 simultaneous telephone conversations plus two international color television channels, was third of the 5 and 5A series of 15 communications satellites planned by INTELSAT to handle international communications, such as telephone, telegrams, telex, data, and television. (NASA MOR 0-491-203-81-03 [prelaunch] Dec 1/81, [postlaunch] Jan 9/82: *NASA Dly Actv Rpt*, Dec 16/81; *Spacewarn*, Dec 29/81; INTELSAT Releases 81-27-1, 81-32-1; *A/D*, Dec 22/81, 268)

December 20: ESA launched Marecs-A, first European maritime communications satellite, from Kourou in French Guiana at 1:29 a.m. GMT on the fourth Ariane booster into a highly elliptical orbit with 35,820-kilometer apogee, 220-kilometer perigee, 632-minute period, and 10.5° inclination, preparatory to a boost into geosynchronous orbit at 26°W. The Ariane also carried a technological capsule (CAT 4) enclosing an experiment called Thesee (Theseus) that would remain in the original orbit.

The European Space Operations Center (ESOC) would test *Marecs* before handing it over to INMARSAT, which would lease its communications capacity over the Atlantic Ocean. A Marecs-B spacecraft was being readied for launch in April 1982 for INMARSAT use over the Pacific Ocean. (ESA Infos 29, 31, 32, [81], 1 [82])

December 22: NASA said that its joint sounding-rocket project with Canada's National Research Council [see November 20] was successful. William A. Brence of WFC said that preliminary results were satisfactory. Data from the seven experiments launched on five large suborbital rockets from temporary facilities at a radar site on the Arctic coast would, in combination with ground-based observations, enlarge understanding of the dynamics of the cleft in Earth's magnetic field. (WFC Release 81-20)

During December: NASA announced the appointment of Dr. Walter B. Olstad, deputy associate administrator for management to direct all matters such as personnel, supply and equipment, facilities, computer support, and the like. He would succeed Edwin C. Kilgore, who retired October 2. C. Robert Nysmith would replace Olstad in an acting capacity. Both appointments were effective immediately.

The Office of Management was created in the NASA reorganization plan effective in November to perform some of the functions previously under the Office of Management Operations and some previously under the NASA comptroller.

Olstad began his association with the agency in 1954, working at the Langley laboratory as a research engineer in the transonic tunnel branch, then in the reentry physics branch. He became chief of LaRC's space systems division in July 1975. He went to Headquarters in 1979 as deputy associate administrator for OAST. (NASA anno Dec 14/81; NASA Release 81-195)

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January

January 6: Marshall Space Flight Center (MSFC) reported testing the thermal performance of a helium cooling system to be used on the large infrared telescope experiment planned for flight on Spacelab 2 in 1984. For the MSFC-managed experiment to work, the cooling system must keep the infrared detectors at a supercold temperature. The liquid-helium coolant stored during the mission in a 250-liter container would vaporize as withdrawn to circulate through telescope channels and keep the instrument near absolute zero, coldest possible temperature, at which all molecular action stops. One objective of the tests was to see how long the system could store the cold liquid; the container would be filled one or two weeks before launch, then undergo a seven-day mission. Tests would continue until March. (MSFC Release 82-2)

January 8: NASA said that it was relocating the Applications Technology Satellite (ATS) *ATS 1* from its station at 149°W to a new position about 50 farther west, at 162°E. Maintaining orbit position in its present location required maximum use of its thrusters; moving to the new station would put *ATS 1* into a more stable position and substantially reduce the stationkeeping power requirement.

Goddard Space Flight Center (GSFC) had considered several options to conserve on-board fuel supplies, which had been estimated adequate until mid-1982.The new location should prolong stationkeeping through 1983 and reduce the need for center contract from biweekly to quarterly. (NASA Release 82-4)

January 15: NASA launched RCA-C from the Eastern Space and Missile Center (ESMC) at 8:55 p.m. on a Delta into a transfer orbit with 36,116-kilometer apogee, 182-kilometer perigee, and 27.5° inclination, from which it would assume a geosynchronous station at 83°W. Called *Satcom 4* in orbit, the 2,385-pound craft with a 10-year design life carried 24 transponders, each able to handle an FM/color television transmission. (NASA Release 82-3; NASA MOR O-492-206-82-05 [prelaunch] Jan 11/82, [postlaunch] May 13/82; NASA wkly SSR, Jan 14-20/82; *D/SD,* Jan 19/81, 83)

• MSFC shipped the induced environment-contamination monitor back to Kennedy Space Center (KSC) after servicing it in preparation for the third Shuttle flight. The desk-sized detector consisted of 10 instruments to check the environment in and around the Shuttle cargo bay for contaminants that might damage or interfere with sensitive equipment. The monitor would play a dual role on the next mission: besides carrying out its normal functions, the

1,000-pound package would serve as a load to exercise the remote-manipulator arm. All instruments on the monitor operated successfully in its first flight on the second Shuttle mission; data collected then were still being analyzed. (MSFC Release 82-7)

—A month-long analysis of the data produced by the monitor on the second Shuttle flight clearly identified every contamination-producing activity (such as thrust firings and water dumps). On future missions, the monitor could differentiate contamination from other sources. It recorded low humidity in, and successful sealing of, the cargo bay from engine byproducts during ascent and descent; few particles of matter larger than five micrometers, but a number of smaller particles well above expectations; a 90% reduction of water molecules and other early-mission contaminants after about 35 hours in orbit; and a temporary cloud of particles from using the attitude-control system or from dumping of water. Project scientist Edgar Miller of MSFC said that, when the orbiter flew with the cargo bay pointing ahead, molecular readout was high because orbiter-generated particles were deflected back into the bay; action would be taken to keep this from happening while using sensitive instruments.

The third Shuttle flight, planned for seven-days, would test the monitor in high temperatures from the planned solar orientation of the cargo bay, compared to the mild levels produced by the Earth orientation of the second flight. The remote manipulator would move the monitor to selected points for readout during the flight. (MSFC Release 82-14; NASA Release 82-13)

January 19: MSFC said that it had shipped the external tank for the fourth Shuttle mission from Michoud Assembly Facility on the NASA barge Orion for a five-day trip to KSC. The fourth launch was set for mid-1982. (MSFC Release 82-12)

—MSFC reported shipment of the monodisperse latex reactor, an experiment "with major medical and industrial applications," to KSC for flight on the third Shuttle mission. Dale Kornfeld of MSFC's space sciences laboratory said that the instrument would produce identical-sized microspheres of polystyrene latex, resembling tiny beads, to measure the size of intestinal pores for cancer research and of pores in the eye for glaucoma research and to act as a carrier of drugs and radioactive isotopes for treatment of cancerous tumors. On Earth, the beads could be produced only up to about 3 microns in size; the low gravity of space would permit them to "grow" up to 20 microns while remaining identical. The National Bureau of Standards had indicated interest in using the beads to calibrate medical and scientific equipment. (MSFC Release 82-9)

January 20: Ames Research Center (ARC) released new findings about Venus from 30 experiments of the Pioneer Venus missions and reported that the orbiter was still returning daily information. The data were available only now because of the complexity of the missions and the large amounts of data returned, combined with the value of comparisons with Soviet data on Venus.

The new data included evidence for two major currently active volcanic areas on Venus; findings that Venus had a thicker crust than Earth and was a "one-plate" planet with little plate-tectonic movement; and models of the Venus cloud system and greenhouse effect that were complete and consistent.

The research also found strong new evidence of former Venus oceans on the scale of Earth's. Data indicated that the Earth would become "a virtual Venus if you stopped its rotation, removed the moon, and moved [it] slightly closer to the sun." Although Venus's atmosphere and environment might have been Earthlike during the solar system's early history, evidence of the lost oceans remained only in the ratio of deuterium to hydrogen (100 times as much deuterium relative to hydrogen on Venus as on Earth). Earlier, abundant water could have sustained life; the greenhouse effect "wiped out most existing phenomena" on Venus, replacing them with the current furnace-like environment. (ARC Release 82-1; NASA Release 82-9)

January 21: MSFC reported a joint-endeavor agreement signed by NASA's Office of Space Sciences and GTI Corporation of San Diego that might lead to flight of a GTI materials-processing device on four future Shuttle flights. The agreement was a new NASA approach to government-industry partnerships in developing future applications or technologies for space-flown devices. The agreement would have three phases: design by GTI of a low-cost multichamber alloy-solidification furnace operable in low-gravity space; development, testing, and integrating the GTI furnace into the Shuttle; and flight on the Shuttle.

GTI's interest was in the manufacturing in microgravity of space alloys that would not be immiscible on Earth, where many theoretical alloys were not possible because of the density variations of the elements and the effect of gravity on the heavier elements. GTI would fund development and testing; NASA, the integration and flight. (MSFC Release 82-13; NASA Release 82-10)

• Dr. Wubbo Ockels of the Netherlands and Dr. Ulf Merbold of West Germany, the Spacelab payload specialists representing the European Space Agency (ESA), had arrived at MSFC to complete training for the first Spacelab flight set for September 1983, a seven-day joint U.S.-ESA mission to carry out 70 investigations in five different disciplines. Of the four payload specialists in training, one American and one European would actually go into space; the other two would provide ground support to those in orbit. (MSFC Release 82-11)

• Marine Col. Jack Lousma and Air Force Col. C. Gordon Fullerton, the astronauts scheduled to fly the third Shuttle mission, told a news conference in Houston that the flight was now set for March 22. A major objective of the mission would be to see how well the Shuttle systems withstood the extreme heat and cold of space. Sections of the ship exposed to the Sun would experience temperatures up to 250°F; sections in shadow, down to -250°F. The Shuttle would also be subjected to slightly higher dynamic pressures during launch and landing, to gain additional knowledge about its flight characteristics and limits. (*W Post,* Jan 22/81, A-16)

During January: NASA named Dr. Burton I. Edelson, a senior vice president of Comsat General Corporation, as its associate administrator for space science and applications, effective February 14. He would succeed Andrew J. Stofan, who had been in an acting capacity and would remain as advisor until NASA appointed him to another management position. Edelson, before joining Comsat, had been an engineering officer in the U.S. Navy with assignments on the staff of the National Aeronautics and Space Council at the White House and the Office of Naval Research. (NASA anno Jan 13/82; NASA Release 82-7)

February

February 1-5: George Bush, U.S. vice president, unveiled at KSC the flight version of Spacelab, a reusable scientific-research facility designed to fly on the Shuttle.

At the ceremony, Mr. Bush called the Spacelab "an extraordinary engineering achievement. . .the largest cooperative space project ever." Noting that more than 2,000 persons, from 50 European firms and 10 member nations, helped to build it, he added: "If today can be considered Spacelab's birthday, then there are a great many proud parents celebrating. . .Let us continue to be partners," he concluded, "and let me take this opportunity to assure you that we intend to continue our international cooperative programs, just as President Reagan recently reconfirmed the commitment of the United States to a vigorous space program."

The joint venture of NASA and ESA was a cylindrical module built to fit into the Shuttle cargo bay, where both astronaut mission specialists and civilian scientists (payload specialists) would work in a shirtsleeve environment, with a series of unpressurized pallets to support experiments requiring direct exposure to space. The first Spacelab flight, planned for a seven-day Shuttle mission in September 1983, would carry out some 70 investigations in 5 different disciplines.

About 50 firms in ESA's participating nations had supplied parts to ERNO, prime contractor in Bremen, West Germany, for assembly and integration. The program, which cost ESA about $1 billion, would provide NASA, at no charge, with one engineering model and one complete flight version of Spacelab with associated ground-support equipment and some computer software. NASA was buying, for about $300 million, a second flight-model Spacelab to be delivered in mid-1982. MSFC would manage the first mission with ESA and had been in charge of U.S. development of flight-hardware items, such as the transfer tunnel and other operating equipment. MSFC would manage the second and third (NASA-only) missions alone. (Ofc of VP anno, Feb 5/82; NASA Release 82-14; MSFC Release 82-15; ESA Info 6, Feb 2/82, Feb 3/82)

• Dr. Stephen P. Synnott of the Jet Propulsion Laboratory (JPL) announced evidence for the existence of four (possibly as many as six, new satellites of Saturn in data from *Voyager 2*'s Saturn encounter. This brought the number of known Saturnian satellites in between 21 and 23; the two "possible" satellites had only one observation each, and their orbits were not yet confirmed. In 1979, Synnott, a member of the Voyager navigation team, had found two new satellites of Jupiter in images studied after the Voyager encounters.

Some of the new "moons" seemed to be influenced by the gravity of larger moons as well as by Saturn itself: while orbiting between the planet and its larger moons, they would move faster than the large ones because of the strong pull of Saturn's gravity. But, while closing from behind on the larger moons, the gravity of those bodies would pull them into orbit outside the larger moons, where Saturn's pull was weaker, and they would slow and drop back into inner orbit. Scientists called this type of track "horseshoe orbits." (JPL Release Feb 1/82; *W Post,* Feb 3/82, A-6)

February 2: ESA announced that it would develop a more powerful version of its Ariane launcher to "enhance its competitiveness on the space transportation systems market over the period 1986 to 1993 by reducing the cost per kilogram in orbit and providing greater adaptability to user requirements."

Ariane 4 would differ from Ariane 3 in enlargement of the first-stage tanks, increasing on-board propellants from 140 tons to 220 tons; addition of liquid- or solid-fuel boosters in various combinations of two or four; and a new fairing fitted as necessary with a new dual-launch system, use of which was expected to increase steadily. Six versions of this new Ariane would permit launch of a wide range of spacecraft with masses between 1,100 and 4,300 kilograms; maximum lift would be twice that of the initial Ariane 1.

The development schedule called for a demonstration flight late in 1985 and an operational flight beginning early in 1986. Cost was estimated as $241 million U.S. (1981 prices). ESA has given France's Centre National d'Etudes Spatiales (CNES) technical direction and financial management of the development program. (ESA Info 5)

February 3: On the basis of data acquired in support of its mission objectives, NASA declared successful the Viking extended mission conducted from the end of its primary mission in 1976 until August 1980. Viking's mission was to explore the planet Mars using two instrumented orbiters operating in conjunction with two instrumented landers on the surface. Identical spacecraft launched in 1975, each consisting of an orbiter and a lander, began operating at Mars in 1976. The design life of the spacecraft was 90 days following orbit insertion or landing on the Martian surface; however, the Viking flight team found "ingenious ways" to extend the operating lifespans and obtain the maximum possible science data.

When the extended mission began November 15, 1976, Orbiter 2 operated until July 24, 1978 (another 20 months), when a small leak in its attitude-control system depleted its gas supply. Lander 2 operated on the planet's surface for 41 months, until April 12, 1980; its transmitter was turned off when its batteries could no longer hold a charge. Orbiter 1 lasted even longer, a total of 45 months after orbital insertion, and completed is operations August 7, 1980, when its control gas was also exhausted. The end of Orbiter 1 operation was to be the official end of the Viking extended mission; however, Lander 1—designated the Mutch Memorial Station January 7, 1981—was still operating in a continuation automatic-mission mode and providing important science data.

Extended-mission objectives were "to obtain seasonal variations, long-duration sampling for statistically important experiments, and to obtain data not possible during the primary mission due to time constraints or observational limitations." Mission results were "far in excess of those expected." The program now consisted of Lander 1's acquiring and storing imaging, meteorology, and engineering data in a seven-plus day cycle and transmitting to Earth on command. Data should continue until the end of 1994, when the radioisotope thermoelectric generator (RTG) could no longer power the transmitters. (NASA MOR S-815-75-01/02 [postlaunch] Feb 3/82; NASA Release 82-36)

February 5: NASA announced a week-long series of Shuttle checks to verify readiness for launch. Prime and backup crew members would fly a mock liftoff, return to launch site, and descend from orbit to a simulated landing on the dry lake bed at Edwards Air Force Base, California. The first 99 hours would be checkout of individual orbiter systems (electrical distribution, environmental control, instrumentation, flight control, and propulsion), the external tank (power, instrumentation, range safety, and tumble-valve systems), and solid-fuel rocket boosters (hydraulic, electrical, instrumentation, and range-safety systems) as well as critical electrical and mechanical connections between Shuttle elements.

The second part of the tests would simulate portions of the mission, the launch, a return-to-launch-site abort with the orbiter's system in control, and descent from orbit. (NASA Release 82-19)

February 8: The Office of Science and Technology Policy in the Executive Office of the President released budget figures showing funds for all federal research and development as $43 billion in FY83, $4.2 billion over FY82. NASA's portion of the research and development (R&D) budget ($6.5 billion for FY83, $672 million over FY82) would "assure timely transition of the space shuttle to an operational system [and] continue the highest priority research and space exploration projects," namely the Space Telescope, the gamma-ray observatory, and the Galileo mission to Jupiter. (NASA anno, Feb 8/82)

—James M. Beggs, NASA's administrator, said in a budget message that "given the tightly constrained fiscal environment...I believe we did well....[T]hough there are no new starts, we are continuing with most of our ongoing activity in what we consider to be a balanced way." (Text, Feb 8/82)

February 10: The *Washington Post* reported that the U.S. Air Force would have to build a $40 million windscreen around its Space Shuttle launch pad at Vandenberg Air Force Base in California to protect the orbiter while the external tank was being attached.

The Air Force was building a second launch complex in California to put the Shuttle into north-south or polar orbit that, combined with Earth's rotation, would carry it over the entire surface of the Earth. This would not be possible at Cape Canaveral for reasons of safety; from Vandenberg, however, the orbiter's route would be over the Pacific ocean.

Hans Mark, deputy NASA administrator, told the House Committee on Science and Technology that the windscreen would be a huge three-sided sheet of metal around the launch pad to protect the orbiter from gusts while attaching the fuel tank. Winds off the Pacific at that location averaged 9 mph year-round and up to 47 mph from January through March, more than enough to break connections between Shuttle and tank. At the Cape, mating took place inside the Vehicle Assembly Building (VAB); Vandenberg had no such building. (*W Post,* Feb 10/82, A-5)

February 16: NASA announced that Donald K. (Deke) Slayton, 58, last of the Mercury Seven astronauts selected in 1958, would leave after 23 years with the space agency. He had retired from NASA in February 1981 but had worked since that time on a temporary basis as a retired annuitant managing the Space Shuttle orbital flight tests at Johnson Space Center (JSC). He planned to work as a consultant to Aerospace Corporation, El Segundo, Calif., and to Space Sciences Inc. of Houston, Tex.

Slayton joined the U.S. Air Force in 1942, flying 56 combat missions in Europe and 7 over Japan as a B-25 bomber pilot; he was a test pilot at Edwards Air Force Base when selected as a Mercury astronaut. Grounded in August 1959 because of a suspected heart condition, he was later approved for flight and was part of the U.S. crew in the Apollo-Soyuz mission of July 1975. (NASA Release 82-23)

—The *New York Times* said that friends and associates "wondered why matters were not handled better": NASA never responded to a JSC request for another year's extension of Slayton's employment. His departure reduced the number of the astronaut corps to 79. Several were doctors or scientists without piloting skills; 6 were women. "Many," the *New York Times* added, "are young enough to be Slayton's children." There had been 108 U.S. astronauts "but only one Original Seven." (*NY Times,* Feb 2/82, A-14; Feb 28/82, 30; *W Post,* Feb 18/82, A-21)

• Presidential Science Adviser Dr. George A. Keyworth announced the names of 13 U.S. scientists and engineers to a White House Science Council.

Chairman of the council was Solomon J. Buchsbaum, executive vice president, Bell Laboratories; vice chairman was Edward Frieman, vice president, Science Applications Inc. Other members were Harold M. Agnew, president, General Atomic Company; John Bardeen, emeritus professor, engineering and physics, University of Illinois; D. Allan Bromley, professor of physics, Yale University (chairman, American Association for the Advancement of Science); George A. Cowan, senior fellow, Los Alamos Scientific

Laboratory; Edward E. David, president, Exxon Research and Engineering (former science adviser to President Nixon); Donald S. Frederickson, resident fellow, National Academy of Sciences (former director, National Institutes of Health—NIH); Paul E. Gray, president, Massachusetts Institute of Technology (MIT); Robert O.. Hunter, president, Western Research Company; Arthur K. Kerman, director, MIT Center for Theoretical Physics; David Packard, chairman, Hewlett Packard; Edward Teller, Hoover Institute, Stanford University. Lt. Col. Thomas H. Johnson, special assistant to Keyworth, said that the council would meet up to six times per year and would study issues with "significant technical components"; it was not meant to be demographically representative of U.S. science but rather would consist of "people with first-rate technical credentials and excellent judgment."

The *New York Times* noted that in an interview last summer Keyworth said that "good judgment is hard to find" among scientists because "our profession is one of the few where arrogance has been condoned if not nurtured."

A presidential science advisory committee formed in 1957 was abolished in 1977 by President Nixon, angry when some of its members took public stands against his policies. The new council, known by its initials WHSC (whisk), was meant to be more modest, the *New York Times* said. It would have its first meeting in March. (OST Policy Release, 2-16-82; *NY Times,* Feb 18/82, A-12)

February 19: A JSC release described a space operations center (SOC) concept completed by a special JSC study team. A manned center in space to exploit the Shuttle and allow incremental growth was the "essential next step in exploitation of space"; it would become a space-base and marshaling yard for large and complex payloads, including an upper-stage propulsion system in low Earth orbit. It would serve as "garage space" for reusable cryogenic stages for easier access, lowering costs of geosynchronous space operations. It could be a manned base with Department of Defense (DOD) military capabilities or a manned platform for science and applications research. It could provide a manufacturing facility in a weightless environment.

The JSC design was for an SOC operating continuously, with maintenance and resupply, for 10 years; parts would be delivered and assembled by the Shuttle orbiter in a low Earth orbit (230 to 280 statute miles). An 8- to 12-man center, about 435 feet long tip to tip, would weigh about 245,000 pounds. Initial launch would put into orbit an energy section, a short cylinder carrying two booms with solar arrays, antennas, reaction-control system, and radiators, weighing in total between 34,000 and 43,000 pounds. A second launch would bring a command module to be joined to the energy section, completing phase 1; this module would have one docking and nine berthing ports, airlocks, command station, guidance and control, data management, open-loop lift support, and accommodations for two (but able to support a crew of four, in an emergency). Weight would be between 40,000 and 50,000 pounds. The next launch would bring a second command module to the other end of the energy section.

Each of the next two launches would bring a habitat module able to accommodate a crew of four; the two habitats would provide emergency accommodations and life support for a crew of eight. Each habitat would weigh between 25,000 and 28,000 pounds.

After phase 3, the SOC would be ready for long-term manned occupations by eight to twelve persons; the platform could now handle full flight support, satellite servicing, and space construction. (JSC Release 82-009; *AvWk,* Feb 15/82)

February 22: JPL reported the selection of Martin Marietta Aerospace for negotiations on study of spacecraft suitable for a Venus radar-mapping mission. Hughes Aircraft, which also submitted a proposal, had been selected in November 1981 as the radar-instrument study contractor for the mission. (NASA Release 82-26)

February 26: NASA launched *Westar 4,* first of a series of second-generation 24-transponder domestic commercial communications satellites built by Space Communications Company for Western Union, from ESMC on a Delta into a suborbital trajectory. An apogee kick motor would put it into orbit at 99°W, 19,300 nautical miles over the equator to relay voice, data, video, and facsimile communications to an area covering the United States from Hawaii to the Virgin Islands.

Westar 4, with a design life of 10 years would join three other Western Union communications satellites: *Westar 1* and *Westar 2,* launched in 1974, and *Westar 3* launched in 1979. It was twice their size and had four times their capacity. (NASA Release 82-17; NASA MOR O-492-203-82-06 [prelaunch] Feb 25/82, [postlaunch] May 13/82)

March

March 1: A robot craft, *Venera 13*, fifth from the Soviet Union to land on Venus, sent the first color pictures of that planet's surface and scooped up a soil sample for the most detailed analysis to date of Venus chemistry, Tass reported.

A module detached from *Venera 13* plunged through Venus's dense carbon dioxide atmosphere to an area called Phoebe, south of its equator. A *Venera 14* identical lander was scheduled to arrive March 5 at an area east of the Phoebe site. Soviet mission planners had consulted scientists and radar maps from the U.S. Pioneer Venus project in deciding where to aim the Veneras; they promised to share Venera data at future international scientific conferences. U.S. scientists familiar with the Soviet plans said that the Veneras were equipped for "much more sophisticated" studies of Venus soil chemistry than previous probes; these were the first craft able to drill into the crust, extract a sample, and analyze it, as the Vikings had on Mars.

Pioneer Venus 1 had been orbiting Venus since December 1978, mapping the planet by radar. *Pioneer Venus 2* deployed five probes to sample the planet's atmosphere, only one of them surviving to transmit an hour of data on surface temperatures. Soviet studies of Mars failed, but *Venera 9* and *Venera 10* in 1975 transmitted the first images from the Venus surface, and *Venera 11* and *Venera 12* in 1978 collected data on radioactive soil. After separation and landing, *Venera 13* had survived to send surface data relayed by the mother ship for 127 minutes. (FBIS, Moscow, Tass in English, Mar 1/82, Mar 2/82; *NY Times*, Mar 2/82, C-1; *W Post*, Mar 2/82, A-10)

• NASA announced the crews for the fourth, fifth, and sixth Shuttle flights. On STS-4, Thomas K. Mattingly would be commander, and Henry W. Hartsfield, pilot. Scheduled for launch early in July, the seven day STS-4 would be the last of four orbital flight tests to verify Shuttle hardware and software. Mattingly, 47, orbited the Moon 10 years ago on *Apollo 16:* Hartsfield, 48, was a rookie.

STS-5, a five-day mission planned for mid-November to deploy commercial communications satellites, would be the first to use mission-specialist astronauts. Vance D. Brand, 50, who was command-module pilot on 1975's *Apollo-Soyuz* rendezvous, would be mission commander. This would be the first spaceflight for Robert F. Overmyer, 45, the pilot. Mission specialists would be Dr. Joseph P. Allen and Dr. William B. Lenoir. Columbia would be the spacecraft for both STS-4 and STS-5.

STS-6, planned for January 1983, would be the first flight of the orbiter

Challenger, a two-day mission to deploy NASA's Tracking and Data Relay Satellite System (TDRSS), one of an eventual two-satellite system providing comprehensive voice and data coverage between orbiting shuttles and the ground. Commander would be Paul J. Weitz, 49, who was pilot on *Skylab 1*; copilot would be U.S. Air Force Col. Karol J. Bobko, 44, another rookie. Donald H. Peterson and Dr. Story Musgrave would fly as mission specialists.

NASA would no longer assign Shuttle backup crews; its pool of experienced pilots at JSC would readily permit interchange of crewmen. (NASA Release 82-33; JSC Release 82-012; *W Post,* Mar 2/82, A-9)

March 2: NASA said that it would change the Shuttle's solid-fuel rocket boosters, reducing weight and increasing payload capability about 6,000 pounds (2,720 kilograms) by replacing 8 of the 11 metal booster motor-case segments with 4 segments made of composite filament. Other components, such as the metal forward and aft domes and the external-tank attachment area of the metal case, would remain. NASA had issued a request for proposals to develop the filament-wound case.

The lightweight case would be needed in high-performance launches from Vandenberg Air Force Base into near-polar orbit, helping to compensate for the loss of lift in west coast launches that could not use Earth's rotation to boost their velocity. The lightweight case could also boost extra-heavy payloads into orbit from KSC. First use of the motor would be in 1985. After plan approval NASA would have Thiokol Corporation make test firings directed by MSFC of solid-fuel rocket motors with filament-wound casings. (NASA Release 82-32; MSFC Release 82-19)

• ARC reported changes in the Shuttle's thermal protection system. New materials developed at ARC, stronger, lighter, and costing less than the original ones, would be installed gradually on the four orbiters over the next few years. Some new materials had been installed on Columbia; others were planned for Challenger, which was under construction for delivery this summer, and for Discovery and Atlantis, scheduled for delivery in 1983 and 1984.

Thermal protection of the Shuttle consisted of tiles and other heat-resistant materials applied to the outside to protect its aluminum and epoxy-graphite skin from extreme temperatures ranging from-170°F (-110°C) in space up to 3,000°F (1,648°C) during reentry. A growing knowledge of reentry problems had brought changes in the system: the original materials had served beyond expectations, but research had provided new answers. Columbia now had a glass-fiber quilt over 20 square feet of its elevon cove, replacing the felt reusable insulation that was inadequate to the 1,500°F (816°C) temperature in that area.

This new material would be used on Challenger, Discovery, and Atlantis. The new orbiters would also use a fibrous refractory composite insulation lighter and stronger than the current tiles that would save about 1,000 pounds on Discovery and Atlantis; the new insulation was developed by ARC and manufactured by Lockheed. (ARC Release 82-05)

• ARC noted that *Pioneer 10* had been in space 10 years as of March 2. Launched in 1972, the first spacecraft to fly by Jupiter had crossed the asteroid belt, survived the radiation near Jupiter, and operated almost flawlessly on its way out of Earth's solar system. It had traveled 3.27 billion miles, received more than 40 thousand commands, and transmitted more than 125 billion bits of scientific data. Now more than halfway between orbits Uranus and Neptune, 2.5 billion miles from the Sun, Pioneer was currently defining the extent of the solar atmosphere, a bubble in the interstellar medium called the heliosphere.

By June 1983, Pioneer would be at a point outside all of the planets of Earth's system, in their current positions. Its transmissions, traveling at the speed of light, already needed 3 hours and 42 minutes to reach the operations center at ARC, and this time was increasing 1 minute every four days. Nearly all of its systems were still performing well; its magnetometer shut down in 1975, but experimenters could use correlations from five other instruments. Data showed that the heliosphere was far larger than predicted; Pioneer was seeking the boundary between the solar atmosphere and true interstellar space, probably 5 to 10 billion miles from the Sun. Experts at the Deep Space Network hoped to track Pioneer as far out as 5 billion miles.

The solar wind had been expected to slow with distance from the Sun, but this had not happened; almost no motion energy was lost as heat. Turbulence in the heliosphere was caused by solar storms, not solar-wind collisions. As solar storms increased in strength, the heliosphere seemed to alter shape, more oval at the Sun's equator than its roundness at solar minimum. *Pioneer 10's* sun-sensor could no longer furnish position data because of its great distance from the Sun and the resultant decline in solar brightness. However, mission controllers would use the Pioneer camera (photopolarimeter) to make star maps that would provide the rotation and attitude data needed to define Pioneer's position. (ARC Release 82-04; NASA Release 82-34)

March 4: NASA launched *Intelsat 5-F4* for the International Telecommunications Satellite Organization (INTELSAT) from Cape Canaveral at 7:23 p.m. EST on an Atlas Centaur into a transfer orbit with 35,953-kilometer apogee, 165. 8-kilometer perigee, and 24° inclination. INTELSAT would fire an apogee motor to put the communications satellite into a near-geosynchronous orbit for testing before moving it over the Indian Ocean to provide communications between Europe, the MIddle East, and the Far East.

This fourth of the Intelsat 5 series built by Ford Aerospace had a capacity of 12,000 voice circuits plus two television channels. INTELSAT's global system consisted of a space segment (10 satellites in synchronous orbit) and a ground segment (295 communications antennas at 242 ground stations in 129 countries and territories). The combined system provided more than 800 links between ground stations, with about 8,500 international voice circuits in full-time use, plus telegraph, telex, and television. (NASA MOR-491-203-82-04 [prelaunch] Feb 25/82, [postlaunch] Mar 25/82; INTELSAT Release 82-4-1)

March 10: The Observatory for Geophysical Monitoring of Climatic Change at Mauna Loa, Hawaii, on March 3 said that scientists doing a routine weather scan had discovered a huge cloud orbiting the Earth and had tracked it for five weeks, but could not explain what it was. The cloud, about 10 to 12 miles high (just above the flight paths of most commercial jets), had probably circled the Earth four or five times. The best guess was that it resulted from an unnoticed volcanic eruption.

On March 10 NASA said that the "mystery cloud" detected over Hawaii definitely came from a volcanic eruption. Chemical analysis of samples showed that it consisted entirely of sulfuric acid, ruling out nuclear explosion or a meteorite, either of which would have produced fragments of rocky material. The cloud had been measured from the equator to Germany, about 50-f8-N, with the heaviest concentration of particles found by a Langley Research Center (LaRC) research aircraft at 20°N.

No volcanic source for the cloud had been identified. Scientists from ARC were studying atmosphere-circulation patterns to see how gas from an equatorial source could spread over the northern half of the Earth. Sulfur gases injected into the stratosphere by volcanic eruptions tended to remain for months, as there would be no rain to remove them; changing gradually into drops of sulfuric acid, the volcanic cloud would increase over time in depth and density as more sulfur compounds arrived. Highly reflective clouds of the acid, like those on Venus, could prevent solar heat from reaching the ground, but the current cloud apparently had not produced any climate changes.

A NASA research plane flying from Wallops Flight Center (WFC) to Costa Rica carried a remote-sensing laser radar that mapped the cloud content while doing previously scheduled data-gathering on local volcanoes. LaRC would continue taking radar data; also, an ARC U-2 aircraft would make follow-on flights beginning March 23. (ARC Release 82-11; LaRC Release 82-12; NASA Release 82-45; *W Post*, Mar 6/82, A-4; *NY Times*, Mar 7/82, P-24)

March 17-30: NASA began the countdown for the third test flight of Space Shuttle orbiter Columbia scheduled for launch March 22, although runways at Edwards Air Force Base in California were too rainsoaked to permit an emergency landing. STS-3 would use a runway at White Sands, N.M., for landing. Marine Corps Col. Jack Lousma and U.S. Air Force Col. C. Gordon Fullerton had frequently practiced landing jet aircraft at White Sands, where the two gypsum-based desert runways were as wide and almost as long as the seven mile-long runway at Edwards. They had also practiced landing on a three-mile-long concrete runway at KSC, to be used only in case of losing an engine during the first four minutes of flight from that location.

Heavy rains all day March 17 left more than an inch of water on the "dry" lake beds at Edwards, where Columbia had landed after its first two flights. NASA said that it was cheaper to move landing equipment to White Sands than to postpone the flight until Edwards dried out: each day of delay in launching the Shuttle cost the agency $3 million. A special landing team immediately began loading support equipment on a 23-car train that would carry it the 1,000 miles from Edwards to White Sands. The equipment should be in place late on Sunday, March 21, ready for use should an emergency occur after liftoff.

The upcoming flight, third of a series of four test flights before the Shuttle began carrying payloads into space later in 1982, would subject the spacecraft to temperature extremes to see how it endured long exposure to dark and light. It would also include further tests of the 50-foot robot arm designed to handle Shuttle payloads. Exposure of the Shuttle tail would test pumping of fuel and restarting rear engines under extremely high or low temperatures.

Exposure of the 65-foot-long cargo bay carrying more than 21,000 pounds of instruments and experiments to the extreme heat encountered in space would show how materials carried into space over the next 10 years would survive. The open cargo bay aimed at the Sun would also seek exposure to solar flares, for which scientists were still seeking explanations.

Lousma and Fullerton flew from JSC at Houston to Patrick Air Force Base, Fla., near KSC in T-38 jet trainers Saturday, March 20, and planned to spend most of Sunday in preflight briefings. KSC said that the countdown had been virtually trouble-free and ahead of schedule.

Liftoff from pad A, launch complex 39, took place Monday, March 22, at 10:59 a.m. EST after an hour's delay caused by failure of a protection circuit in the controller for the heated nitrogen purge of the main engines, required before introduction of cryogenic fuel. Countdown stopped for reestablishment of heater control. Initial orbit elements were 240-kilometer apogee and perigee, 89-minute period, and 38° inclination. Operations began in the fourth hours of flight with the opening of payload doors, removal of ejection suits, and activation of the Office of Space Sciences experiment package (OSS-1). Later reports indicated that the crew suffered from motion sickness after the exertion of removing the space suits; incidence of motion sickness had been less on Mercury and Gemini when astronauts had less area to move in, and both Soviet and U.S. crews had taken time on longer flights to get used to weightlessness before active exertion.

Scheduled for the second day was deployment of the robot arm; for the third was practice in grappling payload packages and extending a set of sensors over the edges of the cargo bay to measure plasma (electrically charged gases) in Earth orbit. The fourth and fifth days would see further tests of the arm, more thermal testing, and two brief ignitions of the maneuvering rockets to see how they performed after long periods of cold. The sixth day would have more thermal tests and experiments on solar radiation; the seventh day would be for shutdown and landing preparations.

All activities planned for day one were accomplished; OSS-1 experimenters reported "excellent data." Thermal attitude tail-to-sun prevailed throughout the sleep period. A survey with the remote manipulator system (RMS) camera showed several low-temperature white tiles missing or damaged on the nosecone. Also, three pieces of black tiles (about 1 1/2 tiles) had been found 700 feet south of the launch pad; others had been found on and near the beach. All had been sent to JSC for identification and analysis.

On Tuesday, the first day in orbit, the "wrist" camera on the manipulator arm went dark, and flight directors postponed the critical grappling test to devise a way to do the test without it. That camera served as the crew's eyes whenever the end of the arm took hold of an object in the cargo bay. Planned use was to raise an 82-pound package and move it around the bay; the instrument inside would measure electrical disturbances caused by the spacecraft and its motion through the electronically charged ionosphere. Instead, the crew extended the robot arm far over the cargo bay and used the "elbow" camera to transmit "the best television ever seen of the earth" from 150 miles up.

The crew turned on the monodisperse latex reactor [see January 19] for 14 hours; the solution would be stirred every 30 minutes for the rest of the mission. Ground control changed the activity schedule to allow for crew rest and troubleshooting; day four activities would be done on day three and vice versa, a prelaunch-planned option. Problems were reported with the environmental control and life-support systems and with the waste-control "slinger"; NASA said it had initiated "backup procedures."

Besides suffering from motion sickness, Lousma had been kept awake by loud radio static, probably from a Soviet radar at Rostov on the Black Sea, said to be the most powerful in the world; it was called Woodpecker by radio ham operators because of its noise, heard from Spain to parts of China.

STS-3 lost three main radio links to Earth Friday, March 25, through the Shuttle's transponders that locked on and amplified ground signals and carried nearly all data on Shuttle condition and its speed and location. Two ultra-high-frequency (UHF) radio channels carried voice transmission, however, and the astronauts were using the remaining transponder, a backup UHF voice line, and the FM-radio line to relay information to Earth.

Gene Kranz, deputy flight director at JSC, said that the mission would go full time unless the high-power transponder link was lost. A premature end to the mission would require a landing somewhere other than at White Sands, because of bad weather with overcast skies and high winds that blew dust across the runways and created haze thick enough to obscure the landing site.

Two days away from the scheduled landing, the crew had completed all the thermal tests on Columbia: baking tail, nose, and top in unimpeded sunlight and chilling the same parts in the icy cold of space for hours. They had restarted the Shuttle engines hot and cold, opened and closed cargo-bay doors under both conditions, and repeatedly tested the mechanical arm under varying conditions with excellent results.

In the last possible opportunity, less than a day before the end of the mission, the crew pointed their solar telescope directly at the Sun and got a solar flare (an event on the Sun's surface they could not have predicted) "almost as if it were planned." Dr. Robert Novick of Columbia University, where the X-ray polarimeter was built, said that this was the first time that an instrument in space with this sensitivity had witnessed a solar flare.

On Sunday night, March 28, the crew went to sleep two hours earlier than usual in preparation for landing Monday. About 40 minutes before the time scheduled for touchdown, astronaut John Young in a Grumman Gulfstream jet tried a practice landing on the White Sands runway and found visibility completely obscured. The Columbia crewmen were about to fire rockets to begin descent. "That's the first time I've seen it this bad," Young told mission control in Houston. "I think we ought to knock this thing off." Less than 15 minutes later, mission control ordered a day's delay. The two astronauts unpacked to await word from mission control on where and when they would return.

Landing finally occurred at 9:04 a.m. MST on Tuesday, March 30, on a dry lake bed at White Sands. Touchdown point was 1,092 feet past the runway threshold; rollout distance was 13,732 feet. The crew left the orbiter 45 minutes after landing, and postflight operations proceeded without incident. (NASA Release 82-29; NASA MOR M-989-82-03 [prelaunch] Mar 13/82, [postlaunch] May 5/82; NASA MOR E-835-03-82-01, OSS-1, [prelaunch] Mar 17/82, [postlaunch] Sept 20/82; *Spacewarn* SPX-341; *NASA Dly Actv Rpt,* Mar 24, 25, 29/82; *NY Times,* Mar 18/82, A-18; Mar 20, 7; Mar 21, 1; Mar 22, A-1; Mar 30, A-1; *W Post,* Mar 19/82, A-7; Mar 21, A-1; Mar 22, A-1; Mar 25, A-2; Mar 27, A-2; Mar 29, A-1; Mar 30, A-1)

March 25: MSFC reported *Heao 2,* second in a series of three high-energy astronomy observatories launched in the late 1970s and the last to reenter, fell from orbit at 1:27 a.m. CST and burned up in the atmosphere. John Stone, project manager a MSFC, said that tracking stations indicated that it broke up over the South Pacific east of Australia. *Heao 1* had reentered in 1979; *Heao 3,* in December 1981. *Heao 2* had not been operational for almost a year, as it had expended its control-gas supply in April 1981, so that it could not maintain attitude and had to be powered down.

Launched in September 1979 and nicknamed Einstein, *Heao 2* had operated for nearly 2 1/2 years, carrying the largest X-ray telescope ever built. It had made detailed imaging and spectroscopic observations of about 300 known X-ray sources and discovered thousands of faint new ones. It also made the first X-ray photographs of supernova remnants, pulsars, galactic X-ray sources, and diffuse emissions from galactic clusters. Scientists said it would take three years longer to analyze the data from the Heaos. (MSFC Release 82-31)

During March: NASA said that Dr. John F. McCarthy, director of Lewis Research Center (LeRC) would return July 1 to MIT as professor of aeronautics and astronautics. Before becoming director at LeRC in October 1978, McCarthy directed MIT's center for space research. From 1962 to 1971 he was with North American Rockwell. (NASA anno, Mar 2/82; NASA Release 82-35)

—Daniel J. Fink, senior vice president at General Electric Company, was named chairman of the NASA advisory council by James M. Beggs, administrator. He assumed the chair March 11. As general manager of General Electric's space division, Fink had received the Collier Trophy for his contributions to the Landsat program. (NASA Release 82-39)

—Administrator Beggs changed the titles of officials in charge of three programs at NASA Headquarters: Harriett G. Jenkins would be assistant administrator for equal opportunity; Stuart J. Evans, assistant administrator for procurement; John F. Murphy, assistant administrator for legislative affairs. (NASA anno Mar 2/82)

—A Thomas Young, director of GSFC, would leave NASA March 20 to become vice president of research and engineering at Martin Marietta Aerospace. He had joined the Langley laboratory in 1961 and in 1975 become Viking mission director. He was deputy director of ARC from February 1979 until taking over at GSFC in February 1980. Acting director at GSFC until the appointment of a successor would be Dr. Leslie H. Meredith, who had been director of applications there since 1976. (NASA annos Mar 1/82, Mar 23/82; NASA Releases 82-31, 82-48)

—Andrew J. Stofan, who was acting associate administrator for space science at NASA Headquarters until Dr. Burton Edelson took over last month, would become director of LeRC, succeeding Dr. John McCarthy as of July 1. Before assignment to Headquarters in 1978 as deputy associate administrator for space science, Stofan was director of launch vehicles at LeRC, where he had begun as a research engineer in 1985. (NASA Release 82-47; LeRC Release 82-14)

April

April 2: The *Los Angeles Times* said that Dr. Bruce Murray would resign later in 1982 as director of JPL. In "an emotional speech" televised to all 5,000 JPL employees, Murray said that he was leaving to move on "to the next phase of my own professional career." He reminded his audience that from the time he arrived at JPL he planned to stay for only 5 to 10 years. The announcement came at the start of his seventh year as director; he had served since April 1, 1976. The California Institute of Technology (CalTech), operator of JPL under contract to NASA, had not chosen a successor. (*LA Times*, Apr 3/82, 1)

April 9: NASA announced the selection of American Airlines to negotiate a contract for a new helicopter-simulation system to be installed at ARC, funded by the U.S. Army and used by both agencies.

The $16 million system, designed to duplicate cockpit configurations and flight handling of helicopters, would aid in rotorcraft design and allow simulation of experiments, flight tests, and evaluation of improvements in basic helicopter technology. Pilots and engineers could simulate sight, sound, and motion of helicopter flight, using the system either stationary or in the vertical-motion simulator. (NASA Release 82-52; ARC Release 82-13)

April 10: NASA launched the Indian Department of Space payload INSAT-1A from ESMC at 1:48 a.m. EST on a Delta into an orbit with 35,985-kilometer apogee, 166-kilometer perigee, and 28.4° inclination. An apogee boost motor fired April 11 and 12 put *Insat 1* into synchronous orbit at 74°E over the equator. Attempts to release the C-band (uplink) antenna were unsuccessful; ground control deployed it by blasting it with the reaction-control jets. The S-band (downlink) antenna deployed without difficulty, but the solar sail would not release as planned. (NASA Release 82-44; NASA MOR 0-492-214-82-01 [prelaunch] Mar 30/82, [postlaunch] May 18/82; *C Trib,* Apr 12/82, 4)

April 14: Christopher C. Kraft, Jr., director of JSC since 1972, said that he would retire from NASA after the fifth (and first operational) Shuttle flight, now scheduled for November. He had begun working at the Langley laboratory of the National Advisory Committee for Aeronautics (NACA) in 1945.

When NASA was established in 1958, he was selected as an original member of the space task group to manage the Mercury project: that group was the nucleus of NASA's manned spacecraft center, which became JSC in 1973. Kraft was flight director of all the Mercury missions and many of the Gemini missions; in 1972 he succeeded Dr. Robert Gilruth, who had been the first director of JSC. Kraft said he had no definite plans for the future. (NASA Release 82-62; *NY Times*, Apr 15/82, B-4; *W Post*, Apr 15/82, D-2)

• NASA reported that its Kuiper airborne observatory (a Lockheed C-141 Starlifter aircraft carrying a 36-inch infrared reflector telescope) had captured an image of Columbia's reentry heating pattern at the end of its third spaceflight.

The procedure, known as IRIS (infrared imagery of Shuttle), was part of an orbiter experiment program using the Shuttle to collect data of value in advancing aerospace technology. The Kuiper plane, operated by ARC, had taken off for observation without knowing whether the Shuttle would land at White Sands or KSC; an update 15 minutes before landing ensured success. A similar attempt on the first flight had failed. (NASA Release 82-56; ARC Release 82-14)

April 15: NASA said that it had turned off the SAGE (stratospheric aerosol and gas experiment) after the spacecraft's battery failed. A joint project of LaRC and GSFC, SAGE was the first to perform extensive vertical measurements of aerosols in the stratosphere and first to detect volcanic dust in that region, 9 to 40 kilometers (6 to 25 miles) above Earth's surface. Launched from WFC in February 1979 with a 1-year design lifetime, it had tracked plumes from five volcanic eruptions, including Mt. St. Helens, and had mapped ozone in the Earth's atmosphere from data taken during more than 13,000 sunrises and sunsets. Its orbit was not expected to decay until about 1984, when it would burn up during reentry. (NASA Release 82-59)

• ESA said that it would begin a follow-on program with Spacelab. Financial contributions from member states for this purpose had reached 80% of the goal April 15, permitting work to start immediately. Part of the new program would be development of a European retrievable carrier (EURECA) to be launched and retrieved by the Space Shuttle as well as a core payload for the first mission consisting of microgravity research emphasizing material and life sciences, with first flight scheduled for the end of 1986.

Weighing about 1,500 kilograms, EURECA would have a design life of six months or more in orbit, providing services for its payload including electrical power and heat protection. Its low gravity-disturbance level would be essential to microgravity research. After deployment, an on-board propulsion unit would put it in a higher orbit with less drag on its large solar arrays. Once in orbit, its experiments, although highly automated, would be operated by remote control and monitored from the ground. It would reassume low orbit for recovery by the Shuttle and return to Earth for refurbishment. (ESA Info 12)

April 16: NASA Administrator James M. Beggs announced the reorganization of Space Shuttle management. Maj. Gen. James A. Abrahamson, who had joined NASA in November 1981 on loan from the U.S. Air Force, would be associate administrator for the Space Transportation System (STS). He would take over the office of Space Shuttle operations formerly headed by Stanley Weiss, named chief engineer for NASA to succeed Walter Williams. The combined offices of space transportation systems and space transportation operations, effective May 15, would be responsible for the final Shuttle development flight and the operational flights that followed and for procuring more shuttles and expendable launch vehicles.

Gerald D. Griffin, formerly Apollo flight director, was named director of JSC to succeed Dr. Chirstopher C. Kraft, who would retire later in 1982. Griffin, who had also been deputy director at KSC and Dryden Flight Research Center (DFRC) and had held other positions at NASA Headquarters, had left in August 1981 to become vice president of Scott Science and Technology. He would return to NASA Headquarters briefly to assist Abrahamson. (NASA anno Apr 16/82; NASA Release 82-58; NY Times, Apr 19/82, A-7)

April 19: The Soviet news agency Tass reported that the Soviet Union had launched space station *Salyut 7* apparently to replace *Salyut 6*, home in space for cosmonauts since September 1977, for a joint French-Soviet manned flight this summer. Orbital parameters were 278-kilometer apogee, 219-kilometer perigee (between 136 and 172 miles), 89.2 minute period, 51.5° inclination. Agence France-Presse said that a Soviet-French team would shortly be launched in a *Soyuz-T* craft to link up with *Salyut 7*.

Lt. Col. Jean-Loup Chretien, France's "spacecraft" who had had "intensive training in Soviet facilities" with his backup, Col. Patrick Baudry, would fly to *Salyut 7* with two Soviet cosmonauts about June 22. The report said that the French preferred the neutral word spacenaut because the Soviets used "cosmonaut" and the Americans "astronaut." (FBIS, Tass Intl Svc in Russian, Apr 19/82; Paris AFP in English, Apr 20/82; *W Post*, Apr 20/82, A-18)

The *New York Times* reporter in Moscow said that the French-Soviet mission would be the first launch of a noncommunist in a Soviet spacecraft and the first East-West spaceflight since Apollo-Soyuz in 1975. Flight commander Vladimir Dzhanibekov and Aleksandr Ivanchenkov would occupy *Salyut 7* a few days earlier. An three-man crew on another spacecraft—two cosmonauts, Leonid Kizim and Vladimir Solovyev, and Jean-Loup Chretien—would join them. The Soviet Union had released few details on the mission.

The USSR's goal was said to be deployment of a 12-man station weighing more than 100 tons, permanently occupied by rotating crews. *Salyut 6's* lifetime had included two "marathon missions" of 185 and 175 days; the U.S. record was 84 days during the Skylab program of 1973 and 1974. Soon after the last mission on *Salyut 6* the Soviet Union had sent a large craft (*Cosmos 1267*) to link with it and test "methods of assembly of orbital complexes of great size and weight." No one said what would become of the Salyut-Cosmos; Western observers believed that the assembly, even with a combined weight of 36 tons could safely burn up on reentry. The U.S. Skylab that scattered debris on western Australia in 1979 during its uncontrolled plunge to Earth had weighed 77.5 tons. (FBIS Moscow Tass Intl Svc in Russian, Apr 19/83; *NY Times*, Apr 21/82, A-12)

April 20: NASA's Solar Max satellite had detected an 18-month decrease in solar-energy output that might have caused an unusually harsh winter in 1981 and 1982, said JPL. In the first direct observation of cause-and-effect between solar output and changes in Earth's climate, a solar telescope—Solar Max's active-cavity radiometer irradiance monitor—recorded a steady decrease from February 1980 to August 1981 of a tenth of 1% in total solar energy reaching Earth.

Systematic increases or decreases as small as 0.5% over a century had produced vast changes in Earth's climate: the "Maunder minimum" in the 17th century, when sunspot activity almost vanished, had coincided with a period known as Europe's little ice age. A 1% decrease could lower mean global temperature by more than 1,000 (2°F), and less than 10% decrease could freeze Earth's entire surface. Earth lifeforms existed in the bioshell, an area 10 kilometers (6.2 miles) on either side of mean sea level, with temperatures fed by solar-energy input and interaction between atmosphere, ocean, and land masses. The time needed to cool down the atmosphere and ocean would allay short-term changes in solar input. JPL's Dr. Richard C. Willson noted that "if you turned off the sun tomorrow, you wouldn't see its full effects on earth for three years."

Solar activity peaked about every 11 years. The current cycle peaked about the time Solar Max was launched early in 1980; the decrease might represent the general decline since then but might also indicate a longer term lowering of solar input. (Telescope at the High-Altitude Observatory, Boulder, Colo., had recorded images of what seemed to be a shrinking sun that might have grown as much as a tenth of 1% smaller every 100 years for the last four centuries.) Solar Max had lost pointing capability in December 1980, and only three of its seven instruments were still returning data. It had been designed for retrieval by the Shuttle, and NASA was seeking authorization for a Solar Max repair mission. (NASA Release 82-57; *W Post,* Apr 20/82, A-6)

During April: Dr. Noel W. Hinners, director of the Smithsonian's National Air and Space Museum, would become director of GSFC June 14, succeeding A. Thomas Young. Dr. Hinners was associate administrator for space science at NASA Headquarters from June 1974 to April 1979, when he took over at the museum; he had also been director of lunar programs in NASA's Office of Space Sciences. He had joined NASA in 1972 as deputy director and chief scientist of Apollo lunar exploration. (NASA anno Apr 1/82; NASA Release 82-49)

—Col. Joe H. Engle, commander of STS-2 in November 1981, was temporarily assigned to the STS office at NASA Headquarters in conjunction with recent organization changes. As deputy associate administrator for manned space flight under Gen. James A. Abrahamson, his special experience would help simplify the integration process for Shuttle users and ensure maximum use of its manned capabilities. He would retain astronaut status and return to JSC to train for his next flight. (NASA Release 82-71)

May

May 1: The first Maritime European Communications Satellite, Marecs A, launched December 20, 1981, began service at midnight. The spacecraft and its payload, leased to the International Maritime Communications Satellite (INMARSAT), was working well and already improving communications between land and ships and oil rigs in the Atlantic.

The Marecs program would lease two satellites to INMARSAT: Marecs A would cover the Atlantic ocean; Marecs B, the Pacific. Launch of Marecs B on an Ariane L5 had been put off to September 1982 to allow time for modifications reducing the effects of electrostatic discharge that had caused the Marecs A command system to malfunction during tests in February. (ESA Info 15)

May 2: The *New York Times* said that the Soviet Union had assembled six, possibly eight, intelligence-gathering satellites over the south Atlantic to watch Argentine and British military movements around the Falkland Islands. U.S. sources said that they assumed information from the satellites was being relayed to the Argentine government but had no proof of this. A senior official at the State Department said that leaders in Argentina had told Security of State Alexander Haig that they would not accept such help from the Soviet Union. The United States had two satellites over the area and was passing information from them to the British.

The Soviet satellites were communications interceptors *Cosmos 1346* and *1354;* radar-sensing craft *Cosmos 1345* and *1351;* and photoreconnaissance craft *Cosmos 1347* and *1352,* and possibly *1350* and *1353.* (*NY Times,* May 3/82, A-14; *AvWk,* May 3/82, 22; *W Post,* Jun 7/82, A-20)

May 3: An analysis of NASA's 1983 budget for research and development, prepared for Sen. William Proxmire (D-Wis.) by the General Accounting Office (GAO), said that more than 25% of it was for military programs. The *New York Times* said that the report would lead to more criticism from Congress that NASA was becoming increasingly militarized, at the expense of civilian science and technology.

Proxmire said that he asked for the report to "determine the extent to which NASA was merely acting as an agent" for DOD. As nearly half the Shuttle flights would take military payloads, more than $1 billion of the $3.5 billion requested for the Shuttle in FY83 was considered military: $1.1 billion of an R&D budget of $5.33 billion (20.5%) and $400 million support funds (7.77%) could therefore be military related. NASA's total 1983 budget request was $6.6

billion; total Pentagon direct spending on space was not known but was probably as much as or more than NASA's annual budget.

Proxmire said that he did not object to use of the Shuttle for military purposes, but paying for DOD activities through the NASA budget was "not the way to ensure that dollars spent on national security are spent with maximum effect." NASA said that it had been tasked with developing the Shuttle as a national endeavor, and reimbursement by other agencies for use of the Shuttle did not change the cost to the government. (*NY Times*, May 3/82, A-15)

May 14: MSFC announced the choice of two firms, Hercules Inc. and Votaw Precision Tool Inc., to negotiate a contract for development of a filament-wound case for the solid-fuel rocket motor used in the Shuttle boosters. The contract to produce the filament-wound item [see March 2] would cover design, manufacture, test, and delivery of four flight cases at an estimated cost of $33 million.

The new case segments would replace portions made of steel, improving performance by reducing Shuttle-liftoff weight about 66,000 pounds (29,937 kilograms). First use would be in late 1985. (NASA Release 82-80; MSFC Release 82-52)

May 20: NASA Administrator James M. Beggs established a space station task force, directed by John D. Hodge, to be responsible for developing program aspects, including mission analysis, definition of requirements, an program management. Hodge would report to Philip E. Culbertson, associate deputy administrator, and would draw on space-station activities at each program office and field center. (NASA anno, May 20/82)

• JPL said that it had joined Australia's commonwealth scientific and industrial organization in a first-time operation of five radiotelescopes in Australia and a sixth in South Africa as a single instrument "half a world wide" for observing astronomical radio sources. The Very Long Baseline Interferometry (VLBI) project could point telescopes located great distances apart at the same object, achieving angular resolution equivalent to a single radiotelescope several thousand miles in diameter. The two-week program observed about 30 quasars and galaxies. (JPL Release 993; NASA Release 82 -99)

May 23: At 9:57 local time May 23 the Soviet Union launched supply ship *Progress 13*, which docked automatically with *Salyut 7*'s service module at 11:57 Moscow time May 25, bringing 660 kilograms of fuel and 290 liters of water as well as air, food, equipment, and mail. On May 28, Tass described the unloading and refueling procedures. (FBIS, Tass in English, May 13-28/82; *NY Times*, May 19/82, A-4)

June

June 4: The Soviet Union launched *Cosmos 1374* from Kapustin Yar into a "round orbit" at 225-kilogram altitude and 50.7° inclination. Press reports said that Australian aircraft watched a seven-ship Soviet task force retrieve from the Indian Ocean an object that might be either a nuclear test craft or a "fairly small" shuttle. United Press International (UPI) said an Australian spokesman claimed to know what kind of craft was recovered but gave no details because the information was "classified"; also, U.S. scientists said that the spacecraft had "an unusually low trajectory."

Associated Press (AP) quoted U.S. government sources "who asked to remain anonymous" that the Soviet Union had launched and recovered, after 1 1/4 orbits, its first space-shuttle type of vehicle; they did not know whether the craft was manned. A Reuters report said that Maj. Gen. Alexey Leonov, who had been one of the cosmonauts on the Apollo-Soyuz mission, hinted that the shuttle guess was right but would give no details. (FBIS, Tass Intl Svc in Russian, June 4/82; *W Post,* June 9/82, A-7; June 10/82, A-26; June 11/82, A-35; *W Times,* June 11/82, 6; *AvWk,* June 14/82, 18-19)

• Esther C. Kisk Goddard, 81, widow of U.S. rocketry pioneer Dr. Robert H. Goddard, whom she married in 1924, died in Worcester, Mass. She had been secretary and photographer for his research; since his death in 1945 she had worked to make his discoveries known. (*NY Times,* June 7/82, D-11; *Goddard News,* June 15/82, 3; Ntl Sp Clb *blltn,* June 82, 3; *Worc Sndy Tlg,* June 6/82, 19B)

• The Soviet Union said that *Soyuz T-5* cosmonauts Anatoliy Berezovoy and Valentin Lebedev, in their fourth week aboard *Salyut 7,* had finished unloading *Progress 13,* launched May 23 to refuel and replenish the orbiting station, and undocked it to make room for a spacecraft carrying a French-Soviet crew later in June. *Progress 13*'s propulsion unit had served twice to adjust the orbit of the Soyuz-Salyut complex. Tass reported that ground control had reoriented the *Progress* June 6 to reenter and burn up over the Pacific Ocean. (FBIS, MscWldSvc in English, Tass in English, June 4/82; Tass Intl Svc in Russian, June 6/82)

June 8: NASA launched Western Union's *Westar 5* commercial communications satellites from ESMC at 8:23 p.m. EDT on a Delta into a transfer orbit with 36,469-kilometer apogee, 167-kilometer perigee, and 27.5° inclination. Firing of a booster at 5:20 p.m. June 11 would move it to station at 123°W over the equator.

Westar 5, heaviest of the series of satellites owned and operated by Western Union, weighed 585 pounds in synchronous orbit, was double the size of *Westar 1, Westar 2,* and *Westar 3,* and had about four times their capacity. Like *Westar 4* it had 24 transponder channels, all under lease; a 10-year design life; and 40% more transmitting power than most domestic communications satellites. It would replace *Westar 2* in service. (NASA Release 82-82; *NASA Dly Actv Rpt,* June 9/82; NASA MOR 0-492-203-82-05 [postlaunch] July 6/82; NASA Wkly SSR, June 10/82; *NY Times,* June 10/82, D-4)

June 11: NASA said that a team of astronomers led by Dr. Michael Werner of ARC had mapped the Orion nebula using infrared data from NASA's Kuiper airborne observatory. The nebula, 1,500 light-years from Earth, was one of the closest known regions in the galaxy where stars were currently forming. Since its discovery 17 years ago, infrared images had shown the total power output of the group of new stars invisible to the naked eye to be more than 100,000 times the power output of Earth's sun. (NASA Release 82-88; ARC Release 82-86)

June 14: LeRC announced the start of a seven-year $45 million test program to increase engine durability for U.S. jet fleets. Aimed at improving analysis methods and prediction techniques, the program would be a pioneering effort in five areas: structure analysis, surface protection, instrumentation, combustion, and turbine-heat transfer. LeRC would award 25 to 30 contracts for this work, about half the research to be done directly by LeRC staff. (NASA Release 82-89; LeRC Release 82-33)

June 21: NASA announced signing of agreements with Telesat Canada for launch of five Anik communications satellites, four on the Shuttle and one on a Delta. The launches would cost Canada's domestic satellite communications corporation about $75 million; the spacecraft would be worth about $130 million. The third-and fourth-generation *Anik C* and *Anik D* communications satellites would be the backbone of Canada's system until the 1990s, carrying new pay-television, voice, video, and data links, private business networks, and other special services. First of the D series would be launched in August from KSC; the next Telesat launch would be an *Anik C,* one of two communications satellites scheduled for the Shuttle's fifth flight and first commercial mission. (NASA Release 82-101)

June 21-23: NASA Administrator James M. Beggs and former astronaut Sen. John Glenn (D-Ohio) were speakers at the 18th National Joint Propulsion Conference in Cleveland, sponsored by the American Institute of Aeronautics and Astronautics, Society of Automotive Engineers, and American Society of Mechanical Engineers. In attendance were more than 800 technical professionals and key managers representing worldwide organizations in research and development, manufacture, and use of propulsion systems for aircraft and space, surface, and marine vehicles. Glenn, keynote speaker, received an award commemorating the 20th anniversary of his orbital flight. Representatives of European and Asian firms presented papers, and a group from the People's Republic of China attended.

Beggs, luncheon speaker, said that foreign competition in high-tech research required a new partnership between government and industry. Although NASA-industry cooperation over the past 25 years was a major factor in U.S. world leadership, many foreign firms had been able, with "far-sighted planning [and] government-industry cooperation," to move from idea to manufacture to delivery in half the time the United States needed.

The world edge once enjoyed by the United States in many high-tech areas has "been eroded," he said: France was ahead in nuclear power; West Germany, in chemicals; Japan, in optics and metallurgy. "The Japanese have managed to capture some 70% of the American market for the 64K random-access memory, which can store 64,000 information units." The *Harvard Business Review* had even suggested that U.S. firms look abroad—even to Iron Curtain countries—to tap foreign technology. What was needed, Beggs said, was a more balanced cooperation between government and industry, geared to investment in projects leading to speedy adoption of new technologies.

"No one ever ran a race by standing still. And we *are* in a race, a dead serious one. The stakes are high. They include not only our own economic security but the economic security of the Free World," he concluded. (LeRC Releases 82-30, 82-34)

June 23: Three astronomers at the University of Hawaii, using NASA's infrared telescope facility on Mauna Kea and data from *Voyager 2*, announced the first measurement of the sizes of four of the five known moons of Uranus. *Voyager 2* was heading for Uranus after a successful flyby of Saturn 10 months ago, and the new calculations would be useful in planning the scientific studies to be done after arrival. Uranus was so far from Earth, about 3 billion kilometers (2 billion miles), that it was visible only through telescopes. Sizes of the moons were figured from their infrared (heat) radiation. NASA had built the Mauna Kea telescope, most sensitive in the world for measuring faint infrared sources, to provide support for spacecraft exploring the planets; Dr. David Morrison of the University of Hawaii team, also a member of the Voyager project, said that the Moon data were exactly the sort of support NASA had in mind.

The moons of Uranus, smaller than Earth's, were all as large as any of Saturn's except Titan, the giant moon that was the only planetary satellite found to have an atmosphere. Oberon, largest of the Uranus moons, had a diameter of about 1,690 kilometers (1,100 miles). Besides measuring the Uranus moons, the astronomers reported that Triton, largest moon of Neptune, and the planet Pluto were both too small and too cold for any heat radiation to be detected; the weakness of the sources led them to decide that Triton must be smaller than Earth's Moon. Triton and Pluto, "based on our current knowledge," might be very similar; past speculation suggested that Pluto might have been a escaped moon of Neptune. (NASA Release 82-104)

• WFC announced the launch of a Nike Orion sounding rocket at 11:40 a.m. to measure magnetosphere instabilities induced by very low-frequency (VLF) waves produced in the troposphere. Its measurements would coincide with a satellite overpass to detect particle precipitation triggered by VLF waves from a high-intensity transmitter. (WFC Release 82-3)

June 24: At 8:30 p.m. Moscow time (4:30 p.m. GMT), the Soviet Union launched *Soyuz T-6* carrying cosmonauts Vladimir Dzhanibekov and Alexandr Ivanchenkov, with French "spationaut" Col. Jean-Loup Chretien, to spend a week with cosmonauts Anatoly Berezovoy and Valentin Lebedev, the *Soyuz T-5* crew who had been occupying orbiting laboratory *Salyut 7* since May 13. This was the first time a five-man crew would occupy an orbital station. Initial orbit elements were 277-kilometer apogee, 248-kilometer perigee, 89.6-minute period, and 51.6° inclination.

Chretien, who had trained with his French backup Maj. Patrick Baudry in the Soviet Union for 21 months, was the first westerner to take part in a Soviet space mission. (The last east-west venture was the U.S.-Soviet Apollo-Soyuz linkup in July 1975.) The mission had been approved by French President Valery Giscard d'Estaing in 1979.

This was also the first Soviet life television coverage of a launch, beginning two hours before liftoff with taped views of crew training, Salyut assembly, Soyuz rollout, departure of the crew by bus, interviews with the crew orbiting in the Salyut, and ending with a live broadcast of the liftoff plus 10 minutes. During the two-hour broadcast, all three crew members gave speeches praising the trip as symbolic of friendship between French and Soviet peoples. (FBIS, Moscow Tass in English, June 24/82, June 28/82; Mosc DomTVSvc in Russian, June 24/82; *NY Times,* June 25/82, A-9; *W Post,* June 25/82, A-22; *Spacewarn* SPX-344, June 29/82)

June 27: NASA launched STS-4, fourth test flight of space shuttle Columbia, from KSC at 11 a.m. carrying Ken Mattingly as commander and Henry Hartsfield as pilot. This was the first time that the Shuttle had lifted off on schedule, but the chase planes televising separation did not show the opening of parachutes on the two reusable solid-fuel booster rockets, and there was no sign on the ocean surface of any of the six main chutes or either of the boosters, which cost $24 million each. Boosters from earlier launches were towed to KSC for refit. After disassembly and cleaning, the first six motor-igniter-nozzle assemblies were returned to Thiokol's Utah plant for rebuilding at $7 million each; this procedure had saved NASA $36 million per flight for the first three flights.

The launch was imperiled the night before by a one-hour hailstorm with pellets "the size of golf balls" denting about 400 of the black protective tiles on the Shuttle's undersides. Workmen on hastily erected scaffolds had applied a hardener to strengthen the tiles. Enough water soaked the tiles to make the crew need to bake the underside of the Shuttle in the sunlight for 10 hours to dry it out, so that low temperatures on the night side of the Earth would not freeze and further damage the tiles. Mattingly and Hartsfield had begun to power up the 2,000-pound cargo put in the payload bay by the Air Force as well as four experiments managed by MSFC, including the first use of the Shuttle by a commercial firm. Press reports called it "an open secret" that the U.S. Air Force instruments included an extremely sensitive infrared telescope, an ultraviolet telescope, and a new space sextant designed to navigate spy satellites without ground command.

Hartsfield, on his spaceflight, suffered nausea but was later able to eat dinner. Instead of televising a view of the payload bay as other crews had done, or using the camera on the end of the 60-foot robot arm to show the Earth as they saw it from space, the crew merely described the view, expressing surprise at the amount of detail discernible. The seven-day mission would "wring out the wrinkles" in the Shuttle not dealt with on the first three flights. NASA said that it would name a board to review "in excruciating detail" how the boosters could sink in 3,500 feet of water although the drogue parachutes were found floating 150 miles downrange. (NASA Release 82-87; MSFC Release 82-56; NASA MOR M-989-82-04 [prelaunch] June 18/82; *W Post,* June 28/82, A-1; June 29/82, A-2; *Dtln Gd,* June 28/82; *Marshall Star,* June 30/82, 1)

During June: NASA announced that Dr. Walter C. Williams, chief engineer since July 1975, would retire in July. Dr. Stanley I. Weiss, associate administrator for space transportation operations, would succeed him. Williams began his career with NACA, NASA's predecessor, in August 1940 and worked during the war to improve U.S. fighter planes. He was founding director of the organization that became NASA's Dryden facility. He went to Langley Field, Va., in September 1959 as associate director of the new NASA space task group created to carry out Project Mercury and later was director of operations for the project. He then became associate director of NASA's manned spacecraft center in Houston that later was JSC. He went to NASA Headquarters in January 1963, leaving in April 1964 to work for Aerospace Corporation's vehicle systems. He became NASA's first chief engineer in 1975. (NASA anño, June 1/82; NASA Release 82-86)

—NASA announced the appointment of George F. Page as deputy director of KSC effective July 5. He had directed Shuttle operations there since 1979 and was launch director for the first three launches of Columbia. From 1964 to 1975 he directed KSC operations planning for 19 Gemini and 25 Apollo spacecraft launches, ending with the lunar landings and the successful Apollo-

Soyuz project. He directed unmanned launch operations from 1975 to 1979, with more than 54 major launches from both KSC and the Western Test Range (WTR) at Vandenberg Air Force Base. (NASA anno June 21/82; NASA Release 82-102)

July

July 1: "A clever bit of rewiring. . .with the skill of an automobile thief" enabled the astronauts aboard Columbia (STS-4) [see June 27] to bypass a defective circuit and turn on the power for part of its payload called the "getaway special." The University of Utah students sponsoring the experiment had given up hope but now planned to accomplish nearly all of their objectives. A thank-you message from the students said, "One small switch for NASA, a giant turn-on for us."

Engineers at JSC and GSFC had transmitted 10 possible corrective measures after figuring out that a cable from a control panel was faulty; on the first try, everything began to work, and the conclusion was that launch vibrations could have loosened a connection.

A more serious problem arose when the clamshell doors of the payload bay refused to shut snugly after exposure to the heat and cold of space had expanded and contracted the aluminum fuselage and graphite epoxy doors. A similar problem on the preceding flight was solved by putting Columbia into a slow roll (the so-called barbecue mode), turning the surface toward and away from the Sun to equalize temperatures around the ship. Columbia had been circling the Earth for most of the last two days with its underside facing the Sun, as a means of baking out moisture trapped in the insulating tiles from a hail storm the night before liftoff. Harold Draughon, a flight director, said that data from the flight showed that all the tiles had baked dry. (NASA MOR MR-004, 3; *NY Times,* July 1/82, B-8)

July 2: Larry Walters of Los Angeles went for a 3-mile-high ride in an aluminum lawn chair borne aloft by 45 weather balloons and ballasted with jugs of water, ending with his unusual craft wrapped around power lines in Long Beach about 20 miles from his starting place in San Pedro. During his 45-minute flight he reached an altitude of 16,000 feet, got so cold he became numb, and had to shoot some of the balloons with a BB gun to make his flying chair descend.

He was also sighted by pilots of Delta Air Lines and Trans World Airlines jets. A safety inspector for the Federal Aviation Administration (FAA) said that Walters had broken "some part of the Federal Aviation Act, and as soon as we decide which part it is some type of charge will be filed." Walters later said, "you couldn't pay me a million dollars to do it again." (*NY Times,* July 4/82, 22)

• The French-Soviet crew of *Soyuz T-6* that had visited *Salyut 7* and its *Soyuz T-5* occupants for a week returned safely to Earth at 6:21 p.m. Moscow time, landing near Arkalyk with cosmonauts Vladimir Dzhanibekov and Aleksandr Ivanchenkov and their visiting spacenaut from France, Col. Jean-Loup Chretien, "in good health." Tass said that the research planned by Soviet and French scientists was "accomplished in full." Work aboard *Salyut 7* continued with cosmonauts Anatoly Berezovoy and Valentin Lebedev. (FBIS, Tass in English, July 2/82)

July 4: Crowds estimated at half a million watched Columbia's fourth return to Earth, the first to use a concrete runway at Edwards Air Force Base. Among about 30,000 guests invited by NASA to the occasion were President and Mrs. Reagan. His comment at the touchdown was "Happy Fourth of July, and you know this has got to beat firecrackers."

The fourth flight, STS-4, was classified as the last of four test flights but carried more than 22,000 pounds of cargo, including a secret military payload. Although security considerations kept it from being photographed for viewers, the 50-foot mechanical arm designed to move objects in and out of the cargo bay and capture objects in space had been in use on this flight to move an 800-pound contamination monitor around the cargo bay.

The runway, about 300 feet wide and 15,000 feet long, was about the size of the one at KSC made for routine Shuttle use after the seventh flight. The fifth (and first operational) flight scheduled for November would carry two commercial communications satellites, one for Canada and one for Satellite Business Systems; each customer would pay NASA $21 million if the spacecraft reached orbit safely. Shuttle Program Manager Glynn S. Lunney said that NASA would do well to achieve one launch per month by the late 1980s and, ultimately, 24 to 30 per year. (NASA MOR M-989-82-04, July 19/82; *NY Times*, July 5/82, A-1, 8; *W Post*, July 4/82, A-1, A-11; July 5/82, A-1; July 6/82, A-9)

July 19: With the end of the four-flight orbital test program using the Shuttle Columbia, Maj. Gen. James A. Abrahamson, NASA's associate administrator for space transportation systems, announced that the STS-4 mission was a success "under conditions more demanding than STS-3 conditions." He said that the test-program flights were "accomplishments of international significance" and a credit to the Shuttle development team. (NASA MOR M-989-82-04 [postflight] July 19/82)

July 20: Marine Col. Robert F. Overmyer, named as copilot with Vance D. Brand on the STS-5 flight, told a JSC preflight press conference that the mission would carry four astronauts, the largest number to fly on any U.S. spacecraft; the other two would be physicists Joseph P. Allen and William B. Lenoir, both making their first spaceflight. Overmyer said that it would take four men to launch the two communications satellites set for deployment from STS-5 over the Pacific between Hawaii and Chile.

The Shuttle's two ejection seats would be replaced with three nonejectable cockpit seats. The fourth crewman would ride in a seat installed in the middeck of Columbia's cabin next to the airlock leading to the cargo bay, designed for use in the first Shuttle space walk. The report said that the crew did not seem bothered to be "the first to fly the shuttle without being able to eject if the spaceliner is damaged during liftoff." (*W Post,* July 21/82, A-1)

July 23: NASA said that *Landsat 4,* launched July 16, was "in excellent condition" and ready for a week's orbit-adjustment maneuvers. The multispectral scanner, one of its two sensor systems, was turned on July 19; the first image had been processed at GSFC, results indicating "flawless operation of the instrument and spacecraft systems." Transmission of data from the new, more powerful thematic mapper began July 20; images of the area around Detroit should be available in a week. (NASA Release 82-112)

July 27: NASA reported the failure at 9 a.m. of a high-speed tape recorder on *Nimbus 5* collecting Antarctic and Arctic radiometer data for the U.S. Navy. The loss of the last recorder on *Nimbus 5* meant that future operations would have to be in real time, subject to the communications satellites view of the Alaska ground station. NASA had agreed to provide *Nimbus 5* data through FY83, and the Navy had reimbursed NASA as a source of data for polar sea-ice calculations. NASA would review real-time operation with the Navy. (*NASA Dly Actv Rpt,* July 30/82)

July 30: Cosmonauts Anatoly Berezovoy and Valentin Lebedev made a space walk from the orbiting station *Salyut 7* to disassemble and partially replace wornout equipment on the station's exterior and study opportunities for doing various jobs outside it. After they donned space suits, Lebedev left the station for the "zone" of operations, while Berezovoy remained in the open manhole to film his walk for television. They dismantled and passed into the station a micrometeorite-measuring instrument and some panels with optical and various structural materials that had been outside the station since its launch April 19. They also tested the station after exposure of thermomechanical and threaded connections made of different metals that might be used in assembling future craft in orbit. (FBIS, Tass in English, July 30/82)

During July: Press reports said that astronauts Margaret Rhea Seddon and Robert I. Gibson were parents of a baby boy, Paul, born July 26 in Houston. Seddon, 34, and Gibson, 35, joined the astronaut program in January 1978 and were married in May 1981. Also, Dr. Sally K. Ride, selected for the seventh Space Shuttle mission as first female U.S. astronaut, announced her marriage to colleague Steven Hawley at her hometown, Salina, Kans. Hawley, an astronomer, had not yet been selected for a mission. (*W Post,* July 27/82, C-3; *St. L P/Dsp,* Aug 15/82)

August

August 3: NASA announced that ARC and LaRC were cooperating in the acquisition of data on the giant stratospheric cloud produced by the eruption of El Chichon volcano in March and April, now covering much of the Earth's northern hemisphere, to define the cloud's effect on global weather patterns. The centers were using satellites, U-2 aircraft, and lidar (light-intensification detection and ranging) for the study. The lidar equipment, mounted in a Lockheed Electra aircraft, would shoot laser pulses into the atmosphere and monitor reflections, "painting" the spatial and vertical extent of cloud layers above the aircraft. Lidar measurements in mid-July confirmed earlier findings of the National Oceanic and Atmospheric Administration (NOAA) that the volcano had put up to 50 times (500 times in some areas) the normal amount of aerosols into the upper atmosphere; that the material layers had spread to different latitudes, depending on altitude; and that sunlight reaching Earth's surface could be reduced several percent.

The cloud, a mixture of dust and sulfuric acid, would offer "a once-in-a-lifetime chance" to form an information base for prediction of dispersion, changes in temperature, and dynamic and photochemical changes, according to Dr. M. Patrick McCormick, head of LaRC's aerosol research branch. Dr. Brian Toon, atmospheric physicist at ARC, said that the most likely effect of the cloud would be a gradual reduction in northern hemisphere temperature over the next two years. (NASA Release 82-115; ARC Release 82-31; LaRC Release 82-57)

August 6: GSFC astronomers said that a new comet, Austin 1982G, brightest since 1979, should arrive in view of skywatchers later this month. The comet, the first one visible to the naked eye since 1976, would be six times as bright as the faintest star. It would pass closest to the Earth August 10 and closest to the Sun August 24. Long before then, NASA's international ultraviolet explorer (*Iue*) would be photographing it in the ultraviolet spectrum to detect its composition. Astronomers hoped to define the content of the comet to compare it with short-period ones previously observed and with Comet Halley, due to appear in 1985-86. (NASA Release 82-118)

August 9: NASA announced that it would try to salvage the two solid-fuel rocket boosters that sank in the Atlantic June 27. Underwater cameras carried by the Scarab 2, a remotely controlled submersible vehicle operated by technicians from Ocean Search, Inc., Lanham, Md., from the deck of the United Space Boosters recovery ship *UTC Freedom,* showed the boosters on the ocean floor, broken up by the impact. The debris had no built-in lifting points, but the Scarab could attach recovery lines to the sunken objects for hydraulic lift by the salvage ships.

Vessels used for recovery would include, besides the Scarab, the *UTC Freedom* and *UTC Liberty* (the designated booster-recovery ships). A remote station on a recovery ship would navigate Scarab, using bridge displays to show range and bearing, heading, depth, and pitch-roll of the submersible. Radar had located the boosters at about 3,500 feet, too deep for humans in hardshell diving suits to inspect; Scarab could operate in underwater currents up to 0.5 knots at 6,000 feet using three television cameras and one still camera with six quartz-diode floodlights to illuminate the ocean-floor.

The solid-fuel rocket boosters' parachutes failed to open properly because explosive bolts on half the parachute risers fired prematurely. Premature firing separated half of the risers from each main parachute, allowing the parachutes to stream instead of filling with air. NASA did not know why the explosive bolts fired prematurely. (*AvWk*, Aug. 9/82, 20; *Spaceport News*, Aug 19/82, 1 & 2; *W Post*, Aug 2/82, 3)

• NASA said that it had selected eight companies to negotiate fixed-price contracts of less than $1 million each for space-station mission studies. The companies were Boeing Aerospace, General Dynamics, Grumman Aerospace, Lockheed, Martin Marietta Aerospace, McDonnell Douglas, Rockwell, and TRW.

The eight-month studies to be covered by the contracts would identify and analyze the scientific, commercial, national security, and space operations missions that could be conducted most efficiently by a space station. Contractors would use the studies to develop alternative concepts for the station, with specific mission requirements and architectural options to be incorporated in NASA's Shuttle-tended permanent orbiting facility. (NASA Release 82-121; MSFC Release 82-75)

August 10: NASA said that Administrator James M. Beggs had signed in Vienna, Austria, a memorandum of understanding with Hans-Hilger Haunschild of the Federal Republic of Germany ministry for research and technology to cooperate in an astrophysics mission called ROSAT (Roentgensatellit), to be launched in 1987. ROSAT would join Galileo and the active magnetospheric-particle tracer explorer missions as another cooperative project between NASA and West Germany.

ROSAT would study X-ray emissions of nonsolar celestial objects, surveying specific sources for extended periods. Operating in both a survey and a pointed mode, ROSAT would compile an X-ray source catalog. The Federal Republic of Germany would provide the spacecraft; NASA, the high-resolution imaging detector and Shuttle-launch services; the United Kingdom's science and engineering research council would provide an XUV wide-field camera. NASA and West Germany would invite proposals from the international scientific community for investigations. (NASA Release 82-119)

August 13: An ESA team of 17 engineers arrived at MSFC to prepare for the first Spacelab launch on the Shuttle, now scheduled for September. Preparations would include extensive training and simulations with the Spacelab payload specialists, including two Europeans already based at MSFC and the NASA payload-operations engineers supporting NASA experiments on the mission. Several months before launch, the NASA/ESA team would begin to support operations from the payload-operations control center (POCC) at JSC.

The ESA team had been working for five years on computer software and displays, crew procedures, experiment simulators to train the crew and the POCC team, and establishing a data base. The team, representing 6 different countries, would support experiments from 11 European countries. The 38 experiments on Spacelab 1 in five scientific disciplines would include 25 ESA experiments. (NASA Release 82-76; MSFC Release 82-77)

• ARC reported the effects of disruption of the body's circadian (24 hour) rhythms on test groups subjected to weightlessness, rapid shifts in darkness and light, and social isolation, conditions similar to those encountered on manned space missions. These effects were important, said Dr. Charles Winget, ARC physiologist, because similar conditions on Earth were associated with boredom, irritability, negative moods, and withdrawal; the desynchronosis could also cause fatigue, insomnia, anxiety, gastrointestinal and other physical symptoms, and resulting decreased performance.

Experimental subjects showed abnormal temperatures and brain waves during circadian disruption; neither measurement returned to normal in less than two weeks. Upset rhythms caused problems with physical health, emotions, behavior, sleep, altered responses to medication, and increased susceptibility to colds, viruses, and infections. Daily rhythms linked to Earth's light/dark cycle appeared to be a natural function of cell-formation cycles in the human body, except for cancer cells, which did not exhibit rhythms. Pulse rate, blood pressure, heart rate, temperature, kidney function, metabolism, and hormone secretions, all followed a pattern; drugs and alcohol affected the body differently at various times. Winget and others had developed a new field of biology called chronopharmacology to study the effects of drugs administered at different times of day. (ARC Release 82-32; NASA Release 82-124)

August 19-29: The Soviet Union launched *Soyuz T-7* at 9:12 p.m. Moscow time August 19 carrying three cosmonauts to orbital station *Salyut 7* to join Anatoly Berezovoy and Valentin Lebedev, who had been working there since May 14. Commander of *Soyuz T-7* was Col. Leonid Popov; flight engineer was Aleksandr Serebrov; and researcher was Svetlana Savitskaya, the second woman to fly on a space mission. Initial orbit parameters were 280-kilogram apogee, 223-kilometer perigee, 89.5-minute period, and 51.6° inclination.

On August 20, *Soyuz T-7* docked with the *Salyut 7-Soyuz T-5* complex at

10:32 p.m. Moscow time. The five-person crew would carry out a week-long scientific program, largely medicobiological research, Tass reported. Soviet manned flights had included many studies of the effects of weightlessness on men; the present crew would check the effects "on the female organism" to understand better how humans adapted to life in those conditions.

An interim report said that *Salyut 7* had "more comfortable conditions for life and work" than *Salyut 6*. On a television broadcast, rookie Savitskaya said, "I think women cosmonauts can work in outer space successfully and. . . in future whole families will work on orbital stations." On August 26 the visitors began preparing for their return trip, packing research materials, like biological objects with technical documentation, and used equipment such as exposed still and motion-picture film. They returned to Earth at 7:04 p.m. Moscow time August 27 in the *Soyuz T-5* that had carried Berezovoy and Lebedev to *Salyut 7*. On August 29 the remaining crew redocked *Soyuz T-7* with the orbiting *Salyut 7* to make room for cargo vehicles expected later. (FBIS, Tass in English, Aug 19, 20, 25, 26, 27, 29; *NY Times,* Aug 20/82, A-28; Aug 21/82; Aug 27/82, A-11; Aug 28/82, 5; Aug 29/82,3; *W Post,* Aug 20/82, A-25)

August 26: NASA launched Canada's Telesat-G, called *Anik D-1* in orbit, from ESMC on a Delta at 7:10 p.m. EDT. Transfer-orbit parameters were 36,358-kilometer apogee, 185-kilometer perigee, and 24.5° inclination. Firing of a booster motor at 5:29 p.m. EDT August 29 put *Anik D* into synchronous orbit, and it was maneuvered to a station 104°W above the equator.

Anik D, weighing 2,370 pounds at liftoff, was the heaviest payload launched into transfer orbit by a Delta from that site. Initial on-station weight was 1,454 pounds. This was a 30th consecutive success for the Delta, a new record. The 24-channel communications satellite would provide Canada with television, data, and voice communications.

Anik D was Canada's tenth satellite and fifth in a series of domestic commercial communications satellites owned and operated by Telesat Canada. It would be a backup in orbit for three aging *Anik A* satellites (launched 1972, 1973, and 1975) and *Anik B* (1978). (NASA MOR M-492-201-82-05 [prelaunch] Aug 24/82, [postlaunch] Jan 17/83; NASA Release 82-126; *Spacewarn* SPX-346, Aug 31/82; *NASA Dly Actv Rpt,* Sept 1/82; SSR, Sept 2/82; *A/D,* Aug 31/82, 343; *AvWk,* Sept 6/82, 53)

During August: Dr. Christopher C. Kraft announced his resignation as director of JSC. He had retired from federal service in March 1980 but had stayed on at the request of the NASA administrator to see the Shuttle program through the flight-test phase that ended July 4. Kraft had begun working for NASA's predecessor organization, NACA, in 1945 and was appointed director at JSC in 1972. He would be succeeded by Gerald D. Griffin. (NASA Release 82-116)

—Pravda announced the death of Nikolai Pilyugin, 74, a key figure in development of the Soviet space program. An obituary signed by President Leonid Brezhnev said that Pilyugin, who had headed a large research institute for 20 years, was an outstanding designer in the field of space-rocket engineering. He was credited with designing the control system for Soviet launch vehicles, space ships, and interplanetary stations. (FBIS, Pravda in Russian, Aug 3/82)

September

September 6: India declared its first commercial satellite, *INSAT 1,* "dead" because its fuel supply had run out and it failed to respond to ground commands 150 days after an April 10 launch. Built by Ford Aerospace to Indian Space Research Organization (ISRO) specifications and launched from Cape Canaveral, INSAT was the first operational spacecraft equipped for telecommunications, direct-broadcast television, and weather. Prime Minister Indira Gandhi's government had planned to use INSAT to broadcast the Asian Games scheduled for New Delhi.

ISRO was reported "caught off guard" by the amount of fuel it had used to correct early malfunctions. Soon after reaching orbit, INSAT's C-band antenna jammed. Fuel was wasted trying to free it, as well as to deploy the malfunctioning solar sail designed to collect energy from the Sun's rays. Failure of the sail would have reduced INSAT's life from 7 to 2 1/2 years. Fuel-supply checks might have been inaccurate.

Because INSAT was built to ISRO specifications, blame would probably fall on Satish Dhawan, head of India's space program, who had argued for a multifunction satellite to bring radio and television to thousands of remote villages and give India international telecommunications links. He considered mass communications the best hope for progress in a country with a 36% literacy rate. India's press hinted that the system had tried for too many functions.

A second India communications satellite had been planned for shuttle launch next July as a backup for INSAT, and the government would have to decide how to proceed. Leasing two transponders on INTELSAT's Indian Ocean satellite as a cost of $16 million per year to partly cover the loss of INSAT would not offer India the prestige of using its own satellite during the games. (*W Post,* Sept 8/82, A-21; *Nature,* Sept 23/82, 293)

September 9: Space Services Inc. (SSI) of America launched the first U.S. privately funded rocket from a small concrete launch pad at a cattle ranch on Matagorda Island, 45 miles northeast of Corpus Christi on the south coast of Texas, at 11:15 a.m. Washington time. Conestoga I rose to 196 miles altitude, traveling 326 miles downrange before dropping into the Gulf of Mexico. The solid-fuel rocket, with a motor purchased from NASA for $365,000, was not designed for recovery. The booster successfully separated from the upper stage of the rocket; a shroud covering a mock payload that weighed 1,097 pounds, including 40 gallons of water, ejected at peak altitude as a visual marker.

After years of planning and one explosive failure in 1981, SSI's launch would offer relatively inexpensive space transportation for firms wanting to put up private satellites without government help. SSI chairman David Hannah, a Houston real-estate man, said that the launch of Conestoga I was a "giant step forward" for his two-year-old company; the plan was to send up an orbital test flight within two years and start operating on a commercial basis shortly thereafter.

Former astronaut Deke Slayton, who joined SSI after retirement from NASA and was in charge of the launch team, said that everything worked perfectly. Besides buying the booster from NASA, SSI also had help from subcontractors with considerable government experience and a variety of ex-NASA personnel. It was negotiating for a permanent launch site in Hawaii but was also looking into a lease of the Atlas Centaur launch site in Florida for the sort of launches that could send heavier spacecraft, such as communications satellites, into orbit.

As SSI officials toasted the successful launch with champagne, former director of KSC Lee Scherer, now an SSI consultant, remarked "You can't do this at a government launch site." He said that a high-level administration statement that SSI was "in the national interest" would put the firm in competition for space business. (*W Post,* Sept 10/82, A-1; *NY Times,* Sept 10/82, A-1)

• FBIS reported that the People's Republic of China successfully launched "another scientific experiment satellite." This was the People's Republic's 12th satellite (the first was launched in 1970) and was timed for the opening of the national congress of the PRC Communist Party. Later reports said that the satellite had "landed with precision at the predetermined recovery site" on September 14 at 2:00 p.m. Beijing time. (FBIS, Xinhua in English/Dom Svc in Chinese, Sept 9/82, Sept 14/82; *Pravda* in Russian, Sept 10/82; Tass Intl Svc in Russian, Sept 14/82)

September 9-20: Europe's first commercial space mission apparently failed when Ariane rocket L5 vanished 14 minutes after its launch from French Guiana September 9 at 11:12 p.m. local time. It was carrying European satellites Marecs-B and Sirio-2, a maritime telecommunications satellite and a weather satellite, both lost with the rocket in the Atlantic north of Ascension Island when the motor stopped 30 seconds early. This was the second failure in five Ariane launch attempts; the two previous attempts succeeded, although they carried no commercial payloads. A success would have put the Arianes into competition for contracts to launch commercial satellites.

ESA began investigating the failure. First reports said that the problem was in third-stage turbopump parts in the casing or the lubrication system. The first and second stages operated correctly, as did the separations and jettison of the fairing. The third stage ignited and ran for 275 seconds when rotation speed dropped, reaching zero at 325 seconds. The drop in thrust and engine cut-out led to a downward trajectory. (*W Post*, Sept 10/82, A-1; ESA Info 27, 29, 30)

September 10: NASA rolled out the first lightweight external tank for the Space Shuttle at its Michoud Assembly Facility near New Orleans. The tank, structural backbone of the Shuttle launch assembly, included an oxygen tank, a hydrogen tank, and a connecting intertank housing the instrumentation.

At 66,824 pounds the new tank was more than 10,000 pounds lighter than the one used for the first Shuttle flight in April 1981; the reduced weight would add payload capability almost pound for pound. The new tank, loaded on a NASA barge for shipment to KSC, would be prepared for the sixth shuttle mission scheduled for January 1983. (MSFC Releases 82-81, 82-83)

September 15: NASA announced that MSFC had selected four of the eight aerospace firms making space-station mission analyses for Headquarters to negotiate contracts exploring early uses of a space station. Each MSFC contract would address a specific area: Boeing would describe building large structures in orbit, such as huge communications antennas; both Martin Marietta and TRW would study servicing and maintenance of satellites by a manned facility in space; and General Dynamics would study operations of a Orbital Transfer Vehicle (OTV) serviced in space by a manned facility to move payloads from lower to higher orbits.

William R. Marshall, MSFC director of program development, said that the studies would posit a space station in orbit by 1990 and the kinds of experimental operations to be carried out there that would lead to a fully operational station by the end of the century. (NASA Release 82-134)

September 16: NASA reported a happy ending to a search-and-rescue mission that began in July with the loss of a pilot somewhere in northern British Columbia. The Canadian government conducted an unsuccessful search that cost $2 million before it ended. The father of the missing pilot started to search with a pilot and another passenger and failed to return on September 9. They had crashed in a valley 3,500 feet deep where the Rockies hid their rescue beacon from passing planes. The Canadian rescue center had no data on their location.

Canada had just joined in the SARSAT (search-and-rescue satellite-aided tracking) program using *Cospas 1*, a Soviet satellite launched June 30, and asked for any data it might gather. Early September 10 the satellite 600 miles up detected an emergency locator-transmitter in the area; a search aircraft found the crash and called for a rescue helicopter. All three persons had been injured but had survived. Canadian authorities praised the timely rescue of the victims at minimal cost. (*NASA Dly Actv Apt*, Sept 16/82; *W Post*, Sept 30/82, A-3)

September 20: NASA announced the selection of a West German physicist, Ulf Merbold, and a U.S. biomedical engineer, Byron K. Lichtenberg, as the first nonastronauts to fly on the Space Shuttle. The two would be part of a crew of six on the ninth Shuttle mission, scheduled for September 1983, and would use the Spacelab workshop installed for the first time in the Shuttle cargo bay to operate 38 scientific packages representing more than 70 investigators from Europe, Japan, and the United States. ESA, which for 10 years had planned and built the $1 billion joint U.S.-European Spacelab unit, had agreed with NASA that one European scientist would be on all Shuttle missions carrying a Spacelab.

Merbold, trained at Stuttgart University, competed for his Shuttle seat with Dutch physicist Wubbo Ockels, trained at the University of Groningen. Lichtenberg, with a Ph.D. from MIT, competed with Michael Lampton, holding a doctorate in physics from CalTech. Winners were chosen in secret ballot by a panel of 36 U.S. and European scientists. (MSFC Release 82-86; ESA Info 31; *W Post,* Sept 20/82, A-5)

September 28: NASA launched *Intelsat 5E F-5* at 7:08 p.m. EDT from Cape Canaveral on an Atlas Centaur into a transfer orbit with 35,962-kilometer apogee, 165.7-kilometer perigee, and 24.4° inclination. This craft would carry for the first time a maritime communications package for ship and shore use by INMARSAT. An apogee kick motor fired October 1 would start it to geosynchronous orbit. (NASA Release 82-136; NASA MOR M-491-203-82-05 [prelaunch] Sept 22/82, [postlaunch] Oct 26/82)

During September: NASA Headquarters announced the reorganization of its Office of Space Transportation Systems and Office of Space Transportation Operations into a new Office of Space Flight. L. Michael Weeks was named acting deputy associate administrator, with assistant associate administrators for policy, space transportation, and institutions. The new arrangement would stress integrated Shuttle operations planning and direction; STS orientation to customers; a manageable span of control for the associate administrator; maximum delegation of authority to subordinate officials and field organizations; and minimum disruption to existing lines of communication with centers and outside NASA. (SP anno, Sept 1/82)

—John J. Quann was appointed deputy director of GSFC, effective September 8. He had been director of GSFC's mission and data operations directorate since October 1980 and had worked at Goddard since 1963. (NASA anno Sept 1/82; NASA Release 82-131)

—NASA named Dr. Frank B. McDonald, chief of GSFC's laboratory for high-energy physics since 1970, as NASA chief scientist, effective September 20. In this position he would be the principal adviser to the administrator and other senior officials on scientific aspects of NASA activities. Beginning at GSFC in 1959, McDonald had been project scientist on nine NASA satellite programs and principal investigator for many space experiments. He previously taught physics at the Iowa State University of Science and Technology. (NASA anno, Sept 9/82; NASA Release 82-133)

—NASA reported that the Shuttle orbiter Enterprise, not slated for flight, was still working for the U.S. space program, helping DFRF engineers to predict and avert structural trouble spots resulting from wear and tear. All pre-Shuttle spacecraft had been one-shot items, so that space fatigue was a new problem. As each Shuttle was meant to fly up to 100 missions, NASA needed a reliable way to foresee difficulties before they developed into problems and to detect potential weakness without damaging the structure. A method called modal analysis measuring structural response to shaker acceleration could track changes from baseline data. Piecemeal testing of parts would not give results valid for the entire structure: Enterprise, built to the same dimensions as the four actual orbiters, was "uniquely qualified for the job," researchers said. (NASA Release 82-139; DFRF Release 82-13)

—MSFC said that Lockheed's contractor facility had successfully extended and retracted an experimental solar-array wing as tall as a 10-story building, scheduled for flight on the Space Shuttle in 1984. Unlike rigid metal structures used on current long-life spacecraft, the accordion-like array consisting of lightweight flexible plastic contained contact solar cells welded directly to the array like a printed circuit. The wing, measuring 105 feet by 13.5 feet, could fold into a package less than four inches thick and expand in orbit to its full length on a coilable extension mast. It could provide 66 watts per kilogram compared to 20 watts in present systems. (MSFC Release 82-84)

October

October 1: NASA signed an agreement with the National Science Foundation (NSF) that transferred management and operation of the National Scientific Balloon Facility (NSBF) at Palestine, Tex., from NSF to NASA as of October 1. The largest and most advanced facility of its type in the world, the NSBF provided launch and services for scientific balloons at its location 200 miles north of Houston. The site had good conditions for launching lighter-than-air craft, and the ground track after launch put balloons over large portions of the continental United States, allowing easy tracking and instrument monitoring.

Balloon vehicles could carry payloads for research in atmospheric physics, astronomy, and astrophysics to altitudes above the stratosphere (70,000 feet or higher). NASA had been the principal user of the facility; other users were NSF and private and foreign research institutions. GSFC's Wallops Flight Facility would manage NSBF for NASA. (GSFC/WFF Release 82-8; NASA Release 82-142)

October 4: The *Washington Post* noted the 25th anniversary of the USSR's launch of an orbiting satellite, saying that "no single event in history assaulted America's image of itself as did Sputnik." Subsequent U.S. space ventures "did nothing but tarnish that image," the Army and Navy arguing over which would launch the first satellite, while the Soviet Union orbited dogs, rats, and mice and took pictures of the dark side of the Moon.

The Navy got the first opportunity December 6, 1957, with Vanguard on the pad at Cape Canaveral and "literally blew it." The Army was given four days in January 1958 to launch Explorer from the Cape. When the launch finally took place after being delayed two days by unsafe winds, sea air had so corroded Army tracking radios in the Caribbean that the Cape never received the signal that the satellite was in orbit. In 1961 "the roof fell in" when Yuri Gagarin became the first man to orbit the Earth, and Gherman Titov orbited 17 times. The "best U.S. orbital effort that year was that of Ham the chimpanzee." Not until 1962 did John Glenn orbit the Earth, and then for only three orbits. By the end of that year the Soviet Union had sent four cosmonauts into space.

President John F. Kennedy had told Congress May 25, 1961, that the U.S. goal would be to put a man on the Moon and return him safely "before the end of the decade." By the time a three-man crew in *Apollo 8* orbited the Moon in 1968 at Christmastime, "the space race was over. What happened to the Soviets?"

Former JSC Director Chris Kraft said in an interview that the Soviet Union

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"abandoned their moon program. We took the wind right out of their sails." Critics said that not all of the effects of the space race were good: it "spurred U.S. determination to improve the quality of schools and students, but whether that succeeded is debatable." Kennedy "never saw the flight of anything to which he gave the initial impetus"; President Johnson, "who did more for the Apollo manned program than any president, suffered through the fatal Apollo fire"; President Nixon "basked in all of the Apollo triumphs only to answer for Watergate."

One educator said "Sputnik is one reason Johnny can't read today. He's more interested in Pac-Man, which you might call an outgrowth of Sputnik." If Sputnik led to Pac-Man, the *Washington Post* said, it also "helped to produce the high technology of the computer revolution. . .Today's state-of-the-art computer processes 5 million operations a second." *W Post,* Oct 4/82, A-1)

October 5: NASA observed the 100th anniversary of the birth in Worcester, Mass., of Dr. Robert Goddard, "father of modern rocketry." President Reagan issued a proclamation calling October 5 "Dr. Robert H. Goddard Day," noting that during his lifetime Goddard was "often ignored or ridiculed for his imagination, including the concept of a rocket going to the moon." "Due to his pioneering vision of space travel and his tireless research efforts in developing the world's first liquid-fuel rocket, the United States has achieved a preeminent position in space," the proclamation said. "Dr. Goddard was a trailblazer to the stars." (Text, procl Oct 5/82; *Dtln Gd,* Oct 5/82)

October 6: NASA announced the selection of four of five crew members for the first DOD Shuttle mission, STS-10, scheduled for launch from KSC in the last quarter of 1983. The commander would be Thomas K. Mattingly; pilot, Loren J. Shriver; and mission specialists, Ellison S. Onizuka and James F. Buchli. The fifth crew member, an Air Force manned-spaceflight engineer, would be named later. (NASA Release 82-146; MSFC Release 82-90; *NY Times,* Oct 7/82, A-18)

• The *Washington Post* said that STS-5, the first operational Shuttle mission, would include simulation of a space repair job to practice for the salvaging of an orbiting satellite, Solar Max, in April 1984. The 5,000-pound Solar Max cost $70 million at its launch in February 1980 to study the Sun during maximum sunspot activity. Less than six months later, the devices pointing its instrumentation at the Sun broke down, and the satellite wa practically useless.

Congress allowed $18 million to put the Shuttle alongside in a 308-mile-high orbit so that astronauts could ground a dozen cables, cut seals holding them to a panel, and pry the entire group from the panel. The greatest expense was for training the spacesuited crew to use tools and to handle the Solar Max as it orbited at 17,500-miles-per-hour alongside the Shuttle. (*W Post,* Oct 7/82, A-23)

• NASA announced that the Federal Republic of Germany was the first nation to buy a dedicated Spacelab mission from NASA, at a cost of about $65 million. Lt. Gen. James Abrahamson, NASA associate administrator for space transportation systems, signed the launch services agreement with the chairman and vice chairman of the German aerospace research establishment (DFVLR).

The D-1 Spacelab mission, set to fly on the Shuttle in June 1985, would consist of low-gravity experiments primarily from German industry and research groups in the field of materials processing in space and life sciences. The Federal Republic had given about 64% of the funding for the billion-dollar European development of Spacelab. (NASA Release 82-145)

October 8: NASA declared successful the heat-capacity mapping mission (HCMM) launched from the WTR April 26, 1978. Carrying a two-channel radiometer to measure reflected solar radiation and emitter thermal radiation over a 1-year lifetime, HCMM acquired more than 25,000 Earth images during its 2 1/2 years in orbit with a spatial resolution superior to all previous thermal sensors. (NASA MOR E-651-78-01 [postlaunch] Oct 8/82)

• JPL reported the discovery of the most distant object in the universe: a quasar named PKS 2000-330, more than 12 billion light years away. Light arriving at the Earth from that object started out before the solar system and probably the Milky Way itself were formed. Astronomers from the United States, Great Britain, and Australia began the search 10 years ago, using JPL's Deep Space Network antennas in Australia to pinpoint radio sources that might be quasars. (NASA Release 82-154; JPL anno Oct 8/82)

October 19: Astronomers from JPL and the University of Hawaii on October 19 reported detection on two solar-system bodies—Pluto and Neptune's largest satellite Triton—of frozen methane, a substance present on Earth as a product of living organisms and petroleum. Although the surfaces, mostly water ice, of Pluto and Triton differed from those of other bodies orbiting the Sun, the methane did not seem to come from biological activity. (NASA Release 82-157; JPL anno Oct 20/82)

October 20: The 200-inch telescope at Mt. Palomar observatory and an extremely sensitive electronic camera made the first confirmed sighting of Halley's comet beyond the orbit of Saturn. Recording the reflected light of an object the night of October 15 and observing it again at a predicted location the night of October 17, G. Edward Danielson and David C. Jewitt of CalTech told an October 20 press conference "it was both where we expected it to be and had the correct brightness."

The sighting was the farthest ever made of Halley's, named for English astronomer Edmond Halley, first to recognize it as one traveling through the inner solar system every 76 years. He correctly predicted its reappearance in

1758 but did not live to see it. Its spectacular appearance in 1910 resulted from a favorable arrangement of Sun, Earth, and comet that would not occur on this visit. (*W Post,* Oct 21/82, D-1)

October 22: NASA Administrator James M. Beggs announced a revised policy on Shuttle-mission opportunities for payload specialists, heretofore available only to those buying half or more of a Shuttle mission of flying a unique experiment needing the presence of a particular scientist or engineer.

Starting in 1984, NASA would no longer require a minimum payload. Flights for payload specialists would be available on a reimbursable basis to all classes of customer: foreign and domestic commercial firms, international cooperative partners, the scientific and applications community, and DOD. The payload specialists would usually be scientists with special skills who would undergo a brief training for spaceflight. The expanded policy reflected a Shuttle-program goal of sending more people into space on a routine basis. (NASA Release 82-158; MSFC Release 82-97)

October 27: NASA launched RCA-E (*RCA-Satcom 5*) from ESMC at 9:28 p.m. on a Delta into a synchronous transfer orbit. It would be stationed on the equator at 143°W over the Pacific to serve the continental United States, Alaska, and Hawaii. First of a series of second-generation domestic communications satellites made by RCA Astro-Electronics, it arrived at ESMC "slightly overweight" and carried no third-stage telemetry. Confirmation of third-stage burn and spacecraft separation was delayed until it passed over the tracking station in New Jersey to confirm that it was working satisfactorily. (*NASA Dly Actv Rpt,* Oct 29/82; NASA Release 82-155; NASA MOR M-492-206-82-06 [prelaunch] Oct 26/82)

• NASA said that Cospas/SARSAT, an international search-and-rescue project of the United States, the Soviet Union, Canada, and France, had located four accident sites and saved seven lives in its first month of operation. The Soviet Union's Cospas satellite, launched June 30, had located two downed planes in Canada during September, another in September in New Mexico, and a capsized catamaran off the coast of New England in October less than 24 hours after receiving the first signal.

As part of the program the United States planned to launch in February 1983 a weather satellite, NOAA-F, carrying a search-and-rescue capability. GSFC managed SARSAT activities for NASA. (NASA Release 82-152)

October 30: The U.S. Air Force launched two military communications satellites from Cape Canaveral on its Space Division's first Titan 34D and inertial upper stage (IUS). The first Defense Satellite Communications System III (DSCS) satellites went into orbit with parameters of 35,779/35,901-kilometer apogee, 35,641/35,839-kilometer perigee, 1440-minute period, and 2.5° inclination.

The Air Force Systems Command said that the launch was the culmination of five years of development effort on an experience base of 47 previous Titan III launches from the Cape. The DSCS system had handled national security communications since the late 1960s, maturing from simple short-lived satellites to flexible systems with six times the capacity and more than three times the on-orbit life. (AFSC *Newsreview,* Nov 19/82, 1)

During October: Leroy R. Grumman, 87, founder of the Grumman aerospace firm and designer of carrier-based airplanes with stubby teardrop-shaped fuselages used by the U.S. Navy in World War II, died October 4 in Manhasset, N.Y., after a long illness. He had started his business with a few other persons in 1929 as a repair shop for amphibious aircraft built by the Loening brothers' company; by the end of the war, Grumman employed 20,000, and it was still Long Island's largest employer. The company built more planes in a single month than any other U.S. firm (664, in March 1945) and made 98% of the Navy's bombers.

In 1966, when Grumman resigned as chairman of the board, the firm was building the lunar module that carried Apollo crews to the Moon. His awards included the Guggenheim Medal for Aeronautics and the Presidential Medal of Merit. (*W Post,* Oct 5/82, C-7; *NY Times,* Oct 5/82, D-25)

November

November 3: A formal ceremony in Washington, D.C., marked the acceptance of the Canadian-built remote-manipulator system as "ready for operational use" on the Space Shuttle. NASA Administrator James M. Beggs and Dr. Larkin Kerwin, head of Canada's National Research Council (NRC), signed an agreement declaring the device (already successfully used on STS-2, STS-3, and STS-4) operational. Although NRC thus fulfilled its obligations under a 1975 memorandum of understanding, it would continue to monitor the arm system on future missions. Next use of the arm would be on STS-7 in April 1983. (NASA Release 82-168)

• DFRF resumed its DAST (drones for aerodynamic and structural testing) flight-test program with a successful launch and flight of the DAST 1 vehicle from its B-52 carrier. The 15-minute test of the remotely piloted research vehicle by NASA civilian research pilot Thomas C. McMurtry used flight-control, instrumentation, and launch and recovery systems. This was the first flight since DAST lost a wing in June 1980.

The joint program of DFRF and LaRC would lead to flying transport and other aircraft more efficiently with more flexible wings and allowing larger aircraft payloads or greater fuel economy, or both. Rather than use "brute force" stiffening in wings to ensure a safe approach to flutter boundaries (the point at which destructive flapping occurred), DAST computers would indicate ways to suppress flutter. (DFRF Release 82-18)

November 4: MSFC said that it had selected Martin Marietta Aerospace to negotiate a $1-million contract for a tethered-satellite system concept. A tethered-satellite system would go into orbit on the Space Shuttle in the late 1980s, suspended downward from the cargo bay on a 60-mile-long tether to troll the atmosphere for days as a time to gather magnetospheric, atmospheric, and gravitational data. It could also be deployed upward to study electrodynamic and other phenomena. The area to be studied was too high for airplanes, too low for satellites to cover for long, and reachable only for brief periods by instrument-laden rockets.

Under a letter of agreement signed in 1981, NASA would join with Italy in developing and launching the system, building the deployment system and managing systems integration and mission operations, while Italy built the satellite itself. (NASA Release 82-169; MSFC Release 82-102)

November 11: NASA launched the fifth flight (STS-5) of Space Shuttle Columbia on time at 7:19 a.m. EST from KSC with a four-man crew, largest ever to take off from Earth at the same time. Feeling none of the motion sickness suffered by three of the first four Shuttle crews, the astronauts were so busy preparing for deployment from orbit of the first of two communications satellites that they had no time for chitchat with mission control. Astronaut Joseph Allen took off his shoes and socks to work barefooted inside the Shuttle cabin: "it's like having four hands," he explained. He and William Lenoir maneuvered the first of twin satellites (one U.S., the other Canadian) into space at 3:17 p.m. EST, while Vance Brand and Robert Overmyer flew the 100-ton Shuttle, positioning Columbia to avoid smearing its windows with exhaust from the satellite engine. The astronauts would use the same procedures November 12 to deploy the Canadian satellite on a similar flight path.

The first commercial cargo carried by the Shuttle was a 21-foot-tall cylinder worth almost $50 million, owned by Satellite Business Systems (SBS), a firm begun as a partnership of Aetna Life & Casualty, Comsat General Corporation (a subsidiary of Communications Satellite Corporation—ComSatCorp), and International Business Machines (IBM). Boeing, General Motors, and General Electric were among its more than 300 clients who used SBS satellites to transmit coast-to-coast computer traffic and telephone calls. Transmissions to SPS satellites were at 14GHz, twice as high as frequencies used by other U.S. communications satellites and were relayed at 12GHz to avoid interference.

President Reagan held a telephone conversation with the astronauts at 10:26 a.m. November 11, repeating his request to an earlier crew to "pick me up and drop me off in California." He added that "if more of us could see [the earth] from that angle we might realize that there must be a way to make it as united in reality here on earth as it looks from outer space." Brand replied, "We're in total agreement on that one." (NASA MOR M-989-82-05 [prelaunch] Nov 5/82, [postlaunch] Dec 7/82; *USA Today,* Nov 12/82, 1A; *W Post,* Nov 12/82, A-1, D-8)

• Charles (Pete) Conrad, who commanded Skylab's first mission and was now a vice president for marketing at McDonnell Douglas, said that pieces of Skylab that crashed in 1979 over western Australia after five years in orbit would go on sale, with proceeds to NASA, for the support of *Viking 1,* the Mars lander still sending messages from the surface of that planet. The Skylab pieces fitted into colorful posters were expected to raise from $150,000 to $500,000. Conrad had been a member of the *Apollo 12* mission that landed on the Moon as well as commander of the Skylab mission in 1973. (*W Post,* Nov 12/82, A-10)

• LeRC said that it had developed a device called MIAMI (micro-wave ice-accretion measurement instrument) to warn airplane pilots of dangerous ice buildup. This was the only device able to measure actual ice thickness and rate of accretion, besides giving a warning. Unlike other such instruments, MIAMI was imbedded in, instead of projecting from, the surface under study;

projecting probes tended to collect ice and confuse detection of how much was actually forming on the surface. The microprocessor in the device could tell the difference between ice and other substances (oil, dirt, grease, insects) and signal only the formation of ice. (LeRC Release 82-56)

LeRC also reported the completion of a five-year $39-million program of engine improvements to conserve fuel in commercial jet aircraft through identifying areas for cost-effective refurbishment and of performance loss. The specific goal was to reduce fuel use by up to 5% for current jet engines. Much of the cost would be repaid by contractors Pratt & Whitney and General Electric; under the reimbursement feature of the program, repayments over a 10-year period would be based on sales of improved components. So far, NASA had recovered nearly $1 million from the contractors, with a potential of $19 to $20 million. (LeRC Release 82-57)

November 14-18: Soviet cosmonauts Anatoly Berezovoy and Valentin Lebedev on November 14 broke the 185-day record in space set by two compatriots, Leonid Popov and Valery Ryumin, in October 1980. Berezovoy and Lebedev were in their 186th day on board the orbiting *Salyut 7* space station, where they would remain for several more weeks. The longest U.S. spaceflight was the 84 days spend on the Skylab station in 1974 by astronauts Gerald Carr, Edward Gibson, and William Pogue.

Salyut 7 had been visited twice by the other crews: on June 24 two veteran cosmonauts arrived with French test pilot Jean-Loup Chretien, the first non-American from the West to travel in space; on August 19, a second set of visitors arrived, including Svetlana Savitskaya, the second woman to fly in space.

Cargo ship *Progress 16* had docked with the combined *Salyut 7-Soyuz T-7* November 2 bringing fuel, research materials, supplies for the crew, and mail. On November 18 the cosmonauts launched from *Salyut 7*'s airlock *Iskra 3,* a small communications satellite created by student designers at the Moscow Aviation Institute to make experiments in amateur radio. Student receiving stations in Moscow and Kaluga would control *Iskra 3* and receive and process incoming data. (*NY Times,* Nov 15/82, B-6; FBIS, Tass in English, Nov 2, 9, 16, 18, 22/82)

November 15-19: Press reports said that problems November 15 with new million-dollar space suits had canceled the first space walk scheduled in nearly nine years and would bring STS-5 to a conclusion November 16. The walk was canceled when the fan in astronaut Joseph Allen's suit quit and the device maintaining oxygen pressure in William Lenoir's backpack behaved so erratically that flight directors feared a breakdown during any space walk. Program managers said that the walk could be done on a later flight; Glynn Lunney at JSC said that the program was "still right on track." The next three flights would carry space suits for any unexpected problems, such as cargo-bay doors that refused to close. The next flight was scheduled for February 1983.

Inspectors after the November 16 landing said that Columbia came through the fifth flight better than previously: an inboard tire on the left side was shredded and flattened on landing by a brake jamming against it, but only 4 of the 33,000 protective tiles were damaged or came loose during reentry. A seven-man panel investigating the space-suit failure said that they hoped to have answers within a week. One possibility was that the suits were dropped while in their cases or when removed and stowed in the ship. Engineers were baffled by the failure of both suits at the same time for different reasons.

The *New York Times* said that the suits, "most complex human garments ever made," differed from those used in Apollo moon landings, or for Skylab in 1973 and 1974, which functioned well but were too stiff for easy handling of tools needed by Shuttle astronauts. Shuttle missions had called for production, by United Technologies' Hamilton Standard Division, of 43 suits and 13 backpacks at a cost of about $2 million each; the suits had been tested by the company 160 times while unmanned and 70 times while manned, said a company spokesman. (*W Post,* Nov 16/82, A-1; Nov 18/82, A-7; *NY Times,* Nov 16/82, C-3)

November 16: Space Shuttle Columbia began a year-long vacation as the second operational Shuttle, Challenger, began final engine tests at KSC in preparation for a three-day mission in January 1983 with a four-man crew.

After its landing at Edwards Air Force Base, Columbia was scheduled to return to KSC for "six dozen minor modifications" after completing its first commercial venture, STS-5. The modifications would prepare it for the December 1983 launch of Spacelab, built for NASA by ESA. NASA spokesman said that the first five flights had proved that the Shuttle could launch satellites into space with "remarkable accuracy"; demonstrated that four men could do high-pressure jobs in a cabin the size of a pickup camper; and showed that the Shuttle, like an airplane, worked better the more it was used. (*USA Today,* Nov 17/82, 3A)

—MSFC said that it had sent NASA's first inertial upper stage (IUS-1) to Cape Canaveral to ready it for launch in Challenger's payload bay in January 1983. The first of six to be built by Boeing for the U.S. Air Force Systems Command, IUS-1 was an unmanned system for pushing payloads to high altitudes unreachable by the Shuttle in its 150-mile orbit. The two-stage vehicle, 17 feet long and about 9 feet in diameter, weighed more than 16 tons, had more than 64,000 pounds of thrust, and could carry up to 5,000 pounds of payload to geostationary orbit 22,300 miles up.

At KSC, the IUS would be mated to a tracking and data-relay satellite (TDRS), first of four planned for launch to replace present ground stations and improve command and telemetry functions for the growing number of operational satellites. NASA hoped to have the four-craft system in operation late in 1983. (MSFC Release 82-103)

November 18: The Space and Earth Science Advisory Committee, a group of more than 80 scientists, met for the first time in Washington to discuss its role in advising NASA on science activities. Associate Administrator Dr. Burt Edelson told the committee of two recent changes in NASA: a reorganization that moved science and applications into the same department and the appointment of Dr. Frank McDonald as chief scientist, a position that had been vacant for a long time. (*A/D*, Nov 19/82, 107)

November 22: NASA signed an $11.6 million contract with a 22-member Arab group of nations and organizations to launch a communications satellite from the Shuttle in 1984. Administrator James M. Beggs signed the agreement for NASA; Dr. Ali Al-Mashat, director general, signed for the Arab satellite group. Arabsat, a consortium, included both Libya and the Palestine Liberation Organization (PLO); some uproar ensued on Capitol Hill until senators were persuaded that the deal did not imply U.S. recognition of the PLO. The United States also had no diplomatic relations with Libya and had a policy of selling no military goods to its government.

A State Department spokesman said that Arabsat members would "get no more than they already had through the existing INTELSAT satellite communications system." The deal envisioned no transfer of technology, as the satellite would never be handled by its Arabsat owners. Saudi Arabia, which would be the center of operations, would control television programming for Arabsat use.

NASA Associate Administrator James A. Abrahamson said that the Shuttle was a commercial service and that its launches "should not be considered a political activity." (NASA Release 82-173; *W Post,* Nov 23/82, A-2)

November 23: The Shuttle imaging radar (SIR) flown on STS-2 in November 1981 had revealed previously unknown river channels, geologic structures, and possible Stone Age occupation sites in the eastern Sahara desert.

JPL's Dr. Charles Flachi, principal investigator for SIR, reported that the radar signal could penetrate the virtually featureless desert surface to show subsurface features nearly as broad as the Nile Valley and up to 50-million years old. Drainage networks detected by radar and confirmed by ground studies would explain the location of present oases in the desert. This new tool could serve in the search for ground water in such arid regions.

Dr. Alexander Goetz of JPL said that the multispectral infrared radiometer flown on the same Shuttle mission had made the first detection from orbit of clay and carbonite-bearing minerals, an important step in the use of remote sensing for geological mapping. The device used an area in Egypt of known mineral content as a baseline for analysis; its narrow spectral resolution made it able to map mineral content in the area, using specific substances as a guide for exploration and development, previously possible only through laboratory sampling techniques.

Dr. Henry C. Reiche, Jr., of LaRC was the principal investigator for the

MAPS (measurement of atmospheric pollution from satellites) experiment flown on STS-2, which proved accurate when compared to ground studies. A gas-filter radiometer, part of the first scientific Shuttle payload, measured carbon monoxide ratios in the lower, upper, and middle troposphere, data to be used in 1984 for seasonal variation studies.

Besides the desert features revealed by the Shuttle radar, Flachi reported readings over densely forested areas such as the U.S. Appalachians, the mountains covered by rain forests in western Guyana and Venezuela, and other remote locations not covered by ground survey. Geologic features shown in the radar images would help identify causes of change: erosion, fault lines, or previously unknown fractures of the Earth's crust. The devices recorded their findings because the Shuttle lacked communications capacity. (NASA Releases 82-174, 82-175, 82-176, 82-177; *W Post,* Nov 26/82, A-1)

November 24: NASA said that the three main engines that powered Space Shuttle Columbia on its five missions would be modified and retested to certify them for operation on the orbiter Atlantis. Rocketdyne would disassemble, inspect, and reassemble the engines before forwarding them to MSFC's NSTL for acceptance tests and certification. They would be installed in Atlantis for its first mission in 1985. Columbia would get three new engines for its Spacelab mission in 1983. (MSFC Release 82-104)

November 28: Press reports said that weather satellite Goes West, monitoring the Pacific Ocean and the western United States, had stopped functioning November 25, leaving more than 60° of Earth's surface (an area responsible for most of the winter storms on the Pacific coast) with a "blind eye." Efforts to revive it were unsuccessful; officials said that the problem was in the Goes radiometer. Launched in 1980, the satellite was designed for three-year operation; a replacement was to be launched in 1983. If further efforts failed, the National Weather Service planned to reactivate one of several older satellites that had been retired but were still in place. *W Post,* Nov 28/82, A-8)

November 29: NASA went before the Federal Communications Commission (FCC) to ask for a market test of a "land mobile satellite service" to complement cellular systems and other mobile arrangements now being planned or in use. NASA asked the FCC to reserve frequencies, for commercial companies offering to establish communications by satellite to rural America via portable radiotelephones that could switch calls between vehicles and local telephone networks. Present "cellular radio" systems were land-based, difficult to install in remote areas amid mountains and other barriers.

The FCC had denied a similar NASA request last year but would not comment on the new request. NASA said that other nations were developing mobile satellite communications services on frequencies provided by the 1979 World Administrative Radio Conference; if the FCC failed to provide the United States with frequencies, it could jeopardize its leadership "in satellite communications and in mobile communications equipment." The application said that mobile systems in the United States had been "available only through terrestrial facilities. . . limited in range" and restricted mostly to urban areas. A satellite system could include up to 288,000 rural subscribers by 1990, NASA said. *W Post,* Nov 30/82, C-7)

November 30: Former *Apollo 13* astronaut Jack Swigert, elected November 2 as congressman from Colorado's 6th congressional district, was hospitalized in Denver after undergoing chemotherapy for bone-marrow cancer. He would remain there "another few days," an aide said. (*NY Times,* Nov 30/82, A-17)

December

December 2: NASA investigators of the failure of $2-million space suits on STS-5 issued an interim report blaming two missing parts and a faulty sensor.

During the mission on Shuttle Columbia, an oxygen device in astronaut William Lenoir's suit failed to provide required pressure, and the fan in astronaut Joseph Allen's suit and portable life-support system would not operate. JSC program Operations Manager Richard A. Colonna, who headed the team, said that two vital plastic parts the size of a matchstick, worth less than a nickel apiece, that several to hold a pair of screws against a metal piece in Lenoir's suit, had been removed for a test last August and were never put back. Documentation indicated that the parts were in place, and during repeated tests, technicians failed to spot their absence.

The team said that the fan failed because a tiny magnetic sensor no bigger than a pinhead apparently gave way just after Allen put on his space suit. The motor running the fan and pumping water through the suit used the sensors, instead of the magnetic brushes used in most motors, because of the danger of a spark igniting the pure oxygen circulating inside the spacesuit.

Colonna said that the team would continue its investigation. He expected it to recommend further and more frequent testing and quality-control inspections by the manufacturer, Hamilton Standard, during space suit production and at JSC and KSC. (NASA Release 82-181; *W Post,* Dec 2/82, A-1)

• Speaking to an audience of U.S. and Brazilian businessmen in the governor's palace at Sao Paulo, Brazil, President Reagan proposed that "a Brazilian astronaut train with ours so that Brazil and the United States can one day participate in a shuttle launch together as partners in space." George P. Shultz, U.S. secretary of state, told newsmen on Air Force One that Brazil's president Joao Figueiredo, hearing of Reagan's proposal, said "That's wonderful, and I know just who the first astronaut is going to be, Me."

Brazilian officials said that Reagan had initiated a welcome new climate in U.S. relations with Brazil but said that the closer ties were more a matter of potential than reality. (Text, Dec 2/82; *W Post,* Dec 3/82, A-1)

December 3: NASA named Dr. Peter J. Denning head of a new Research Institute for Advanced Computer Science (RIACS) to begin at ARC in June 1983. Denning, chairman of computer sciences at Purdue, would direct research in computer science and engineering with potential for use in NASA programs. Funded by NASA through the Universities Space Research Association (USRA), RIACS would be an academic center for applications of the computer to solve scientific and engineering problems. (*NASA Dly Actv Rpt*, Dec 3/82)

December 9-15: Tass reported preparations for the end of the record-setting flight in *Salyut 7* of cosmonauts Anatoly Berezovoy and Valentin Lebedev, the crew of *Soyuz T-7* launched May 13. The crew was stowing in a reentry module a number of containers with flight documentation, biological samples, motion picture and still films, and monocrystals of semiconductor materials. They were also mothballing research equipment and support units on the station.

On December 10 the crew returned to Earth at 10:03 p.m. Moscow time in the preset area 190 kilometers east of Dzhezkazgan "not far from" the space center at Baykonur. Beijing's Xinhua press service said that a special lighthouse equipped with a strong beam was installed at the site to guide helicopters with ground crews to assist the cosmonauts. Difficulties with the landing meant that journalists for the first time were not at the site.

Berezovoy later reported that "Judging from previous crews, who hardly felt the shock of landing, this landing was quite severe and was followed by a few more rolls, apparently because we were on a small incline, and we ended up on our side with one on top of the other—Valentin [Lebedev] was on the (?upper) couch and I was on the lower. . . .We spent about 20 minutes in the descent module while an offroad vehicle was made ready but then spent 5 hours in this vehicle because of poor conditions. It was not bad, it was warm. We changed our clothes for clean and dry ones, replacing spacesuits with flight suits." (Interview recorded for Moscow DomSvc in Russian, December 13)

Later press reports said that the cosmonauts had "a harrowing reentry" in a craft rolling across a steppe swept by a blizzard and fog. Although initial USSR reports implied all had gone well, the *New York Times* said that the crew had "anxious moments" when unexpected bad weather landed them in darkness, near-zero temperatures, and blowing snow. One helicopter "force-landed" without injury, and another had to turn back. (*NY Times*, Dec 14/82, C-2; *W Post*, Dec 12/82, A-31)]

Tass carried reports December 12 of the first meeting with the cosmonauts. Their doctors said that "the cosmonauts feel fine which is somewhat at variance with the real state of their organisms." Good appetites indicated "energetic adaptation to terrestrial conditions. In 24 hours the cosmonauts gained about a kilogram in weight each. They particularly liked a bath with the air temperature of up to 70°." Berezovoy said afterward "If we could have such a pleasure at the Salyut station I would have worked for more time in orbit."

On December 16 Ivan Skiba, chief physician of the space training center, said that the cosmonauts had been "put on a regime approximating their usual lifestyle." He said that the doctors were "naturally worried over the decree to which the additional 26 days spent by [Berezovoy and Lebedev] in outer space over the 185-day space mission of [Popov and Ryumin] will affect the human organism. These 26 days constituted the "unknown path" both for the cosmonauts and for us physicians. Now we can say with certainty that the [additional] time in space. . . has not affected the cosmonauts' organisms. Their cardiovascular activity, blood composition, and other characteristics are returning to preflight figures." Skiba recalled that Boris Yegorov, "a representative of the medical profession," was among the first cosmonauts and hoped he would not be the last medical man to fly in space.

Cosmonaut Aleksey Leonov told a magazine December 17 Berezovoy and Lebedev had "made an important step in increasing the endurance of weightlessness. . . essential for activity in large orbital stations, space plants and factories, and interplanetary missions." When the two returned from the 211-day mission, they "were sunken physically and had become thinner and paler. . . [wanted] regular human communication with friends. They eat with a good appetite. . . swim every day. . . to have some weightlessness in water and make their life easier. They still find it a bit difficult to be seated as the muscles that make the position comfortable are out of their elementary function."

U.S. space officials were watching the cosmonauts' adaptation to gravity after 30 weeks of weightlessness. A television broadcast three days after their return showed them moving unaided to the edge of a whirlpool where they were assisted down a ladder. A commentator noted they were "like infants" and would have to relearn how to walk. The Soviet Union had announced plans for a station orbiting for a year and permanently manned, its crews remaining in space indefinitely to reduce ferrying costs. Soviet experts, like former cosmonaut Konstantin Feoktistov, had talked of manned missions to destinations such as Titan, a satellite of Saturn. (Longest U.S. flight so far was the 84-day mission flown by Gerald Carr, Edward Gibson, and William Pogue on Skylab in 1973 and 1974.)

The *Washington Times* said that Soviet planners were "seriously divided about what to do next." Valery Ryumin, who spent 175 and then 185 days on *Salyut 6* and was now a senior program chief at the space center, talked of grave risks to crew health on long-term missions and said that "four months is about the optimal period." Ignoring reports that Berezovoy and Lebedev were in fine health, Ryumin said that it would take "through medical tests on earth" to show how they had fared. (FBIS, Tass in English, Dec 9-17/82; Beijing Xinhua in English, Dec 11/82; *NY Times,* Dec 11/82, 12; Dec 14/82, C-2; *W Post,* Dec 11/82, A-23; Dec 12/82, A-31; *W Times,* Dec 15/82, 8A)

December 18: NASA successfully completed a 30 second flight-readiness firing of the new higher power space shuttle main engines at KSC. The test was to verify flight readiness of the three new engines and demonstrate in a launch-day environment the proper integration of all elements before the STS-6 mission. The successful test was a major step in preparation for STS-6, scheduled for launch in January 1983. Pre- and post-test activities included personnel from KSC, JSC, and MSFC.

This was the second time in history for static-firing the primary propulsion system of a manned spacecraft on the launch pad. A similar test of Columbia's three main engines occurred Febraury 20, 1981, before the first Shuttle launch. Challenger's more powerful engines, each generating 390,000 pound of thrust at sea level, had been fired individually at NSTL but were fired for the first time today in a flight configuration.

The most significant problem was a high level of gaseous hydrogen in the aft compartment. NASA said that so much work remained in the crew compartment that Rockwell employees at KSC were scheduled to work in that area over the holidays. (*NASA Dly Actv Rpt*, Dec 21/82; NASA Release 82-187; MSFC Release 82-111)

December 21: NASA said that it had added two physicians, Dr. Norman Thagard and Dr. William Thornton, to the crews of STS-7 and STS-8, respectively, to study space motion sickness, because other measures had failed to indicate the causes of the sickness. Neither physician had flown in space before.

Thagard would join STS-7 commander Robert L. Crippen, pilot Frederick H. Hauck, and mission specialists John M. Fabian and Dr. Sally K. Ride. Thornton, the oldest astronaut at 53, would join STS-8 commander Richard Truly, pilot Daniel Brandenstein, and mission specialists Dale Gardner and Guion Bluford, Jr. A five-person crew would not require spacecraft changes. (NASA Release 82-190; MSFC Release 82-115; *W Post*, Dec 22/82, A-3; *NY Times*, Dec 22/82, B-12)

December 27: ARC said that it had developed, with the aid of General Electric, a portable remote-communications system: a terminal and a folding antenna sized to fit inside two suitcases and be carried aboard an airplane and powered by either an ordinary AC outlet or the cigarette lighter in an automobile. Working with experimental communications satellite *ATS 3*, operated by NASA since 1967, an operator anywhere in North or South America or most of the nearby Atlantic and Pacific Oceans could contact any of several ground stations at any time.

The system would fit into two ordinary suitcases that could be carried as luggage in an automobile or on public transportation; one suitcases contained the collapsible antenna, the other an alphanumeric terminal to send or receive messages. The alphanumeric system would not disturb voice communications over the satellite, so that a NASA-authorized user could use it at any time without prior scheduling. *ATS 3* had already served in many emergencies. When Mt. St. Helens erupted in May 1980, an Air Force jeep at the disaster site maintained voice communications through *ATS 3* and a GE station near Schenectady, showing the need for rapidly deployable long-distance systems not dependant on land lines, often destroyed in emergencies. Organizations, including the state of California and the National Association for Search and

Rescue, were working with NASA on further uses of the technology. (NASA Release 82-195; ARC Release 82-48)

During December: George B. Kistiakowsky, 82, a developer of the first atomic bomb who later became a leading opponent of nuclear weapons, died of cancer at his home in Cambridge, Mass. In 1944 he headed the explosives division at Los Alamos Laboratory of the Manhattan project, where he designed the arrangement of conventional explosives needed to detonate the atom bomb, receiving the Presidential Medal of Merit for his work. After he saw the first nuclear bomb explode at Alamogordo July 16, 1945, he said "I am sure that at the end of the world—in the last millisecond of the earth's existence—the last human will see what we saw" (*W Post,* Dec 9/82, C-17)

—Jack Swigert, the former astronaut elected to Congress by Colorado's 6th district voters, who knew he was fighting cancer, died December 27 at the age of 51 a week before he was to be sworn into office. He had flown on the aborted *Apollo 13* Moon mission in April 1970, substituting at the last minute for Thomas K. Mattingly who had been exposed to German measles and was not immune. Swigert left NASA in 1973 to become executive director of the House committee on science and technology and had worked for two energy firms in Denver before resigning to run for Congress. (*MiHrld*, Dec 29/82, 1A)

January

January 3: President Reagan approved a joint resolution designating 1983 the "Bicentennial of Air and Space Flight." His proclamation recalled the first manned flight in history, in a hot-air balloon that traveled 5½ miles after its launch on Novemeber 21, 1783, over Paris, France. He said that the commemoration would be "an opportunity to increase public awareness of our nation's achievements in aviation and space flight and to rededicate ourselves to the spirit of excellence which has brought us so far so fast." (Text, Jan 3/83)

January 5–31: The Pentagon issued a warning January 5 that a nuclear-powered Soviet reconnaissance satellite had "run into problems" and would probably crash somewhere on Earth before the end of January. The Soviet Union's *Cosmos 1402*, like an earlier Cosmos that crashed in northern Canada in January 1978 and caused minor radiation contamination, was carrying about 100 pounds of enriched uranium to provide electrical power for its radar.

The Soviet Union confirmed loss of its control over *Cosmos 1402*, launched to observe U.S. naval operations from an orbit of 64.9° inclination that covered most of North America and all of China, Africa, South America, and Australia, as well as part of the Soviet Union. The danger lay not in the possibility of an explosion but in the radioactivity of the nuclear fuel core if the craft should come down in a densely populated area.

The foreign press had warned that *Cosmos 1402* had "separated into individual fragments on a command from earth." The nuclear power unit aboard it was a matter of concern to all other nations; the United States had "expressed its concern to Moscow" that the object and its 100 pounds of uranium would crash on the Earth like the other. (FBIS, Xinhua in English, Jan 7/83; *Pravda* in Russian, Jan 8/83; Tass in English, Jan 15/83)

Normally, said the United Press, when an ocean-surveillance satellite such as 1402 exhausted its 4-to-7-month life expectancy it would be raised and "parked" at a high orbit altitude "for centuries." The Tass news agency said January 7 that *Cosmos 1402* had been "divided into separate fragments by commands from earth in order to isolate the active part of the reactor, which ensured its complete combustion in the atmosphere strata." Department of Defense (DOD) sources said January 10 that one piece had burned up in the atmosphere, but two larger sections were still descending—those holding the reactor, biggest and heaviest part of the 6,000-pound satellite. At the current rate of descent, the parts could enter the atmosphere in the week beginning January 23, sources said.

Tass reported January 24 that "the main part of the satellite structure" had reentered over the Indian Ocean at 1:10 a.m. Moscow time: the fuel core was forecast to enter between February 3 and 8 [see Feb. 7]. (*NY Times*, Jan 6/83, A-1; Jan 22/83, 9; Jan 31/83, A-25; *W Post*, Jan 7/83, A-21; Jan 8/83, A-11; Jan 11/83, A-9; Jan 20/83, A-2; Jan 24/83, A-1; Tass in English, Jan 7/83, Jan 24/83)

January 7: NASA said it would conduct another flight-readiness test of Challenger's three main engines late in January because of high gaseous-hydrogen levels in the aft compartment after the first firing December 18. Several leaks had shown up, including a split cooling tube in the # 3 engine nozzle. The need for a second test would delay the STS-6 Challenger launch to late February. (NASA Release 83-2; MSFC Release 83-2; *AvWk*, Jan 17/83, 24)

• Lewis Research Center's (LeRC) basic organization was revised following a recent strategic planning session. The four research and technology (R&T) directorate (aeronautics, energy, science and technology, and space) were changed to aeronautics, spaceflight systems, space technology, and materials and structures. An office of comptroller was established to manage resources and budget. Other directorates affected were administration, engineering services, and technical services, (NASA anno Jan 14/83; LeRC Release 83-3)

January 17: The People's Republic of China (PRC) announced that it would buy from the United States a Landsat ground station to be hooked into the U.S. system. A spokesman for the China Academy of Sciences said that the new station would help analyze China's geological structure, locate mineral resources, and provide data for land use, crop estimates, irrigation, environmental monitoring, alterations in watercourses, pest and disease control, and predicting natural disasters.

The *Washington Post* said that a Maryland company, Systems and Applied Sciences Corporation, had a signed contract with the People's Republic of China to build the station at a cost of up to $12 million. The firm, among the largest black-owned enterprises in the United States had "worked on many projects" for NASA, but the PRC contract would be its first significant international venture. PRC officials would press Secretary of State George Shultz when he visited in February to approve the sale, as the United States had blocked technology transfers in the past because of possible military application. Both the Carter and the Reagan administrations had approved such a sale in the past, but the People's Republic's economic problems had forced a delay. (FBIS, Xinhua in English, Jan 17/83; *W Post*, Jan 18/83, A-18; *AvWk*, Jan 31/83, 21)

January 19: The press reported the death in North Carolina at the age of "about 26" of Ham, the chimpanzee sent on a Mercury capsule into suborbital flight January 21, 1961, to prepare for the flight of Alan B. Shepard, Jr., first U.S. astronaut.

Ham, named after the Holloman Aerospace Medical Center in New Mexico, retired from the space program in 1963 to live at the National Zoological Park in Washington, D.C., and after 1981 in the North Carolina Zoological Park. His trip in "a very primitive space capsule on an experimental suborbital run" was attended with "excitement and suspense," even dread, because no one could predict whether he would survive the shocks of the trip or undergo emotional trauma.

"Ham rose to the occasion and took it all in stride," the report said. "Never mind that the capsule, through an error, had been shot 40 miles higher than planned or that it had landed 30 miles past the target area where a fleet awaited it or that it had been traveling 5,000 miles an hour, 800 miles faster than planned. . . . During the time radio signals were received the chimp pushed various levers and performed other behavior tasks assigned him." (*W Post*, Jan 21/83, A-16; Jan 26/83, B-3; Jan 27/83, A-22)

January 21: NASA declared successful the mission of *Nimbus 7*, launched October 24, 1978, from Vanderberg Air Force Base into a polar orbit. Using eight interdisciplinary research experiments representing domestic and international scientific and government communities, it accomplished mission objectives, including proof of the feasibility of mapping upper-atmosphere characteristics, of supplying space-collected oceanographic data to scientific uses, and of extending the solar-radiation and Earth-radiation data base. Objectives were met or exceeded with high-quality and high-quantity data, and *Nimbus 7* would continue into its seventh year "in good health." (NASA MOR E-604-78-08 [postlaunch] Jan 21/83)

January 25: NASA launched the Infrared Astronomical Satellite (IRAS) at 6:17 p.m. PST from Vandenberg Air Force Base on a Delta into polar orbit with 883.6-kilometer apogee, 856.6-kilometer perigee, 100.1°inclination, and 102.4-minute period. A joint endeavor of NASA, Netherlands Aerospace Agency, and U.K. Science and Engineering Research Council, IRAS, was a 2,360-pound spacecraft carrying a 22-inch Cassegrain telescope cryogenically cooled by a helium tank to measure infrared radiation in four bands between 8 and 119 microns. At low temperature the detectors would have the sensitivity needed for an all-sky survey of the "heat signatures" of stars.

The $80 million mission might find up to a million infrared sources not previously detected, filling "a significant gap in the electromagnetic spectrum between visible light and radio waves. . .about which we have no or very little information," according to Dr. Dale Compton, telescope manager at Ames Research Center (ARC). IRAS was designed to cover about 95% of the sky over the next sixth months and produce the first comprehensive catalog of infrared objects.

The United States built the telescope and the rocket and was managing operations through the Jet Propulsion Laboratory (JPL). The Netherlands built the spacecraft and three other scientific instruments. The United

Kingdom would handle the tracking and collect the data. (NASA MOR E-885-83-01 [prelaunch] Jan 3/83; *NASA wkly* SSR, Jan 27/83; *Spacewarn* SPX-352; *NY Times*, Jan 27/83, A-7)

• Discovery of another hydrogen leak during a second test-firing of Shuttle Challenger's main engines would delay the launch recently postponed to late February for at least several more weeks, said Lt. Gen. James A. Abrahamson, Shuttle program head, at Kennedy Space Center (KSC). The leak meant delaying Challenger's five-day mission for a month or more if one or more of the engines had to be removed from the Shuttle, test-fired, and replaced. The new leak was "on the same order of magnitude" as the first; as the source was never located, the leaks might be from the same or different areas. (*W Post*, Jan 26/83, A-5)

January 31: James M. Beggs, NASA's administrator, told a press conference on the agency budget that President Reagan was committed "to a strong national space and aeronautics program," citing NASA's obligation to help strengthen national security and maintain U.S. leadership in space. "This budget, I believe, moves us forward toward those goals," he said.

NASA's FY84 budget would be just over $7.1 billion, an increase of $267 million (4%) over FY83. Of $5.7 billion sought for research and development (R&D), 61% (about $3.5 billion) would be earmarked for the Shuttle program to cover Shuttle procurement and operation, upper stages for Shuttle use, the Spacelab, the tethered satellite, and other equipment and launch vehicles.

Beggs said that the trend begun last year was to spend relatively more on operations and less on capability development. NASA's FY84 budget request included four initiatives to "stretch the scope of our program in science, applications, and aeronautics." They were the Tethered Satellite System (TSS), a cooperative U.S.-Italian project for conducting experiments in space up to 100 kilometers from a Shuttle orbiter; the Venus radar mapper, replacing the Venus-orbiting imaging radar (VOIR) authorized by Congress in FY82; the Advanced Communications Technology Satellic (ACTS) to flight-test high-risk technology, using "a novel procurement approach" of cost-sharing with industry; and a numerical aerodynamic simulation (NAS) capability, a large computer system to improve accuracy and reliability in aircraft design while reducing the need for wind-tunnel and flight testing.

Beggs said U.S. space policy called for "permanent space facilities," to be embodied in the Space Shuttle program; FY84 money would define and plan for such facilities. We have no specific plans to establish a permanent manned space station in earth orbit," he said, but NASA would continue the study of user requirements, hardware and software systems, science applications, and designs to accommodate specific missions. (Text, press conf, Jan 31/83)

During January: Speaking in the House of Representatives, Reps. Don Fuqua (D-Fla.) and Larry Winn (R-Kans.) noted the 25th anniversary of the start of the U.S. space program. When the Navy's Vanguard rocket exploded on its pad in December 1957, the Army "quickly moved forward" to finish developing Explorer 1, and the Jupiter C rocket carried it into orbit January 31, 1958. After two Soviet space firsts—Sputnik 1 on October 4, 1957, and Sputnik 2 carrying the dog Laika into space on November 3, 1957—the United States had entered the space race that would land two astronauts on the moon just over 11 years after Explorer 1.

Explorer 1 exceeded all expectations, transmitting data until its batteries were exhausted May 23, 1958. Scientists basing a decay rate on data from Sputnik said that Explorer 1 would not last more than five years. But on March 3, 1970, more than 12 years after launch, Explorer 1 plunged back into Earth's atmosphere and burned up. It had made the most significant discovery of the International Geophysical Year (the Van Allen radiation belt about Earth), controlled the temperature in a satellite, and found that micrometeorities were not serious hazards to space vehicles, data valuable to the Moon missions.

Although "the American story in space is only 25 years old," Winn added, "we have made tremendous progress in that quarter century, and it all began with Explorer 1." (*CR*, Jan 31/83, E204; AFSC *Newsreview*, Feb 11/83, 1)

• The hydrogen leak that caused postponement of Challenger's maiden launch had been traced to one of the three engines, according to KSC's Dick Young. A three-quarter-inch-long crack appeared in the combustion manifold of the #1 engine, a piece of metal an eighth of an inch thick. (*W Post*, Jan 30/83, A-2)

• NASA reported a number of differences between Shuttle orbiters Columbia and Challenger, most of them stemming from Columbia's being a vessel for research and development, whereas Challenger came equipped as an operational craft.

Control and display panels on Columbia had sensors configured for data collection and processing in the flight-test phase; those on Challenger had fewer of these and more support equipment, such as a Ku-band antenna system for tracking future data-relay satellites. On the first four flights, Columbia had an ejection-seat system for the commander and pilot in case of accident in the launch or landing phase of flight-testing. Challenger had no ejection system; the space used for it on Columbia would serve on Challenger to seat the mission specialists. On its first flight in February, Challenger would seat all four of the flight crew on the orbiter's flight deck; it would be able to seat three more crew members in the mid-deck on later flights.

Challenger would weigh abot 2,000 pounds (907 kilograms) less than Columbia and could carry more payload and additional crew on operational flights. The orbiters differed in thermal-protection systems: heat-shielding tiles on Columbia were being replaced with densified tiles to eliminate porosity that made the original tiles vulnerable to loosening. All of Challenger's tiles had been densified. Challenger also had an advanced thermal-protection blanket, a silica material sandwiched between an upper and lower quilt and bonded directly to the orbiter skin. Its identification marking also differed from Columbia's, being located so the name would be visible during on-orbit operations. (*NASA Actv*, Jan 83, 4)

February

February 1: NASA transferred operation and management of its Landsat system to the National Oceanic and Atmospheric Administration's (NOAA) National Environmental Satellite, Data, and Information Service (NESDIS) during ceremonies at Goddard Space Flight Center (GSFC). Beginning in 1972 with the launch of *Landsat 1* (*Erts 1*, the Earth-resources technology satellite), the Landsat program was a research and development effort to determine the usefulness of satellite multispectral data from synoptic views of the Earth's surface for agricultural and urban planning, geologic exploration, land management, and snowmelt and flood-runoff analysis.

Over the following 10 years NASA had operated four Landsats, including *Landsat 4*, launched in July 1982, and a ground system at GSFC. *Landsat 1* and *Landsat 2* were no longer operating; *Landsat 3* would be retired later in 1983 because of degradation related to age. In 1979 the Reagan administration told NASA to transfer operation to NOAA so that the latter agency could work toward eventual commercialization of the system.

NASA had relinquished operation of *Landsat 4* (except for the thematic mapper, which NASA would continue to use), the control center at GSFC, and the multispectral-scanner data-processing facility, also at GSFC, and would hand over control of the thematic mapper early in 1985. NOAA would also take over the *Landsat 4* backup spacecraft (the Landsat D now in final checkout by General Electric) that would replace *Landsat 4*, probably in mid-1985. NOAA would reimburse NASA for the use of buildings and utilities. (NASA Release 83-7)

February 1-11: Despite "intense efforts" to communicate with Viking lander 1 on the surface of Mars, silent since mid-November, controllers and scientists at JPL and a Martin Marietta group had received no signals during a scheduled downlink February 11. Since February 1 they had sent commands that should have started the lander's on-board computer executing the steps needed to transmit to Earth. Declining battery power on the lander was thought to have tripped a protective low-voltage switch that shut down major subsystems; if the commands had been followed, the lander would have communicated February 11.

JPL would go ahead with efforts to reestablish contact, which would be unsuccessful if the lander had multiple problems. No telemetry data were available to diagnose the situation. The 64-meter Deep Space Tracking Network antenna, near Canberra, had bombarded the lander on Mars with 80- to 100-kilowatt signals, said George Gianopulos, Viking team leader at JPL. Gianopulos said that commands from JPL through Australia could be up to

40° off the receiving line into the leader's antenna dish and still be picked up. Getting into the lander to reset the switch "is going to be a neat trick," he added.

Launched August 20, 1975, and designed for a 90-day mission, *Viking 1* had shown "incredible stamina" in the harsh environment of Mars. Radioisotope thermoelectric generators (RTGs) could provide power for years, but in 1982 its four nickel-cadmium batteries began to show their age. Viking could be instructed to charge or discharge batteries to keep them functioning longer. A command sent November 19 to repeat this exercise apparently got into the antenna-pointing subroutine and switched the crucial communications antenna to point away from Earth. (*NASA Dly Actv Rpt*, Feb 16/83; JSC *Roundup*, Jan 28/83, 1)

• A NASA team investigating space-suit failures that occurred during STS-5 issued a report listing ways to improve and simplify contractor test and inspection procedures. Regulators and motors would undergo more extensive testing on the Shuttle orbiter just before being stored, and space suits would be fully tested the day before a scheduled space walk. The first failure to be detected, shutdown of a fan motor while Joseph P. Allen was donning his suit, was the fault of sensors in the motor electronics. The other failure, that of an oxygen regulator in William Lenoir's suit, resulted from the absence of two tiny devices holding a regulator spring in place. (NASA Release 83-9)

February 4: Japan launched its first "practical communications satellite, *Cs2A*, at 5:37 p.m. local time from its Tanegashima space center on a three-stage rocket toward a stationary orbit at 36,000 kilometers over New Guinea. It would be Japan's sixth in stationary orbit, although it would be the first used for practical purposes.

Cs2A carried eight transponders with communications capacity equal to 4,000 telephone circuits, to improve links between the mainland and outlying islands in the Pacific south of Tokyo. It would be used by government agencies and public transportation rather than by the public sector for research to develop new media such as television communications links, electronic mail, high-speed datafax, and color television. (FBIS, Tokyo Kyodo in English, Feb 4/83)

• NASA announced crew selections for STS-11 and STS-12, both to be commanded by veterans of earlier shuttle missions. The crew for STS-11 in January 1984, led by Vance D. Brand, who commanded STS-5 in November 1982, would include pilot Robert L. Gibson and mission specialists Bruce McCandless II, Robert L. Stewart, and Dr. Ronald E. McNair. STS-11 would be the fifth flight of Challenger, and its seven-day mission would launch an Indonesian communications satellite.

The crew for STS-12, led by Henry W. Hartsfield, who commanded STS-4 in June 1982, would include pilot Michael L. Coats and mission specialists

Dr. Judith A. Resnik, Dr. Steven A. Hawley, and Richard M. Mullane. Marshall Space Flight Center (MSFC) said that a sixth crewman might be added later under a new NASA policy permitting major customers to send a payload specialist along. To be launched in March 1984, STS-12 would be the first flight of a new orbiter, Discovery; its 5-day mission would include deployment of the third tracking and data-relay satellite. (NASA Release 83-15; MSFC Release 83-6)

• MSFC announced that it would begin drop tests in cooperation with Dryden Flight Research Facility (DFRF) to try out larger parachutes for Shuttle boosters. The current means of slowing booster descent after launch into the ocean for retrieval and later use consisted of small pilot chutes, a drogue, and three main chutes 115 feet in diameter. The new main chutes being tested would be 13 feet in diameter. Use of larger chutes would slow velocity at impact from 89 feet per second to about 75 feet per second, reducing loads on (and amount of damage to) boosters that had occurred during Shuttle flight tests, officials said.

A modified B-52 aircraft from DFRF would fly the test article to about 20,000-feet altitude and release it. Both ground-based and airborne cameras would record the mock booster's descent to evaluate design, deployment, and parachute performance. (MSFC Release 83-9; DFRF Release 83-1)

• NASA announced its decision to locate a refurbishment and assembly facility for Shuttle solid-fuel rocket boosters elsewhere than in the Vehicle Assembly Building (VAB) at KSC. High production rates required in the 1986-and-later timeframe could not occur in the available space; also, the VAB did not lend itself to efficient "factory operation" for refurbishment of the solid-fuel rocket boosters.

NASA had considered alternate locations, such as a complex on government property at KSC or Canaveral Air Force Station or an off-site location near KSC. All these sites had problems, and the search had expanded to include some partially empty industrial facilities formerly used to build Saturn rockets at MSFC. The location chosen would be cost-effective as well as the best for recompeting the contract. (NASA Release 83-17; MSFC Release 83-7)

February 7: In a White House speech to persons from the aviation, government, diplomatic, military, and business areas, President Reagan hailed 200 years of manned flight and announced a decision to "keep the shuttle production lines intact" to "preserve the option of building the fifth shuttle" and advantage of "the tremendous opportunities that lie ahead." (Text, Feb. 7/83)

• Senior NASA managers, headed by Lt. Gen. James A. Abrahamson, associate administrator for space flight, had met with contractors and "cleared the way" for returning the tracking and data-relay satellite to KSC's launch pad in preparation for the first launch of Challenger, the agency said.

Results of the second flight-readiness firing led to a decision not to conduct a third firing before launching Challenger early in March. The #1 engine had been removed for exchange with the flight spare. The spare would have the high-pressure pump from the #1 engine installed before the change took place. (NASA Release 83-16)

• Tass reported that the fuel core for the nuclear-powered *Cosmos 1402* entered the atmosphere over the Atlantic at 1:56 p.m. Moscow time and "burned up entirely." Data from "competent Soviet organizations tracking the flight" said the Sputnik "totally ceased its existence." (FBIS, Tass in English, Feb 7/83)

February 18: A panel investigating the loss of two solid-fuel rocket boosters after the launch of STS-4 said that a switch in the booster decelerators was at fault.

Premature separation of one of two riser attachments on each main chute occurred about 365-seconds after liftoff, when the frustrums were exploded away from the booster, instead of at impact with the water. A switch designed to release the chutes when the boosters hit the water had freed the parachutes from the boosters before impact, probably because of severe shock when the explosion separated the frustrum from the boosters.

Before STS-5, NASA modified the decelerating system to fix both risers firmly to each booster, to eliminate switch separation, and to prevent shock from affecting other subsystems. The booster deceleration worked perfectly during STS-5. (NASA Release 83-19)

February 22: NASA announced the selection of crews for STS-13 and Spacelab 3, as well as mission specialists for Spacelab 2. Robert L. Crippen, who piloted STS-1 and was scheduled to command STS-7, would command STS-13 in April 1984 with Francis R. Scobee as pilot. Mission specialists would be Dr. George D. Nelson, Terry J. Hart, and Dr. James D. van Hoften.

Robert F. Overmyer, who has pilot of STS-5, would command STS-18 (the Spacelab 3 mission, now scheduled for launch ahead of Spacelab 2) with Frederick D. Gregory as pilot. Mission specialists would be Dr. Don L. Lind and physicians Dr. Norman E. Thagard and Dr. William E. Thornton. Both of the latter would be on Shuttle flights before Spacelab 3: Thagard on STS-7, Thornton on STS-8. Payload specialists would be selected later.

Mission specialists for STS-24 (Spacelab 2) would be Dr. Anthony W. England and Dr. Karl G. Henize. Spacelab 3 was originally to be the first operational mission; Spacelab 2, which should have preceded Spacelab 3, was delayed for completion of an instrument-pointing system. (NASA Release 83-22)

During February: The Florida Historic Preservation Society charged that NASA had breached a 1974 agreement by arranging for demolition of the last

Apollo launch tower at KSC and sale of the metal as scrap. NASA said that it had to award a contract for demolition by February 18 or risk further delay in Shuttle schedules: the tower had to be removed by October so that NASA could begin modifying the mobile launch pad for use by the Shuttle beginning in 1986.

NASA had postponed demolition for a week to let the society find a way to preserve the tower but said none of the suggestions was practical. The matter arose when two U.S. Air Force engineers at KSC said that the tower could be a major tourist attraction and started a move to save it. NASA said that it would cost up to $4 million to remove the tower and reassemble it for display. The agency had accepted a bid of $557,000 to remove the tower, and the demolition company would keep the steel, worth about $400,000, as scrap. A coalition of historic preservation groups said that the tower could be removed and rebuilt for $1 million (admittedly only an estimate). NASA had offered free storage and a site for reconstructing it if the coalition would pay a contractor to dismantle and move it. (NASA Release 83-25; *W Post*, Feb 17/83, A-17)

• NASA said that its IRAS launched January 25 had revealed infrared sources in the Large Magellanic Cloud not visible to optical telescopes on Earth. The Large Magellanic Cloud was the galaxy closest to Earth, about 155,000 light years away. IRAS produced an image from the nebula, called 30 Doradus, of a cloud called Tarantula by astronomers, from its long separate filaments giving it a spider-like appearance. Astronomers suggested that the nebula (a giant H II region, consisting of hydrogen clouds ionized by the ultraviolet radiation from a very hot star) might contain a monster star thousands of times more massive than Earth's Sun. (NASA Release 83-21)

March

March 1: NASA technicians at Cape Canaveral removed two of Challenger's main engines for repairs; a third engine, on its way from Mississippi, would undergo similar maintenance. Lt. Gen. James A. Abrahamson, associate administrator for space transportation systems, told a House subcommittee on science and technology that discovery of the flaws while the Shuttle was still on the ground showed the agency's conservative approach to safety. He blamed tight budgets in the past for a lack of spare parts. Delay from the original January 20 launch date had already cost NASA about $1.5 million; costs would increase later when crews would have to work overtime to meet program commitments.

Challenger's #1 engine was removed February 4 when a crack in a coolant line allowed inflammable gas to leak into the aft compartment. Then, the replacement engine was found to have an oxygen leak in its heat exchanger, a system to pressurize the external fuel tank. An inspection of the #3 engine revealed the same flaw.

As Challenger's engines were intended to handle heavier payloads than Columbia's, a design change had added a metal sleeve over the fuel-supply tubes to absorb greater vibrations. Soldering apparently overheated and embrittled the underlying metal tubing. Welding new tubing would make the configuration like the old Columbia engines, and Challenger would not be able to run at full thrust. (*NASA Dly Actv Rpt*, Mar 2/83; *NY Times*, Mar 2/83, A-1; *W Post*, Mar 2/83, A-5)

March 5: NASA said that it would have to revise the schedule for Challenger's first launch because delays had pushed the date past the vernal equinox and would put the Shuttle's communications satellite payload in Earth's shadow for an undesirably long time. Liftoff would be reset for 1:30 p.m. EST, regardless of the date, shortening the launch window from 4 hours to 18 minutes, because of the need for daylight conditions at an emergency-landing runway in Dakar, Senegal.

Spring would start March 20 at 11:39 p.m. EST. With the sun directly over the equator, the time in darkness between transferring the communications satellite from the Shuttle's low Earth orbit to stationary orbit at 22,300 miles altitude would have resulted in too much heat loss. All five Columbia missions were launched in the morning, the earlier the better according to NASA, so that the crews had more daylight to work in. (*NY Times*, Mar 6/83, 38)

March 7-19: A KSC spokesman said that another problem could delay further the first flight of Challenger: contamination of the giant tracking and data-relay satellite (TDRS) to be carried on that flight. A storm February 28 with winds from 60 to 70 mph had carried "sand, salt, silica particles, and paint chips" into the room at the launch pad where the payload was kept and onto the satellite. NASA said earlier that the TDRS was not seriously damaged by "particulate matter" found on it; however, the contaminants were undergoing laboratory tests, and the sensitive Earth-scanner and tracking instruments were being closely examined. Launch would again be delayed, probably to April 7.

Spokesman James Kukowski said that NASA could fly the 2½-ton satellite as is; try to clean it inside the Challenger cargo bay (where it was installed February 25); remove and clean it at the launch pad; return it to a KSC payload assembly building; or send it back to TRW's plant in California. Delays were costing up to $3 million a day in overtime. (*NY Times*, Mar 8/83, C-8; Mar 11/83, A-14; Mar 19/83, 14; *W Post*, Mar 9/83, A-17; Mar 11/83, A-18; Mar 19/83, A-10)

March 9: NASA said that it had joined with the Department of Energy (DOE) and the DOD in a program to advance technology of nuclear-reactor power systems for use in future civilian and military space missions. The SP-100 program would assess promising concepts with the aim of beginning engineering and ground testing within a few years. Research would proceed on thermoelectric and other power-conversion systems; high-temperature metals and materials; radiators for dissipating waste heat in space; and high-temperature nuclear fuels. A project office at JPL would provide day-to-day management of SP-100. (NASA Release 83-30)

• LeRC issued a request for proposals to design, build, and launch an ACTS system, including flight spacecraft, ground system, and operations. Launched by the Space Shuttle in 1988, ACTS would serve for two years in communications experiments. (NASA Release 83-28; LeRC Release 83-14)

• Tass announced the docking of *Cosmos 1443*, probably an advanced version of earlier Salyut craft, with *Salyut 7* that had been orbiting since April 1982. *Cosmos 1443*, launched unmanned from Baykonur March 2, weighed about 20 tons and was larger than the Soyuz or Progress spacecraft. The 21-ton *Salyut 7* was about the size of a small house trailer, said the *New York Times*. The linkup was thought to demonstrate the Soviet Union's ability to assemble larger space stations. (FBIS, Tass in English, Mar 10, 11/83; *NY Times*, Mar 11/83, A-12; *W Post*, Mar 11/83, A-24)

March 12: Launched January 25, IRAS had already discovered up to 20 distant galaxies too small to see previously. Dr. James Houck of Cornell University, one of 18 astronomers on the three-nation IRAS science team, said at JPL that only 20 small galaxies outside the Milky Way were measured before IRAS went into orbit. "In 12 hours of operation with this satellite, we doubled that number." In a single minute, the 22.4-inch IRAS telescope found out more about the Large Magellanic Cloud, galaxy closest to the Milky Way, than ever discovered by Earth telescopes.

The IRAS telescope, cooled by liquid helium to 2.5° above absolute zero to offset any stray heat that might confuse its imaging, was so sensitive that it could detect an object with temperatures far below that of freezing on Earth. Optical telescopes, by contrast, could see only objects with temperatures hot enough to make them shine (above 10,000°F). The telescope was built in the United States, the spacecraft in the Netherlands; Great Britain was tracking it.

The biggest surprise, said Houck, was that the $80 million satellite was "working better than we had hoped," seeing cooler objects in greater detail than astronomers thought possible. Over its 12-month lifetime, IRAS could survey 95% of the sky in the infrared, never attempted from the ground. Infrared lightwaves were longer than those in the visible spectrum but shorter than radiowaves. The projected lifetime would probably be extended by 50% because of the slow rate of helium use so far. (*W Post*, Mar 12/83, A-10)

March 17: MSFC test-fired a high-performance development motor for a Shuttle solid-fuel rocket booster, redesigned for more thrust at liftoff and higher payload capability. Successful completion of the test would qualify the motor for flight. First use would be on the eighth Shuttle mission, set for summer 1983. (MSFC Release 83-12)

March 22: NASA announced the establishment of a Research Institute for Advanced Computer Science at ARC, to begin operations in June. Funded by NASA through the Universities Space Research Associations (USRA), the institute would be a place for the academic community to work in computer science, applied math, and computer applications to solution of scientific and engineering problems. Director of the institute would be Dr. Peter J. Denning, head of the computer sciences department at Purdue University. (NASA Release 83-38)

March 23: The *Nimbus 5* Earth-observation satellite would end operations as of April 1, said Dr. S.G. Tilford of NASA's environmental observation division. Launched in 1972, *Nimbus 5* would probably reenter after the year 2000. Its last on-board tape recorder stopped in November 1982. The U.S. Navy, the only user of its data, would get this information from *Nimbus 7*. (NASA Release 83-40)

• MSFC said that NASA transferred the Astro program (Spacelab astronomy missions beginning in 1986) to it from GSFC. Leon B. Allen, Astro manager, said that the move followed reallocation of internal resources at GSFC. MSFC was the logical place for the program because of experience in managing shuttle missions. (MSFC Release 83-14)

March 28: NASA launched NOAA-E for NOAA from the Western Space and Missile Center (WSMC) on an Atlas vehicle at 7:52 a.m. EST into an orbit with 829-kilometer apogee, 806-kilometer perigee, 101.2-minute period, and 98.8° inclination. Called *NOAA 8* in orbit, it carried search and rescue (SAR) equipment to locate signals from emergency beacons on planes and ships.

An hour later, when the satellite came over Vandenberg Air Force Base for the first time, malfunction of a control device was rotating the spacecraft "like the propeller on a plane," said a NASA spokesman. As it solar panels could not fix on the Sun, the spacecraft was losing the power needed to make corrections and was put into a safety mode to prevent further discharge of battery power. A similar problem occured in 1978 with *TIROS-N* and was corrected in two weeks. (NASA MOR E-615-83-04 [prelaunch] Mar 23/83; *NY Times*, Mar 29/83, A-14; *W Times*, Mar 29/83, 3; *A/D*, Mar 30/83, 171; *P Inq*, Mar 30/83, 10; *Spacewarn* SPX-354, Apr 26/83)

• A report from the House Appropriations Committee said that the Space Telescope, called by NASA Administrator James M. Beggs "the most important scientific instrument" ever to be flown, would cost $200 million more and reach orbit a year later than expected because of difficulties in development.

The report blamed delays and cost overruns on NASA for understaffing the program by 50% in its early development, and on Perkin-Elmer Corporation, one of two major contractors, for failing to "properly plan for a project of the technical and manufacturing difficulty of the Space Telescope." Besides the glitches in tracking and alignment devices, possibly unremovable dust on the primary telescope mirror after 15 months in a Perkin-Elmer "clean room" had lowered its reflecting power by 20 to 30%. (*W Post*, Mar 28/83, A-8)

March 29: An international team of scientists studying the upper tropical atmosphere completed a month of rocket launches in Peru. Project Condor was an equatorial-atmosphere rocket and radar mission by universities and agencies of the United States, Peru, and the Federal Republic of Germany. The equatorial jet stream spawned the largest electrical currents and fields outside the auroral zone. Also, high- and low-density plasma mixing in the post-sunset ionosphere created greater disturbances than magnetospheric substorms.

Project Condor, part of NASA's sounding-rocket program, was managed by GSFC's Wallops Flight Facility. Condor would map electrical conditions and wind- and radio-wave patterns in the tropic upper atmosphere; applications would include, for instance, satellite ranging systems used to locate ships at sea that could be affected by ionosphere conditions. (GSFC Releases 83-4, 83-7)

April

April 1-14: Countdown for the April 4 launch of STS-6, first flight of shuttle orbiter Challenger, began when inspection of its payload—TDRS—showed "a much lower level of contamination than originally thought." Robert E. Smylie, associate administrator for space tracking and data systems, said that the cargo bay and critical parts of the TDRS solar array had been cleaned and that TDRS would be put back into the cargo bay.

Press reports noted that the 75-ton Challenger, a slimmed-down version of Columbia, could lift more and was nearly 2,500 pounds lighter than its predecessor. Made of lighter materials, it had no crew-ejection seats. Crew of the five-day $26-million mission would be Paul Weitz, the only spaceflight veteran; Karol Bobko; and Donald Peterson and Story Musgrave, who on the fourth day of the mission would perform the first Shuttle space walk.

Launch April 4 at 1:30 p.m. EST from KSC exhibited "no sign of the engine trouble that forced four of its five launch postponements," said press reports. Challenger was in orbit 10 minutes after liftoff.

About 11:30 p.m. the crew launched TDRS from the cargo bay by firing six explosive bolts that hurled it a mile or so from Challenger. About one hour later, from a distance of about 32 miles, the crew fired a huge rocket engine attached to TDRS to start boosting it to a permanent position 22,400 miles above the equator. TDRS-A would be first of three communications satellites to be stationed in a global network that would quadruple the area from which U.S. spacecraft could communicate with Earth, as well as the amount of time available for such communication, and would begin to eliminate the need for global ground stations.

About 6 a.m. EST April 5 ground control lost touch with TDRS during a 104-second firing to nudge it into higher orbit. This was the second use of the rocket system called inertial upper stage (IUS), built by Boeing for the U.S. Air Force. The second state ignited but burned only about 70 seconds; TDRS and its rocket were out of contact for 3 hours. The STS-6 crew was asleep at the time. At 9 a.m. EST, mission control suddenly reacquired signals from TDRS, and project officials reported that it had separated from the IUS and stabilized itself. All satellite sytems appeared to be working normally. NASA said that it had appointed a panel to look into anomaly, which was blamed on misfire of an on-board rocket. The misfire put TDRS into an eccentric orbit at an angle to the equator, instead of almost directly over it. Flight directors said that they could correct the TDRS orbit by period firings of on-board hydrazine.

Just before the space walk April 7, President Reagan congratulated the STS-6 crew on being "ahead of schedule," adding "I can't say I envy you."

A reporter who asked the president why was told "May be a little claustrophobia."

Musgrave and Peterson exited through an airlock just after 4 p.m. EST, fastened themselves to 50-foot safety wires, and moved about the 65-foot-long cargo bay to test new space suits, handholds and footholds, tools, and ropes to be used in retrieval and repair of orbiting spacecraft. While Weitz and Bobko watched from inside, Musgrave and Peterson stayed outside Challenger for 3 hours and 52 minutes, doing the first U.S. space walk since February 1974, when Edward Gibson and Gerald Carr left Skylab to retrieve film from an exterior camera. A space walk scheduled last November from the Shuttle Columbia had been canceled when both space suits exhibited mechanical failures.

On April 8 from JSC mission control, Vice President George Bush told the crew that their mssion was a "significant contribution." The crew had suffered some space sickness but felt "pretty chipper," according to the capsule communicator. When the astronauts appeared on television during Bush's visit, Musgrave was performing rolls in the weightless environment, and Weitz explained that he was "trying to see if he can make himself sick again."

Challenger, with Weitz at the controls, landed at Edwards Air Force Base April 9 at 1:53 p.m. EST. Lt. Gen. James A. Abrahamson, NASA associate administrator for space flight, said that the crew and the vehicle were "in great shape." Besides launching TDRS, the mission exposed seeds to effects of weightlessness and cosmic radiation. It also carried a snowflake machine from the Japanese newspaper *Asahi Shimbun* to produce symmetrical crystals, such as those needed in computers; a device to separate rat and egg proteins in weightlessness, aimed at ultrapure medicines; a device to produce uniform microscopic latex beads to test supersensitive measuring instruments; and an Air Force Academy canister containing a tiny oven to solder metals in weightlessness.

STS-7, tentatively set for June 9, was to land Challenger at KSC only a few miles from its launch point. STS-8 was supposed to take TDRS-B into orbit as part of a communications link needed for the European Space Agency's (ESA) Spacelab mission due to fly on STS-9; Spacelab would carry about 40 scientific experiments requiring constant communications with Earth through the two TDRS communications satellites.

However, Abrahamson said that NASA "will not fly a second satellite on the eighth shuttle flight until we understand what went wrong on this flight." He said that a U.S. Air Force camera in New Mexico had recorded, from a distance of about 20,000 miles, what happened to put the $100 million TDRS into a wrong orbit. (NASA MOR T-313-83-01 [prelaunch] Jan 14/83, Mar 25/83; NASA Releases 83-37, 83-49; MSFC Release 83-21; text, Pres. Doc., Apr 4, 7/83; *NY Times*, Apr 6/83, A-1; Apr 7/83, D-7; Apr 8/83, A-1; Apr 9/83, 8; Apr 10/83, 1; *W Post*, Mar 31/83, A-15; Apr 5/83, A-1; Apr 6/83, A-1; Apr 8/83, A-1; Apr 10/83, A-1; *W Times*, Apr 5/83, 2A)

April 4: For the first time in the U.S. space program, one satellite used signals from another satellite to navigate. The Air Force System Command said that Landsat D (*Landsat 4*), a NASA remote-sensing craft built by General Electric, was getting signals from the U.S. Air Force Space Division's NavStar global-positioning system (GPS) satellite to compute position, velocity, and time. *Landsat 4*, first satellite to carry a GPS receiver, could record its precise position as it acquired Earth-imaging data. The receiver also eliminated transmission of navigation signals between space and Earth; direct signal reception ensured efficient and economic spacecraft operation. (*AFSC Newsreview*, Apr 4/83, 5)

April 11: NASA launched RCA-F at 5:39 p.m. EDT from the Eastern Space and Missile Center (ESMC) on a Delta into a transfer orbit with 36,266-kilometer apogee, 169-kilometer perigee, 634.2-minute period, and 24° inclination, before reaching geosynchronous orbit at 139°W where for 10 years it would provide commercial and official voice, digital, and video communications between Alaska and the continental United States.

Called *Satcom 1R* in orbit, the 3-axis stabilized craft weighed nearly 600 kilograms (1,320 pounds) and carried 24 solid-state transponders. It would replace the first of RCA's domestic communications satellites, *RCA Satcom 1* launched December 12, 1975, which had served for seven years. *Satcom 1R* joined five previous RCA communications satellites to provide television, voice, and high-speed data transmission to all 50 states and Puerto Rico. More than 4,000 Earth stations had direct access to these spacecraft. (NASA MOR M-492-206-83-07 [prelaunch] Mar 31/83; NASA Release 83-44; SPX-354; NASA wkly SSR, Apr 14/83)

• NASA said that President Reagan asked his Senior Interagency Group for Space, chaired by William P. Clark, assistant to the president for national security affairs, to establish a basis for an administration decision on whether to proceed with NASA development of a permanently based manned space station. (NASA Release 83-51; MSFC Release 83-24)

• After months of unsuccessful effort to communicate with Viking lander 1 (the Mutch Memorial Station on the surface of Mars), engineers at JPL decided that they probably could not reestablish contact.

Launched in August 1975, the lander reached Mars July 20, 1976, and was joined by lander 2 September 3 of that year for the most thorough examination of another planet ever undertaken. When contact was lost in November 1982, engineers vainly transmitted command series based on studies of possible failure modes. However, lander 1's internal program could initiate signals to Earth without being commanded; if the lander were still operating, it might transmit in May.

Lander 1 was renamed the Mutch Memorial Station to honor Dr. Thomas A. Mutch, former leader of the Viking imaging team, who disappeared in

September 1980 during a climbing trip in the Himalayas. (NASA Release 83-47)

April 14: Efforts to push the $100-million TDRS communications satellite into its proper orbit were suspended when NASA engineers found that two of its maneuvering rockets were damaged and would not work. Firing the 16 small thrusters on the satellite was the obvious way to correct the orbit, but Ron Browning, TDRS project manager, said that engineers from NASA and TRW Inc., manufacturer of TDRS, would take four to six weeks to figure how to operate it with "less than a fully optimal control system." (*W Post*, Apr 14/83, A-3)

April 16: A Solar System Exploratory Committee, representing the science community and NASA, concluded a two-year study by recommending that the agency undertake "moderately priced missions" to Mars, Venus, Titan, and a comet before the end of the century. NASA had sent 32 unmanned spacecraft to other worlds in the 1960s and 11 in the 1970s; only 2 in this decade.

Proposals were a Venus radar-mapper in 1988, a Mars orbiter in 1990, flyby of an asteroid and rendezvous with a comet in the mid-1990s, and a probe of Saturn's moon Titan between 1988 and 1992. Other missions of interest to the group would be sampling Mars and comets; robot rovers on Mars; and probes to Neptune, Uranus, and Saturn. (*W Post*, Apr 17/83; A-9; *NY Times*, Apr 17/83, 22)

April 17: India, for the third time since 1980, launched a satellite into orbit from its own soil. Prime Minister Indira Gandhi watched liftoff of the 17-ton four-stage rocket carrying the 91-lb Rohini satellite from Sriharikota island off India's east coast. The launch, part of a series aimed at perfecting the launch vehicle, would be followed in the next 10 years by higher investment in the national space research program, Gandhi said. (*W Post*, Apr 18/83, A-17; FBIS, Apr 20/83; *NASA Dly Actv Rpt*, Apr 25/83)

April 18: NASA announced a deal with Orbital Systems Corporation, a private company, to develop and market a $20-million propulsion system for launching satellites from the Space Shuttle. (*NY Times*, April 19/83, D-1)

• GSFC said that signals radioed to the NOAA-E environment satellite had stabilized it, apparently solving the attitude-control problems it had developed after launch March 28 from Vandenberg Air Force Base. A team of experts from government and industry drew up instructions for the corrections that resulted in complete recovery, according to Gerald W. Longanecker, project manager. The satellite carried six environmental-monitoring devices and one search-and-rescue satellite-aided tracking (SARSAT) experiment, the latter for use in locating and rescuing victims of plane crashes and ships in distress.

Launched on a U.S. Air Force Atlas E, NOAA-E went into near-perfect orbit but was found to be in the wrong attitude after reaching a 450-nautical-mile altitude; it was in a spin every 17 minutes instead of pointing its sensors and antennas toward Earth. The correcting signals stopped the tumble and allowed the control system to acquire Earth lock. (NASA Release 83-61)

April 19–22: The Soviet Union launched from Baykonur three cosmonauts at 5:11 p.m. Moscow time in *Soyuz T-8* on a mission to dock with orbital complex *Salyut 7-Cosmos 1443*. Commander of the mission was Soviet air force Lt. Col. Vladimir Titov as commander, Gennady Strekalov as flight engineer, and Aleksandr Serebrov (who was on a week-long mission in August 1982) as researcher.

Tass later said that "deviations from the planned rendezvous program" canceled plans to dock with the orbital station, and the crew made a soft landing near the city of Arkalyk April 22 at 5:29 p.m. Moscow time. Radio Moscow had said this would be the first time a piloted craft docked with such a huge space complex. Although North American Air Defense Command (NORAD) radar showed the Soyuz and Salyut in close orbits, the Kettering satellite-monitoring group in England said that the mission did not proceed as expected and that communications between the cosmonauts and ground control were "very terse." This was the first failure of a Soyuz-T, a type in use for three years. (FBIS, Tass in English, Apr 20/83, Apr 22/83; Beijing Xinhua in English, Apr 22/83; *W Post*, Apr 19/83, A-20; Apr 22/83, A-1; Apr 23/83, A-1)

April 25: Scientists at ARC said that *Pioneer 10* would be nearly 2.8 billion miles beyond the Sun at 2 p.m. PDT, when it passed the orbit of Pluto, traveling 30,000 mph on its way outside the solar system. The first manmade object to reach such a distance, *Pioneer 10* might go on for millions of years and carry Earth greetings to another galaxy. Launched March 2, 1972, the craft had functioned "almost with flaw," said project manager Richard Fimmel.

Because of its elliptical orbit, Pluto—usually the outermost planet—at this time was nearer than Neptune to the Sun and would travel inside Neptune's orbit for the next 17 years. *Pioneer 10* would cross Neptune's orbit June 13, effectively leaving the solar system behind. Radio signals moving at the speed of light needed more than four hours to cross the distance between Earth and spacecraft; even after a decade in space, *Pioneer 10* was transmitting data of great value to scientists. Since the date of its launch with a predicted lifetime of 21 months, long enough for a Jupiter encounter, *Pioneer 10* signals over vastly increasing distances had remained detectable because of improvements in antenna sensitivity. NASA said that it hoped to track the craft for another eight years, to a distance of 5 billion miles, 2.2 billion miles beyond its present location. (NASA Release 83-57; ARC Releases 83-13, 83-14; *W Post*, Apr 25/83, A-23)

• In an exercise called Balloon Intercomparison Campaign, NASA launched four giant balloons from the National Scientific Balloon Facility (NSBF) at Palestine, Tex., to a 40-kilometer (25-mile) altitude in the largest study ever of ozone depletion in the stratosphere and global air pollution from natural events like El Chichon's eruption in April 1982. Each 800-foot-high, 450-foot-wide balloon could carry two tons of scientific devices. Investigators were from Canada, Europe, Japan, and the United States. (JPL Release 1019; NASA Release 83-62; LA *Her-Exam*, April 24/83, 2)

April 28: NASA launched GOES-F from ESMC at 6:26 p.m. EDT on a three-stage Delta into a transfer orbit with 48.400-kilometer apogee, 33,483-kilometer perigee, 1707.4-minute period, and 0.5° inclination, before moving it into geosynchronous station at 135°W over the Pacific to acquire environmental data as "Goes West." The launch was the 34th consecutive success for a Delta. (NASA MOR E-612-83-04 [prelaunch] Apr 28/83; *NASA Dly Actv Rpt*, Apr 29/83; *Spacewarn*, SPX-355)

• Press reports described NASA plans to raise the orbit of TDRS to the proper 22,300 miles altitude by as many as 12 separate firings of different engines over a two-week period. Robert Aller, TDRS program manager, said that TDRS was essential to U.S. military and civilian satellites for the next 20 years. "Without it, we can't use the space shuttle [or] Spacelab the way we want to, and we can't use some very expensive projects like Landsat or the space telescope at all." The $1 billion telescope, called the most ambitious scientific instrument ever built, would be useless without TDRS's high-speed communications relays.

TDRS was about 10,000 miles below the lowest point at which it should approach Earth. The proper orbit would be geosynchronous at 22,335 miles altitude, where its speed would match Earth's spin at the equator. TDRS should reach that point by June: if not, NASA would face "a long trudge up Capitol Hill to explain the impact of the loss." (*NY Times*, Apr 25/83, B-12; *W Post*, Apr 28/83, A-17)

May

May 2: Engineers at GSFC sent commands to fire 6 of the 24 small control thrusters on the TDRS that was launched from Challenger in April into a faulty orbit. Scheduled to last one hour, the firing ended after 41½ minutes, when one thruster overheated. Engineers said that they could prevent overheating in future maneuvers. The firings would continue daily for two to three weeks. (*NY Times*, May 3/83, C5; *W Post*, May 3/83, A-11)

May 4: MSFC reported successful simulation of Solar Maximum Mission (SMM) spacecraft-repair procedures in its huge neutral-buoyancy tank as rehearsal for the actual task set for 1984 during the 13th shuttle mission.

Solar Max, launched February 14, 1980, worked for 10 months until fuses blew on three of its four attitude-control momentum wheels. The repair mission would replace its 500-pound attitude-control subsystem and part of the coronagraph-polarimeter. Three of its seven instruments continued to work despite the malfunction.

Dr. George Nelson, lead astronaut for the repair, and STS-13 pilot Francis Scobee wore space suits during the underwater simulation to experience the physical difficulty of working in the space environment. Dr. Nelson and Dr. James D. van Hoften would make the actual repairs.

Dr. Ernie Hildner, coinvestigator on the polarimeter and MSFC's solar physics branch chief, said that watching the simulation made him "more optimistic about the success of the endeavor." (MSFC Release 83-30)

May 6–27: Challenger's second flight in August would probably not include the second TDRS, said NASA's Robert Aller, as the agency still had no idea why the first tumbled out of control after launch April 5. STS-8 would carry only a small communications satellite for the government of India; as a substitute for the $100-million TDRS, NASA would fly the "payload flight test article," an 8,500-pound package designed to test the robot arm's ability to retrieve and deploy satellites.

Postponement of TDRS-B would keep the $1 billion Spacelab built by ESA and scheduled to fly in September on STS-9 from carrying out its full mission, as its 40 instruments were designed to work at such high speeds that they needed at least two tracking satellites to operate properly. However, ESA and NASA agreed to launch Spacelab on schedule and get a 60% to 70% return from its experiments. Even this, Aller said, would depend on NASA's ability to move TDRS-A into a synchronous orbit. Two test firings had raised its perigee 350 miles, and Aller expressed "confidence we will have [TDRS] in geosynchronous orbit sometime in June."

Press reports said that firings May 10 and 11 raised the perigee more than 800 miles, still 7,000 miles short; it would take another three weeks of daily firings to achieve synchronous orbit. On May 27, NASA said that it removed TDRS-B from the cargo manifest for STS-8 and substituted the test article. By that time it had moved TDRS-A within 3,675 miles (5,915 kilometers) of proper perigee. (*W Post*, May 7/83, A-3, May 11/83, A-9; May 12/83; NASA Release 83-86; MSFC Release 83-38)

May 16: President Reagan issued a directive for the government to rent launch pads and sell rocket parts and plans to private firms as "a domestic backup for the shuttle at essentially no cost to the U.S. government. . . .the private sector would assume all costs of [expendable launch vehicle] production now borne by the U.S. government." U.S. government facilities and equipment that would otherwise be underutilized or no longer required would find a market.

The government began 10 years ago to phase out expendable rockets like Delta, Atlas, and Titan in favor of reusable Space Shuttles. Contracts with rocket firms were ending, and launch pads at the Cape were closing down.

Gilbert Rye of the National Security Council said that the costs of keeping the U.S. facilities open and operating would be borne by the private companies. The president's directive would allow the firms to buy parts and government-owned plans for the rockets at cost and to pay for the use of launch pads, equipment, and engineers. (Text, PresDoc, May 16/83; *W Post*, May 17/83, A-1)

May 18: Pioneer 9, orbiting the Sun since its November 1968 launch, returned its last signals to Earth. The 148-pound TRW-built craft and its sisters, *Pioneer 6*, *Pioneer 7*, and *Pioneer 8*, were among the earliest interplanetary probes, and the other three were still functioning. Designed to transmit data for only six months, *Pioneer 9* had continued to do so until May 18, 1983. ARC engineers tried vainly to revive it. (NASA Release 87-23; *W Post*, Mar 5/87, A-9)

May 19: NASA launched *Intelsat 5-F* at 6:26 p.m. EDT from ESMC on an Atlas Centaur into a transfer orbit. This was the 100th launch for LeRC. The 4,400-pound Ford Aerospace-built communications satellite carried 12,000 voice and two color television channels and was the first to have a maritime communications link for ship-to-shore communications. (NASA Release 83-77; LeRC Release 83-25; *NASA Dly Actv Rpt*, May 20/83; *D/SD*, May 17/83, 95)

NASA declared the May 19 launch of *Intelsat 5-F* successful, as the Atlas Centaur had put the satellite into the desired transfer orbit. After an apogee kick motor fired May 22 put it in near-geosynchronous orbit for initial positioning and preliminary tests, the *Intelsat* would be moved on station over the Atlantic Ocean. (NASA MOR M-491-203-86-06 [postlaunch] June 13/83)

May 22: Final attempts to contact the Viking 1 lander on Mars failed, and JPL spokesman said that they would try no more "unless NASA Headquarters changes its mind." The craft outlived its 90-day guarantee by years; it was survivor of a pair of two-part spaceships, each including an orbiter that circled Mars while its robot laboratory sampled and photographed the planet's surface. Viking 2's lander and Viking 1's orbiter went mute in April 1980. The $500-million project returned data on Mars, including pictures of rust-red rocks and boulders, dust storms, and periodic layers of frost; recorded temperatures ranged from 124°-24°°F below zero. (*NY Times*, May 23/83, A–17; *W Post*, May 23/83, A–8)

May 26: NASA launched ESA's X-ray observatory, Exosat, from Vandenberg Air Force Base at 3:18 p.m. GMT on a Delta. Designed to study cosmic X-ray sources from 0.04 to 80 Kev, the craft carried four instruments: two imaging telescopes, a large-area proportional counter array, and a gas-scintillation spectrometer. It reached a planned highly elliptical orbit with 192,000-kilometer apogee, 340-kilometer perigee, and 72.5° inclination. ESA's operations control center (ESOC) took over shortly after liftoff. (NASA MOR M-492-304-83-01 [prelaunch] May 20/83; ESA Infos 18, 20)

May 27: NASA reached agreement with the National Trust for Historic Preservation and five co-plaintiffs in a U.S. district court suit to preserve the last of the Apollo-program rocket gantries at KSC. NASA said that it would disassemble the gantry into 20-foot sections and store them until a place was found to display the tower and money could be raised to reassemble it.

Michael Ainslie, president of the National Trust, said that the agreement recognized "the growing national imperative for the preservation of our physical history, even if that history was built less than 20 years ago." NASA said that it would cost $1.8 million to take the tower apart and $8 million to reassemble it. (*W Post*, May 28/83, A–11)

During May: Dr. Jack Kerrebrock, associate administrator for aeronautics and space technology at Headquarters, announced that he would return to the Massachusetts Institute of Technology (MIT) July 1 to resume the position as head of MIT's department of aeronautics and astronautics that he held before coming to NASA in July 1981. Dr. Raymond S. Colladay would act as associate administrator until the position was filled (Hq anno May 27/83)

—Robert C. Goetz, director of structures at Langley Research Center (LaRC), would become deputy director of Johnson Space Center (JSC), effective July 1, replacing Clifford E. Charlesworth who would become JSC director of space operations. (LaRC Release 83-32)

June

June 2–7: The Soviet Union launched from Baykonur two interplanetary spacecraft, *Venera 15* on June 2 on *Venera 16* on June 7. The spacecrafts first went into "an intermediate orbit of an artificial earth satellite"; then, an on-board engine sent them toward Venus, where they were scheduled to arrive in October.

Venera 15 had no descent module, indicating that "a landing is not being planned" and that the spacecraft would conduct atmospheric and surface research from orbit. Tass said that *Venera 16*, "by its design and mission," was "analogous to" *Venera 15*. Tass also mentioned the lapse of more than 20 years since the Soviet Union began its interplanetary program with the launch in February 1961 of *Venera 1*, which reached a heliocentric orbit. First probe to land on Venus was *Venera 3*, in March 1966; *Venera 4* landed gradually and sent data on the planet's atmosphere for 93 minutes. *Venera 13* and *Venera 14* soft-landed in March 1982 and returned photographs of the landing site. (FBIS, MoscDomTvSvc in Russian, Tass in English, June 2&7/83)

June 10: A NASA board said that slippage of a mechanical adjustment caused a December 1982 accident at ARC during tests of the world's largest and newest wind tunnel. The collapse of a structure smoothing airflow through the tunnel pulled debris through the power section and damaged the fan blades beyond repair. The damage cost more than $10 million and would delay completion by a year or more. No persons were injured. (NASA Release 83-96)

June 12: The prototype Shuttle Enterprise, returning from an overseas tour that included the Paris air show, flew over Washington, D.C., and Baltimore, Md., early in the morning before landing at Dulles airport in Virginia for public viewing at a distance. "Hundreds of thousands," according to the *Washington Post*, came to see the Shuttle, "despite soaring temperatures." Enterprise and its Boeing 747 transport jet left for California the next day. (NASA Releases 83-89, 83-93; *W Post*, June 13/83, B-1; *USA Today*, June 13, 7A; *W Times*, June 13/83, 1A)

June 13: Press reports said that the 10th Shuttle mission originally set for November, first to have a secret mission and first to be flown solely for the U.S. Air Force, was delayed "indefinitely" at the request of the Air Force and that NASA officials had "no idea" when it would be rescheduled. The Air Force confirmed the delay but would not discuss the reasons. NASA and the Air Force had an agreement allowing the service to preempt any scheduled Shuttle mission.

Unidentified sources said that the reason was the Boeing-built upper stage that failed when the TDRS was launched from the Shuttle in April. Postponement indicated that the payload scheduled for the Air Force would have used the type of upper stage that malfunctioned. A special board convened to investigate the matter had not issued a report. (*NY Times*, June 14/83, C-3; *W Post*, June 14/83, A-7)

• At 8 a.m. EDT June 13, unmanned U.S. spacecraft *Pioneer 10* crossed the orbit of Neptune on the way out of the solar system. The 570-pound robot craft 2.81 billion miles from the Sun and traveling 30,558 mph at the time. (NASA Releases 83-39, 83-91; ARC Releases 83-11, 83-18; *W Post*, June 12/83, A-1; June 14/83, A-1; *NY Times*, June 14/83, A-1)

June 16: Associated Press (AP) said that ESA launched Ariane 6 at 7:59 a.m. EDT from Kourou, French Guiana, carrying two communications satellites: the first ESA telecommunications craft, the British Aerospace-designed *Ecs 1*, and a smaller West German satellite to retransmit amateur radio broadcasts.

This sixth attempt to get the three-stage Ariane off the ground was considered a "crucial boost" to Europe's space program as a way to break th superpower monopoly on space. Ariane faced competition from the U.S. Space Shuttle and from private companies planning to buy conventional Thor, Atlas, and Titan vehicles from the U.S. government. ESA was counting on enough business for everyone, but admitted that Ariane would have had trouble getting any if this sixth launch had failed. (ESA Info 21; *W Post* (AP), June 17/83, A-2)

June 18-26: STS-7, carrying the first U.S. woman astronaut, took off June 18 at 7:33 a.m. EDT from KSC launch pad 39A for a six-day mission that would deploy two foreign communications satellites and practice freeing and retrieving a pallet containing 11 experiments from the West German government. Crew members were Navy Capts. Robert L. Crippen, commander, and Frederick H. Hauck, pilot, plus mission specialists Dr. Norman E. Thagard, a civilian physician; U.S. Air Force Col. John M. Fabian; and Dr. Sally Ride, a civilian with a Ph.D. in physics.

Mission control stated that the group of five was "the largest human payload in the history of the space age." The Soviet Union had maintained crews of five on its Salyut space station but had never carried that number on a single launch.

First deployment of a payload was at 5:02 p.m. EDT when the crew launched from the cargo bay a seven-ton communications satellite, *Anik C2*, for Telesat (Canada's governmental telecommunications organization). At 9:36 a.m. EDT the next day the crew launched a $40 million *Palapa B* communications satellites for the government of Indonesia. Two previous Palapas launched by the United States were providing communications to Indonesia, Thailand, Singapore, Malaysia, and the Philippines. *Palapa B*, twice the size of the earlier communications satellite could increase television and telephone traffic in the area by 10% to 15% a year. The 147 million Indonesians living on islands extending more than 3,200 miles east to west had only 560,000 telephones: *Palapa B* could provide service for as many as a million new telephones in the next 10 years.

After the second communications satellite was launched, the four rookie astronauts (Ride, Fabian, Hauck, and Thagard) appeared on the television screen assembled in the cockpit and wearing dark-blue T-shirts with white letters reading "TFNG: We Deliver." TFNG stood for "thirty-five new guys," the astronaut class, recruited in 1978, to which all four belonged. Crippen stayed out of camera range, but mission control said "That's all right, Crip. We can tell you're a steely-eyed veteran from here."

On June 19 mission control said that the families of the four fathers aboard Challenger had gathered "to wish you a happy Father's Day." The four male astronauts had a total of 10 children: Crippen and Thagard, 3 each, Hauck and Fabian, 2 each.

Major activities for the next three days would be the release of the mechanical arm and rehearsal for deployment and retrieval of the West German pallet. Ride and Fabian would drop the 15-foot, 5,000-pound package off the Shuttle and try to pick it up again. (This would be a first for an exercise that could be commonplace on future missions.) On June 22 the team released and retrieved the package five times, as television cameras on Shuttle and package sent spectacular shots of the procedure with a backdrop of Earth and black space. When the exercise concluded and the arm and the payload were back in the cargo bay, Crippen reminded mission control that some crews had announced "We deliver" (referring to the STS-5 crew's boast when they launched two communications satellites from the shuttle last November): "Well, for flight 7, we pick up and deliver."

The USSR's Valentina Tereshkova, first woman to make a flight in space 20 years ago, wired congratulations to Sally Ride. The telegram expressed pleasure "to know that a third representative of this planet's women, now from the United States of America, is in outer space today." Last year the Soviet Union sent a second woman, Svetlana Savitskaya, into space.

Among more than 20 experiments in Challenger's cargo bay and mid-deck was the colony of 150 carpenter ants sent into space by high-school students from Camden, N.J., to record their reactions to weightlessness. The ants were considered good space subjects, being hardy and naturally social creatures.

Marginal weather at KSC raised a question whether Challenger would land near its launch point, as planned. Landing on the Florida runway was a way to reduce time in preparing Challenger for its next flight. STS-7 could be extended, or landing could be shifted to Edwards Air Force Base in California; a shift to California would mean an eight-day delay in bringing Challenger back to KSC for a mid-August mission, adding pressure to the timetable for launching Spacelab between the end of September and mid-October. The next chance for a Florida runway landing would be early in 1985; the two intervening missions would be a night launch and landing and the heavyweight touchdown of the Shuttle carrying Spacelab. Also of concern was the effect of rainstorms on the Shuttle tile covering: planes carrying strips of the insulation had been flown through rainstorms with a uniform result of "significant erosion of the tile surfaces."

Mission control offered three landing times, 6:53 a.m. and 8:29 a.m. EDT at KSC and 9:56 a.m. EDT at Edwards Air Force Base. The crew appeared on television "stowing the cabin" in preparation for landing. A sign "The Doctor Is In" was held up as Thagard showed viewers the experiments he was conducting to find clues for the cause of space sickness. STS-7 had been the first shuttle mission to have no space-sick astronauts.

The Challenger landed at Edwards Air Force Base June 24 at 9:57 EDT after a steady downpour began at KSC. In a congratulatory telephone call to the astronauts, President Reagan mentioned Ride's handling of the mechanical arm and said "You were there because you were the best person for the job." Ride said that the flight was "the most fun I'll ever have in my life." When the astronauts attended a brief homecoming ceremony at Johnson Space Center June 24, Ride refused to accept a bouquet of flowers from a NASA official; she had said before the mission that she wanted to be treated no differently from her four male crewmates. Wives of the male astronauts each received a red rose; Ride's husband, astronaut Dr. Steven Hawley, did not. (NASA MOR E-420-07-83-04 [prelaunch] June 9; NASA MOR M-989-83-07 [prelaunch] June 13/83; *NY Times*, June 20/83, A-1; June 23/83, A-1; June 25/83, 16; June 26/83, 4-8; *W Post*, June 17/83, A-2; June 20/83, A-1; June 21/83, A-6; June 22/83, A-3; June 23/83, A-1; June 24/83, A-3, C-4; June 25/83, A-1; June 26/83, A-2)

June 27: NASA launched HiLat (U.S. Air Force satellite P83-1) from WSMC on a Scout at 11:37 a.m. EDT into an orbit with 834-kilometer apogee, 765-kilometer perigee, 100.9-minute period, and 82° inclination. The 248-pound HiLat would obtain data on propagation effects on plasma distortion on radar and other communications and baseline data for interpreting the distortions. (*NASA Dly Actv Rpt*, June 29/83; NASA MOR M-490-604-83-01 [prelaunch] June 22/83)

• U.S. balloonists Maxie Anderson, first to make a balloon crossing of the Atlantic, and Don Ida were killed when they crashed in a forest in Bavaria during the Gordon Bennett race for distance from Paris. Police saw the basket of the balloon detach and fall into the forest; a West German search-and-rescue unit said that the ballon struck a high-tension wire that separated it from the gondola. Police found both occupants dead at the scene.

Anderson, with Ben Abruzzo and Larry Newman, landed Double Eagle II in France August 17, 1978, after a transatlantic flight. He and his son Kris hand flown across North America from San Francisco to Quebec, landing the balloon at Kitty Hawk May 12, 1980, far from its North Carolina goal. He and Don Ida had attempted a 45-day around-the-world flight in the balloon Jules Verne last November but encountered mechanical trouble in India. (*NY Times*, June 28/83, B-8)

June 27-30: The Soviet Union launched *Soyuz T-9* at 1:12 p.m. Moscow time June 27 to link with orbiting complex *Salyut 7-Cosmos 1443.* Crew members were Col. Vladimir Lyakhov, pilot, and flight engineer Aleksandr Aleksandrov, *Soyuz T-9* docked with the complex at 2:46 p.m. Moscow time June 28, and the cosmonauts entered the station to begin "practicing. . .control of large-size manned complexes." On reactivating life-support and communications systems, the crew began unloading the automatic cargo craft that had brought about three tons of supplies. (FBIS, Tass in English, June 27, 28, 29, 30)

June 28: NASA launched *Galaxy 1,* first of a series of three wholly owned Hughes communications satellites, at 7:08 p.m. EDT from ESMC on a Delta into a transfer orbit before stationing it at 135°W to serve the cable television industry. Hughes had sold its 24 operating transponders on a noncommon-carrier basis to ensure purchasers a stable source of programming. NASA would launch the other Galaxies in September 1983 and June 1984. (NASA MOR M-492-215-83-01 [prelaunch] June 27/83; *NASA Dly Actv Rpt*, June 29/83)

June 29: NASA said that TDRS-1 had achieved geosynchronous orbit at 67°W at 12:31 p.m. EDT. By 7:41 p.m. EDT, the communications satellite was stabilized in a normal Earth-oriented mode, with momentum wheels and Earth sensors controlling it for the first time. The White Sands ground station was activating the payload.

The press said that NASA's $100 million rescue mission had put TDRS into proper stationary orbit on the equator over Brazil, two months after the 5,000-pound communications satellite went off course when a second-stage thruster misfired after launch from the Challenger in April. The 39th firing of thruster jets moved TDRS into an orbit parallel to Earth's rotation and at the same speed, keeping it in the same position above Earth. Saving the satellite meant that Spacelab, due to fly in September on STS-9, could proceed as planned. Also, the *Landsat* now in orbit could send its images to Earth through TDRS, and all future Shuttle flights could keep in touch with Earth 85% of the time instead of the present 20%.

An adjacent story in the *Washington Post* said that the House had approved and sent to President Reagan for signature a compromise bill authorizing NASA to spend $7.3 billion in FY84, slightly more than the president's request, but approval was expected. (*NASA Dly Actv Rpt*, July 1/83; *W Post*, June 30/83, A-3)

July

July 1: Tass reported that the two cosmonauts aboard *Salyut 7* had opened doors to a large attached module, *Cosmos 1443*, and were working in essentially a three-part assembly consisting of a Salyut, a Cosmos, and the *Soyuz T-9* in which they arrived at the space station June 28.

When the Cosmos docked automatically March 10 with the Salyut, U.S. space experts said that it would double the size of the 21-ton Salyut and had carried 3 tons of cargo, such as scientific gear, experiments, and life-support materials. Cosmos had sets of small thrusters generally used to change the orbit of the entire complex, which weighed in total about 50 tons. The Cosmos itself, 43 feet long and 13 feet in diameter with solar-cell panels to generate electricity, consisted of an orbital module and a descent module. The descent module could return to Earth unmanned and land by parachute carrying experimental data and materials no longer needed on the Salyut, giving the same sort of round-trip supply service instead for the U.S. Shuttle without being reusable.

Tass said that the cosmonauts, Vladimir Lyakhov and Aleksandr Aleksandrov, were unloading *Cosmos 1443* and reactivating systems on *Salyut 7*, putting film into cameras and turning on observation instruments, such as an East German mass spectrometer, which would photograph and measure "vast tracts of Soviet territory in middle and southern latitudes." (FBIS, Tass in English, July 1/83; *NY Times*, July 1/83, A-1)

• A team of engineers from NASA and industry celebrated at GSFC their success, after 58 days of maneuvers, in putting the tracking and data-relay satellite into geosynchronous orbit. Using tiny one-pound thrusters with nozzles about the size of a thimble, the team boosted the 5,000-pound TDRS more than 8,600 miles further into space, a feat never before attempted. The TDRS was launched from the Shuttle Challenger during its first mission April 4; after a successful deployment from the Shuttle, some difficulty in the inertial upper stage (IUS) rocket threw TDRS into a tumble from which ground control rescued it, stabilizing it far short of the altitude needed for geosynchronous orbit.

A joint board representing NASA and the U.S. Air Force said later that the problem was loss of oil pressure in an engine seal, probably caused by excess engine heat. The board had viewed photographs taken by U.S. Air Force camera over New Mexico and had conducted "extensive tests." Because of the importance of TDRS operation to space communications, NASA and the Air Force had rescheduled two shuttle missions that were to use the IUS. (NASA

Releases 83-104, 83-114, 83-116; MSFC Releases 83-49, 83-50; *W Post*, July 13/83, A-1; July 28/83, A-4)

—NASA announced that Charles D. Walker, an engineer at McDonnell Douglas, would be the first payload specialist representing a project designed for commercial purposes. He would fly on the 12th Shuttle mission set for March 1984, operating a materials-processing device developed by McDonnell-Douglas to separate large amounts of biological materials in space for new pharmaceutical uses. As chief engineer responsible for spaceflight tests and evaluation, Walker had worked with project support at KSC and JSC, training NASA astronauts who operated the device for electrophoresis research on earlier Shuttle missions. (NASA Release 83-105)

July 5: A colony of carpenter ants flown on the shuttle Challenger in June had apparently not survived the trip. Press reports said that no signs of life were seen through the clear plastic top of the casing housing the 151 ants. The sponsors, students from two New Jersey high schools who flew to Cape Canaveral with a teacher to recover the experiment, checked heat and light supply to the canister, as well as the cameras—one making periodic exposures and the other recording on television tape—that monitored the ants in flight. Everything worked. RCA Corporation had supported the experiment with a $10,000 grant.

Press reports noted that the ants had been inside Challenger's cargo bay almost two months before launch and might have died before the flight; however, two control colonies in New Jersey had survived under the same conditions. The canister would be opened in New Jersey in the presence of two biology professors from Temple University who were advisers to the students. (*W Post*, July 7/83, A-2)

July 15-17: Reports from Tass on the flight of the *Salyut 7-Soyuz T-9-Cosmos 1443* complex included "an unpleasant surprise" when a micrometeorite struck one of the windows with quite a loud crack, leaving a four-millimeter at diameter crater on the pane. "Luckily," the report added, "the windows have double panes, each 14mm thick. That is why nothing terrible has happened." Earth was passing through a meteorite shower, and Valery Ryumin had noted during his space walk that the skin of *Salyut 6* had been riddled with small craters.

The incident had "amazingly coincided" with a preplanned exercise in "urgent escape from the station." Journalists "could not help asking" how long it would take for the crew to abandon station. Deputy flight director Victor Blagov said that the "minimum required time is 15 minutes, but we consider 90 minutes—that is, one orbit—to be standard time" during which the crew could take all steps needed for an emergency mothballing of the station and enter the return module. The cosmonauts could "spend several days [there] in absolute safety," Blagov added, but if necessary they could "splash down in the reentry vehicle in the ocean, or touch down in one of the reserve landing ranges in the USA, France, and other countries. There is an international convention on that score." (FBIS, Tass in English, July 15, 22, 27/83)

July 18: NASA Administrator James M. Beggs told a symposium of several hundred government, industry, military, and foreign space-station planners that President Reagan would approve a manned U.S. space station within the next 12 months. Dr. George A. Keyworth, presidential science adviser, had dropped opposition to the space station and asked NASA to come up with a "grand vision." NASA hoped to get from the administration and Congress "seed money" of about $200 million for the fiscal year beginning October 1, 1984; Beggs said that it would cost $6 to $8 billion to get a permanent station with four to six persons aboard into orbit by 1991. The station would enhance U.S. economic well-being by providing new areas for research. (*NY Times*, July 19/83, C-3; *C Trib*, July 18/83, 1)

July 28: NASA launched *Telestar 3A* for the American Telephone and Telegraph Corporation (AT&T) from the Eastern Space and Missile Range at 6:49 p.m. EDT on a Delta into a transfer orbit with 37,516-kilometer apogee, 185-kilometer perigee, 23° inclination, and 664-minute period, preparatory to moving it to geosynchronous station at 96°W over the Pacific just west of the Galapagos.

Telestar 3A was the first of a new series of three domestic communications satellites offering AT&T long-lines customers television, phone, and data service over the continental United States, Alaska, Hawaii, and Puerto Rico; it had 24 transponders and 6 spares, each able to relay a color-television signal at 60 million bits per second or up to 3,900 two-way phone calls. (*Telestar 1* launched 21 years ago for the first transatlantic television relay could offer only 600 one-way voice channels or one television channel.) Launch of *Telestar 3A* was declared successful December 16. (NASA Release 83-110; NASA MOR M-492-216-83-01 [postlaunch] Dec 16/83; *Spacewarn* SPX-358, Aug 30/83, 2)

During July: NASA appointed Dr. Milton A. Silveira, assistant to the deputy administrator, to succeed Dr. Stanley I. Weiss as chief engineer. Weiss, who came to NASA in 1980 as associate administrator for space transportation operations at Headquarters, was leaving to become vice president for engineering at Lockheed Corporation, where he had worked from 1957 to 1978.

Silveira began at Langley with the National Advisory Committee for Aeronautics (NACA) in 1951 and worked in the Mercury, Gemini, and Apollo programs. He was deputy project manager at JSC for the shuttle orbiter program before coming to Headquarters in 1981. (Anno, July 1/83)

NASA also appointed John W. Boyd associate administrator for management at Headquarters effective September 4. He had begun at ARC in 1947 and served there until appointed deputy director of DFRC in 1979, returning to ARC in 1980 as associate director. (Anno, July 1/83)

• Dr. Homer E. Newell, Jr., associate administrator of NASA when he retired in 1973, died July 18 at his home at the age of 68. Before joining NASA shortly after its formation in 1958, he had been acting superintendent of the Naval Research Laboratory's atmosphere and astrophysics division, and coordinator of the science program for the Navy's Project Vanguard. The *New York Times* said that Newell was "primarily responsible for organizing early [U.S.] scientific efforts in space" and "firmly championed the view that scientific exploration of space should be under civilian rather than military auspices." (*NY Times*, July 20/83, B-8; *W Post*, July 20/83, C-8)

August

August 5: Japan launched a second operational communications satellite, *Cs-2B* (code-named *Sakura 2B*), at 8:20 p.m. GMT from Tanegashima Island toward a stationary orbit above northwestern New Guinea. This seventh satellite launched by Japan was only the second "for practical purposes"; the first was *Sakura 2A* launched in March as communications link between Japan's mainland and outlying Pacific islands. Each communications satellite had capacity equal to 4,000 phone circuits, and the two were designed for use in a major emergency like an earthquake. (FBIS, Tokyo Kyodo in English, Aug 6/83)

August 9: JPL said that NASA's IRAS launched in January had found a formation of large particles orbiting Vega, one of the brightest stars seen from Earth, in what might be a solar system like Earth's in a different stage of development. This was the first evidence of large solid objects orbiting a star other than the Sun.

IRAS scientists Dr. H.H. Aumann of JPL and Dr. Fred Gillett of Kitt Peak National Observatory, working at the Rutherford-Appleton Laboratory in Chilton, England, had decided to use Vega (commonly serving astronomers as a standard for measuring other stars' brightness and spectra) as a source for calibrating IRAS. "To their surprise," *Science* magazine said that Vega's image in the 20-, 60-, and 100-micrometer channels was much brighter than the infrared images of similar stars or than expected from an A-type star.

The heat-sensitive telescope on IRAS was measuring infrared radiation extending out as far as 80 astronomical units (about 7.4 billion miles) from Vega, reporting the temperature of the bodies in orbit around the star at about −300°F, far above the norm of "cold black space" and about that of the inner rings of Saturn. The JPL announcement said that the material orbiting Vega could compare in mass "to all the nine planets and other matter" in Earth's solar system, not including the Sun. Scientists had long speculated that Earth and its companion planets were not the only system of that type in the cosmos, but they had never had evidence to prove it. The IRAS discovery was a bonus of the decision to use Vega as a ship's navigator might use the North Star as a guide across the ocean. (JPL Release Aug 9/83; NASA Release 83-120; *NY Times*, Aug 10/83, A-1; *W Post*, Aug 10/83, A-1; Aug 11/83, A-2, A-22; *Science*, Aug 26/83, 846)

August 12: NASA signed with the California Institute of Technology (CalTech) an extension of its contract for performance of research and development at JPL. The contractual relationship had been in effect since

1962; JPL studies for NASA's Office of Space Science and Applications (OSSA) had been principally in space science and unmanned exploration of the Moon and planets. Extension from October 1, 1983, through September 30, 1988, would cover space exploration and Earth observation. (NASA Release 83-122)

August 15: MSFC said that it had installed the reusable orbital-research Spacelab in the cargo bay of the Shuttle Columbia at KSC. Designed, developed, and funded by ESA, Spacelab had undergone tests for three months in a cargo-integration test equipment (CITE) stand at KSC. Columbia would carry Spacelab and a four-member crew into orbit October 28 to perform more than 70 individual investigations in five research areas during a nine-day mission. (MSFC Release 83-59; ESA Info 36)

• In "a frank portrayal of the difficulties of life in orbit. . .extremely rare in the Soviet media," the daily newspaper *Pravda* printed extracts from the diary of a cosmonaut who spent a record 211 days in space between May and December 1982, the *Washington Post* reported.

Flight engineer Valentin Lebedev, flying on *Salyut 7* with Lt. Col. Anatoly Berezovoy, found the seven-month mission an intense strain relieved only by the fascination of Earth spinning by below the station. Halfway through the mission, fatigue had made the two so nervous and sensitive that effort was needed to avoid losing their tempers. Arrival of two visiting space crews was viewed with apprehension because the original crew feared they might disrupt the working relationship they had established; one entry said "They won't get any of our food. We think they will have to bring their own." Once on board, the visitors apparently offered welcome company. The Soviet Union had presented the cosmonauts as heroic, almost superhuman figures, Reuters news agency said, and television had invariably shown them smiling. (*W Post*, Aug 16/83, A-18)

August 19-25: The People's Republic of China launched *RPC 13* August 19, according to the *People's Daily* quoted by Reuters, which gave no other information on it. The People's Republic had retrieved the spacecraft from orbit August 25 and said that all systems had worked normally. (*Spacewarn* SPX-358, Aug 30/83; *W Post*, Aug 26/83, A-20)

August 22: ARC scientists said that exercise, coupled with a low-calorie diet, might counteract effects of weightlessness on the levels of insulin and glucose in the blood of space travelers. Plasma and glucose had increased during simulated weightlessness, returning to normal after exercise.

Simulations of weightlessness for one or two weeks of prolonged bed rest had approximated the physiological responses occurring in space; resting without exercise had decreased the ability to use glucose, and average levels of blood sugar rose more than 10% above normal, a condition like a prediabetic state. Also, a more than 200% rise in blood insulin occurring in the test subjects seemed to result from normal production of the hormone and less use of it. Tests showed that, even with ample circulation of insulin, the body was less able to control glucose storage. Exercise and low-calorie diets would be used to solve the problem in test subjects. (NASA Release 83-130; ARC Release 83-37)

August 26: NASA said that IRAS had completed its primary mission objective at 12:30 p.m. EDT by conducting an all-sky survey and giving an opportunity for double confirmation of sources. Survey data had a few "holes" because of Sun-Earth-Moon observation constraints and an anomaly that occurred early in June. NASA had begun another survey to fill in the gaps and confirm earlier observations; end-of-life would come early in January. (*NASA Dly Actv Rpt*, Sept. 1/83)

August 30-31: NASA STS-8 at 2:32:02 EDT August 30 from KSC after a 17-minute hold because of thunderstorms passing through. "Tropical disturbance" Barry had moved ashore August 26 about 40 miles south of the Cape and could have turned into a hurricane, but it bypassed the launch-pad area. This third flight of Shuttle Challenger was commanded by Navy Capt. Richard H. Truly, who was copilot of the second Shuttle mission two years ago; pilot for STS-8 was Navy Cdr. Daniel C. Brandenstein. Mission specialists were Navy Lt. Cdr. Dale A. Gardner; civilian physician William E. Thornton, oldest American in space; and U.S. Air Force Lt. Col. Guion S. Bluford II, first black American in space.

This was also the first night Shuttle launch. NASA was testing its ability to launch at night from KSC, where weather was often more favorable than in the daytime. The DOD wanted a demonstration of night launch in case of needing the Shuttle for a military mission on short notice. And Challenger was carrying into orbit a $43 million India satellite to forecast weather and relay radio, television, and phone calls that required a night launch for proper location. NASA's first manned night launch had been December 7, 1972, when *Apollo 17* lifted off at KSC on its way to the Moon; that launch had been visible to people in the Great Smoky Mountains more than 500 miles away.

NASA also planned to land STS-8 at night, another first, for the same reasons it launched at night. Landing would be at Edwards Air Force Base in the Mojave desert of California instead of KSC, because of the longer runway and the greater probability of good weather there in midsummer. This would be the first time the public would not be allowed at the landing; NASA did not want "hundreds or even thousands of moving automobiles with headlights" to confuse Shuttle pilots descending out of total darkness toward the concrete runway.

About three hours after reaching orbit, the crew began communicating with mission control through the properly relocated $100 million TDRS launched from STS-6 in April, instead of using ground stations out of reach during most of their orbit. The first major task of the STS-8 mission would be deployment of INSAT-B, and the crew spent most of August 30 checking the performance of the 50-foot mechanical arm in the Shuttle's cargo bay that had entitled "a slightly arthritic reaction" in its elbow. The arm would grapple and move a heavy dummy-spacecraft package later in the mission in rehearsal for future release or retrieval of satellites.

INSAT-B was launched over the Indian Ocean August 31 at 7:49 GMT and successfully put into transfer orbit, according to the Indian Space Research Organization, which said that all on-board systems were working well and that the solar panel was partly deployed. (*NASA Dly Actv Rpt*, Aug 30/83; FBIS, Delhi DomSvc in English, Aug 31/83; *NY Times*, Aug 3/83, A-10; Aug 31/83, A-1; *W Post*, Aug 25/83, A-8; Aug 26/83, A-10; Aug 30/83, A-1; Aug 31/83, A-8; *USA Today*, Aug 30/83, 1A, 3A; *W Times*, Aug 30/83, 12A; Aug 30/83, 1A; *Intervia*, Aug 83, 817)

During August: NASA said that it would cease in September to operate *Nimbus 6*, launched June 12, 1975, for tracking balloons floating around the Earth to gather data on winds in the tropical and mid-latitudes. This system was the forerunner in one-way platform-to-satellite data collection that had provided worldwide ocean temperatures from buoys, tracked animal migration on land and sea, and kept in contact with numerous adventures, such as the crew of the Eagle I balloon rescued after it crashed in the Atlantic and a Japanese who crossed the North Pole by dogsled from Canada.

Nimbus 6 had lost attitude-control capability in October 1982 when two momentum wheels failed with an accompanying severe power reduction. It would remain in polar orbit at 600 miles altitude, reentering the atmosphere some time after the year 2500, NASA said. (NASA Release 83-126)

• Tass reported that the cosmonauts on the *Salyut 7-Soyuz T-9-Cosmo 1443* complex were working on a "new and unusual mission" to determine the ways in which man affects Earth's environment. The Soviet Union had established about 10 biospheres in its territory, and space photography would allow experts to assess the state of the flora and fauna there. The Soviets were emphasizing environmental issues, as provided in the USSR constitution, and space surveys were helping to detect sources of environmental pollution and mapping ways to improve land reclamation or bring water to desert areas.

The crew had loaded *Cosmos 1443* with half a ton of excess material for the return to Earth, including photographic films and some instruments (including a nonworking air regenerator and a defunct memory unit of the autonomous navigation system) that would be examined for effects of space. *Cosmos 1443* undocked August 14 at 6:04 p.m. Moscow time and soft-landed August 23 with 350 kilograms of cargo. Another cargo ship, *Progress 17*, was launched August 17 at 4:08 p.m. Moscow time and docked August 19 at 5:47 p.m. Moscow time. (FBIS, Tass in English, Aug 1-23/83)

September

September 1-6: Press reports said that the continuing STS-8 mission followed up its successful nighttime liftoff and nighttime launch of India's INSAT-B, deployed from Challenger's cargo bay at 3:49 a.m. EDT by mission specialist Air Force Lt. Col. Guion S. Bluford, Jr. This was the sixth successful launch of a communications satellite from a shuttle cargo bay in orbit. Navy Capt. Richard H. Truly and Navy Lt. Cdr. Dale A. Gardner spent most of the mission's third day using the 50-foot mechanical arm to lift and move around a 19-foot 7,460-pound lead-and-aluminum dumbbell-shaped weight "the size of a truck," practicing for retrieval next April of a dummy satellite platform before trying to catch and repair the crippled 20,000-pound Solar Max satellite.

The next two days would see tests of the TDRS, now properly located to transmit communications during next April's Spacelab mission for most of the Shuttle orbit rather than the present 20%.

The odd workday beginning at night and launching INSAT in the dark had the crew retiring about 2 p.m. EDT, starting tasks in the late evening, and ending in the early afternoon. The computer at White Sands began refusing to acknowledge commands or to correctly position the three TDRS-use antennas at White Sands, on board the Challenger, and on TDRS. Flight controllers encountered a three-hour silence from TDRS, but other communications links showed no problem with Challenger, and the crew was not awakened. Harold Draughon, flight director at JSC, said that 90% of the trouble lay in the instructions given the White Sands computers and that he expected Spacelab to fly on time.

The crew also underwent tests by Dr. William Thornton on the causes of space sickness. In an unusual news conference between mission control in Houston and the crew in orbit, Thornton said that he had "learned more in the first hour and a half on orbit here than I had by all literature research I had done and all of the active work in the past year." His crewmates had suffered symptoms like nausea, drowsiness, and "just plain giddiness," although he refused to give details. However, he expressed confidence that the medical problem could be solved through physiological studies aboard the Shuttle flights and would become a thing of the past "as in the early days the weight losses that were of great concern turned out to be a simple thing."

The mission also accomplished a successful first-time separation in weightlessness by mission specialists Bluford and Gardner of live pancreas cells, in a pharmaceutical process that could be a step toward conquering diabetes. The "astrorats"—six specimen flown on STS-8 to try out an "animal housing module" that would carry laboratory animals into orbit for various tests—were returning healthy and "feisty"; veterinarians at DFRF later found them dehydrated, as potatoes had been their source of water during flight. The rats were flown to ARC, where tests showed a postflight drop in blood volume like that of astronauts.

STS-8 concluded its series of firsts September 5 with a first-time night landing at 3:40 a.m. EDT on an Edwards Air Force Base runway, touching down 300 feet from the aiming point with no on-board power or lights to assist. "That's as good as we see in the daytime," said Lt. Gen. James A. Abrahamson, NASA associate administrator for space flight. "Based on what we've seen here tonight, I think night landings will become routine," Truly told a welcoming ceremony. NASA had turned on the world's most powerful searchlights, beams of 4.8 billion candlepower, visible for 100 miles in every direction, to guide Challenger down.

The largest and most enthusiastic crowd of invited guests ever gathered at the end of a Shuttle mission gave the crew a standing ovation; Bluford said he was "really humbled tonight to see so many people out here at 4 o'clock in morning to welcome us back." Thornton, the oldest person at 54 to fly in space, was visibly moved by the welcome and said "I know of no point in my life that will ever reach this." President Reagan's plan to visit KSC on Labor Day September 5 to greet the crew in person was canceled; he returned to Washington cutting short a vacation, when a Korean airliner was reportedly shot down. However, Vice President George Bush was to come in his place and attend a picnic for 15,000 employees, government and contractor.

Challenger was in better shape than any of the Shuttles used on the seven previous flights, said Herman K. Widlick, KC ground operations manager, at Edwards to plan for the fastest turnaround so far. Despite a four-hour exposure to pelting rains before liftoff, six days in orbit, and landing in the dark on a concrete runway, Challenger showed less damage on the fuselage or underbelly. Tires and brakes also came through the night landing in good shape; however, the space toilet experienced the eighth straight breakdown in flight. Lt. Gen. Abrahamson said that he was "not at all pleased with the waste management system" and would set up a task-force equivalent to deal with the problem. (*NASA Dly Actv Rpt*, Sept 9/83; *NY Times*, Sept 2/83, D-20; Sept 4/83, 1, 36; Sept 5/83, 9; Sept 7/83, A-18, A-22; *W Post*, Sept 2/83; Sept 3/83, A-3; Sept 5/83, A-3; Sept 6/83, A-3; Sept 7/83, A-4; *W Times*, Sept 1/83, 2A; Sept 2/83, 2A; Sept 5/83, 3A; Sept 6/83, 1A; *Time*, Sept 12/83, 42)

September 4-19: INSAT 1B, the India communications satellite successfully launched from STS-8 August 31, had solar-array problems, said Indian Space Research Organization (ISRO) scientists who worked with engineers from Ford Aerospace, the manufacturer, to extend the panels on both sides of the spacecraft.

Press reports later said that the ISRO center in Bangalore had been able to put the entire solar panel in operation after tilting it toward the Sun. But ISRO also announced September 9 that "an unidentified object" struck *INSAT 1B* only seconds after its release from Challenger; an object about eight inches across that came from outside the Shuttle hit the satellite 23 seconds after separation. Study of a videotape shot during INSAT development ruled out origin of the object in Challenger's cargo bay. Experts said that this was the first spacecraft to be hit in space by a stray object. INSAT reached the correct geostationary orbit 19 days after launch and was to be operational by October 15; the first transmission test, sending and receiving a picture by a master control facility at Hassan, was successful and INSAT 1B was "fully responding to ground commands."

India's first commercial communications satellite *INSAT 1*, built and launched by the United States to India specifications, was declared officially dead a year ago when it failed to respond to ground commands and ran out of fuel 150 days after launch. (FBIS, Delhi DomSvc, Sept 8, 10, 11, 14, 15/83; *W Post*, Sept 6/83, A-3; Sept 10/83, A-22; Sept 12/83, A-21; Sept 20/83, A-6; *W Times*, Sept 12/83, 6A)

September 7: Three new companies entering the "race to commercialize space" would launch Space America, a venture to provide remote-sensing satellite data services by 1986, the *Washington Post* reported. The companies were two in Washington, D.C.—American Science & Technology and AEROS Data Corporation—and Space Services Inc. (SSI) of Houston, which developed the first U.S. privately funded and operated launch vehicle. SSI would be managing partner. All three companies were less than three years old, privately owned, and "actively seeking capital," according to Donald "Deke" Slayton, former astronaut and president of SSI. The group hoped to put into polar orbit a privately owned satellite built by Honeywell Inc. and Ball Aerospace Systems with sensors to collect data on Earth resources such as agriculture, mineral deposits, and water. (*W Post*, Sept 8/83, D-1)

September 8: NASA launched RCA-G, third in a series of high-traffic capacity communications satellites, for RCA Americom from ESMC on a Delta at 6:52 p.m. EDT into a transfer orbit with 35,758-kilometer apogee, 176-kilometer perigee, 104-minute period, and 24° inclination, preparatory to assuming station over the equator at 72°W. RCA-G would join four other communications satellites in orbit (RCA-C through RCA-F) to provide a five-satellite RCA network providing coverage to all 50 states. More than 4,000 ground stations had direct access to these communications satellites, which all carried 28 completely solid-state C-band amplifiers in a configuration that gave 24 operating channels for television, voice, and high-speed data transmission. (NASA MOR M-492-206-83-08 [prelaunch] Sept 8/83, [postlaunch] July 26/84)

September 21: NASA said that it had signed a contract with Fairchild Industries for design and development of an unmanned space platform called Leasecraft, to be deployed from the Shuttle to serve commercial and government users. James M. Beggs, NASA administrator, said that the move was consistent with administration plans to promote space exploitation by commercial firms. Fairchild said that the platform, which would measure 15 by 15 by 9.5 feet and carry power and command and data-handling modules with other equipment needed by various payloads, would cost more than $200 million. Payloads would include materials-processing and remote-sensing equipment and scientific experiments. (NASA Release 83-143)

September 22: NASA launched Galaxy-B for Hughes Communications from ESMC on a Delta at 6:16 p.m. into a transfer orbit before moving it on station at 74°W over the equator. Second of 3 for Hughes to relay television, voice, data, and FAX for U.S. business customers, the craft carried 24 transponders and 6 spares, 12 of these already sold to MCI and another to be used by IBM. The Galaxy craft were designed to take full advantage of the concept of private ownership. (NASA MOR M-492-215-83-02 [prelaunch] Sept 20/83, [postlaunch] July 26/84)

September 23: NASA began moving the TDRS to its permanent location over the Atlantic Ocean, from 67°W to 41°W, said Charles M. Hunter, deputy TDRS project manager at GSFC. Using six tiny thrusters, the move began with a 19-minute burn at 8:57 p.m. EDT, with a second burn for 17 minutes at 8:57 a.m. September 24. The craft would move to its permanent station at the rate of 1.2° per day, drifting until October 16, when the first of two burns to stop the drift would occur. Another burn on October 17 should put TDRS over the Atlantic just east of Brazil, Hunter said. The fuel to be used, about 8 pounds, would not affect operations over the planned 10-year life of TDRS. (NASA Release 83-145)

During September: NASA announced that Richard H. Truly, commander of STS-8, was named the first commander of the Naval Space Command to be set up October 1 at Dahlgren, Va. Selected as a NASA astronaut in August 1969, Truly had been on one of the crews for Shuttle approach-and-landing test flights in 1977. His spacecraft was as pilot of STS-2 in November 1981. (NASA Release 83-133)

• NASA said that astronaut Jack R. Lousma would leave the agency and retire from the Marine Corps October 1. A NASA astronaut since April 1966, he was pilot on *Skylab 3* in 1973 and commanded shuttle orbiter Columbia on its third test flight in March 1982. (NASA Release 83-151; *W Post*, Sept 30/83, A-4)

• Cosmonauts Vladimir Lyakhov and Aleksandr Aleksandrov on the *Salyut 7-Soyuz T-9-Progress 17* complex continued geophysical observations using photography and spectrometry from orbit. They loaded used equipment on *Progress 17* and undocked it September 17 at 3:44 p.m. Moscow time; Tass reported that it "ceased to exist" in the atmosphere the next day. The *Cosmos 1443* module sent into the atmosphere August 14 also burned up September 18. On September 29 the crew marked three months in the complex. (FBIS, Tass in English, Sept 2, 13, 17–18, 23, 29–30/83)

October

October 1: President Reagan issued a proclamation calling on the nation to observe the National Aeronautics and Space Administration's 25th anniversary with "appropriate ceremonies and activities." Reviewing the agency's history and accomplishments, including preeminence of U.S. civil and military aviation, the Apollo program, planetary exploration, and the Space Shuttle, the message stated "The future looks bright, and NASA will be an important part of it." (Text, pres. doc., Oct 1/83)

October 3: The *New York Times* carried a report by "American intelligence sources" that three Soviet cosmonauts escaped death but might have been injured when a USSR launch vehicle exploded or caught fire September 27 at a site in Asia. The crew was saved when an escape rocket on top of the capsule pulled the spacecraft away from the booster. The incident, first of its kind in manned space programs, occurred as the liquid-fuel rocket was about to launch the crew to the orbiting *Salyut 7* space station. (*NY Times*, Oct 3/83, B-13)

October 4: The *Washington Post* said that an experiment on the next U.S. Shuttle flight was canceled because of the shooting down last month of a South Korean airliner by the Soviet Union. The experiment would have made the first mapping photographs from orbit of the entire area of Afghanistan, whose government the Soviet Union supports.

Cancellation was a joint decision of NASA and ESA, which built the $1 billion Spacelab scheduled to make its first flight October 28 in the Shuttle Columbia's cargo bay. This mission would take the Shuttle farther north and south than any previous manned U.S. flight, going 55° from the equator over the end of Argentina as well as the Hudson Bay region of Canada and the upper areas of Scotland. Columbia and Spacelab would also fly over most of the Soviet Union (including Moscow for the first time) but would take no photographs of the Soviet Union. (*W Post*, Oct 4/83, A-2)

October 7: NASA said that prelaunch processing for STS-9 would include removal of the OV-102 waste-management system and replacement with the system from OV-099. The job would take place after the completion of a launch-confidence test that included a wet-countdown demonstration, hot-fire testing of propellant units, and operation of the fuel-cell power systems. (*NASA Dly Actv Rpt*, Oct 7/83)

October 10: Tass said that *Venera 15*, launched June 2, had reached Venus October 10 and fired its engine to assume an elongated elliptical orbit around the planet with a 24-hour period of revolution. *Venera 16*, still on its way, was scheduled to arrive about October 14. (FBIS, Tass in English, Oct 10/83)

October 10–27: FBIS carried a report from Paris quoting "a source close to Soviet space circles" that three Soviet cosmonauts, one a woman, were injured when a rocket blew up at Baykonur two weeks ago. The crew was ejected from the launcher by a secondary rocket, the source said. (FBIS, Paris AF in English, Oct 10/83)

The *New York Times* said that Soviet officials had "privately admitted" that one of their rockets exploded on the launch pad as three cosmonauts prepared to join the crew on orbiting space station *Salyut 7.* However, "in the absence of any public accounting of the incident," questions remained as to the damage done to the Soviet Union's space program or its effect on the mission of the crew now in their fourth month aboard *Salyut 7.*

The private sources said that the 160-foot A-2 rocket began to topple on the launch pad before its liquid oxygen and kerosene fuel exploded. The accounts were contradictory, some saying that a woman was in the crew and others that the crew was either injured or merely shaken up by the experience. The explosion could amount to a major setback, in view of a Soyuz crew's failure to dock with the Salyut last April at the end of a "harrowing 17-hour struggle."

The *Washington Post* said that the crew sustained "unspecified injuries" and that the event was important because the visitors to the Salyut would have returned to Earth in the capsule that took occupants Aleksandr Aleksandrov and Vladimir Lyakhov to the station June 28, leaving their module for the "permanent crew" to use on their return. No immediate concern was expressed about the latter, as the original capsule was still usable.

A later report noted that Aleksandrov and Lyakhov had been endangered September 9 by a leak of nitrogen tetroxide propellant into space; the cosmonauts had put on their space suits in case the toxic gas entered the cabin. They were allowed to remain in orbit after they found no traces of the gas. But the leak had left 16 of the station's 32 control jets unusable, and less than 1,000 pounds of the gas in its single operating tank, meaning that a new crew could not operate the station in a normal mode. A new crew could fly a different type of space tug to one of the docking ports, however, and use its control jets to maneuver the station.

The *New York Times* reported October 18 that a Soviet official with direct contact to senior mission control that said two experienced cosmonauts were recuperating from effects of acceleration when emergency rockets blew their capsule clear of the exploding A-2 launch vehicle and that the crew did not include a woman.

The *Washington Post* said October 20 that the two cosmonauts on *Salyut 7* were "in no danger," according to Eugeny Tabakaev of the Soviet academy of sciences; the statement followed a British Broadcasting Corporation (BBC) report that the station was crippled because of a propellant leak. British teacher Geoffrey Perry, a regular listener to Soviet radio transmissions, told AP that he had detected no signs of stress and that the cosmonauts "sound fine." James Oberg, U.S. specialist on Soviet space programs, said that the *Salyut 7* crew could get back to Earth in the Soyuz that took them into space, but the Soviet Union had not used the Soyuz craft after 115 to 120 days in space because batteries and other systems could deteriorate over time. Oberg said that Lyakhov and Aleksandrov were to have returned late in September after another crew arrived but were delayed by the launch-pad explosion.

The Soviet Union launched a supply ship, *Progress 18*, from Baykonur at 4:59 a.m. EDT October 20 to rendezvous with *Salyut 7*, claiming that the cosmonauts there were "living normally." Lyakhov and Aleksandrov appeared on Moscow television October 16 and appeared to be "in high spirits." However, their flight had reached its 116th day October 21, and the previous record for a stay in space was the 114 days set last year in the course of a 211-day endurance flight. It would take 10 days to 2 weeks for the cosmonauts to unload *Progress 18*, which would be burned on reentry.

Nature magazine, published in Great Britain, said that the crisis was exaggerated and concern for the crew came not from Soviet engineers but from physicians, who had seen significant declines in activity and efficiency after four months in space. *Nature* described as "fanciful" a suggestion that the Soviet Union wanted to keep the cosmonauts in orbit until they could be rescued by the U.S. Shuttle on its November flight. (FBIS, Paris AFP in English, Oct 10/83; Tass in English, Oct 14, 20, 21, 22, 28/83; *NY Times*, Oct 12/83, A-7; Oct 18/83, C-2; *W Post*, Oct 12/83, A-19; Oct 14/83, A-10; Oct 20/83, A-39; Oct 21/83, A-7; *Nature*, Oct 27/83, 756)

October 13: LeRC said that Dr. Henry G. Kosmahl, an electron physicist employed there, had developed an amplifying system that could double the number of channels on a communications satellite. The system, called a dynamic velocity taper, was a "relatively minor technical modification" of an existing device.

Most nations had been seeking additional output from communications satellites for voice, picture, and data transmission. However, communications satellites could be spaced around the globe no closer than 2° part; otherwise, the signals from one would interfere with those adjoining. The number of possible communications satellites in orbit was therefore limited, and all available slots would be full by the year 2000.

Kosmahl's idea would make each communications satellite able to handle more traffic without affecting quality of the signals or increasing the power supply. He had applied for a patent on the device, which would be owned by NASA but available to industry. (LeRC Release 83-62)

• The Smithsonian's National Air and Space Museum said that it would build an adjunct facility at Dulles International Airport to house an expanding collection of aircraft, including the Shuttle Enterprise. Estimated to cost $40 million, the facility would replace the restoration site now at Silver Hill, Md., but would not be completed for another 7 to 15 years. Possibilities for Dulles included a group of four buildings to accommodate a Boeing 707, a Boeing B17 bomber, Boeing 727, a Boeing 747, and others; the design and funding were not yet settled.

The collection had outgrown the Mall area, said Walter Boyne, director of the museum: "We are going to get the space shuttle and the Concorde," which it would be physically impossible to move to the Mall area. "They are so complex, you can't simply take a wing off and move them." The present museum now has 10 million visitors a year, and Boyne said that people would be as interested in the Shuttle 100 years from now as they were in the Wright Brothers' plane today. (*W Post*, Oct 13/83, D-1)

October 13-17: Press reports said that NASA might have to delay the first flight of Spacelab on the Shuttle Columbia until the end of November, because a protective liner on the inner surface of the solid-fuel rocket-engine exhaust nozzles might be part of what one official called "a bad batch."

A three-inch layer of the carbon-epoxy material was intended to protect the metal nozzles from flaming exhaust by charring, to dissipate heat; about half the layer would normally burn away during the two-minute firing of the booster. On the last mission, one nozzle's lining came within 0.2 inches of burning away completely. Damage to a metal nozzle could send the Shuttle off course; had the flame burned through part of the engine in flight, "it could have caused a catastrophe," said the *Washington Post*. A test firing October 11 at Thiokol's Utah plant, where the rockets were built, showed that the liner had begun to "delaminate," which would make the Shuttle aerodynamically unstable after two minutes of flight.

If NASA decided to replace one of Columbia's motors, it would have to move the entire vehicle off the pad. Lt. Gen. James A. Abrahamson, head of the Shuttle program, said that chances of staying on schedule for a Spacelab launch between October 28 and November 5 were "diminishing rapidly"; however, he would not set a launch date "with this type of uncertainty." The next possible launch date after November 5 would be November 27: astronomy experiments to be carried on Spacelab had to orbited while the moon was dark.

[Students at Camden, N.J., high schools said that the carpenter ants flown on Challenger in June had died from lack of moisture before leaving Earth.]

The *New York Times* said that NASA might have to delay the next Shuttle mission for one to four months, possibly to next February 6, because of concern about reliability of the nozzles in the Shuttle boosters. Positions of stellar targets would again be favorable for Spacelab observations by next February. ESA and scientists from the United States and Europe were asked to suggest rescheduling that would have the least impact on their experiments.

A later report said that engineers who examined one of the engines recovered from the Atlantic after the mission in August found that the three-inch coating inside the rocket nozzle had burned down to 0.2 inches. Astronaut Daniel C. Brandenstein, pilot of that flight, told CBS News that the lowest part of the engine would have burned through if the engines had fired 2.7 seconds more, which would have "spelled curtains for the crew." A NASA official said that was conjecture, though the agency admitted that a burn-through might have occurred after 20 more seconds.

NASA decided October 14 to postpone the first flight of Spacelab for "at least a month" but would announce a new launch date. Gen. Abrahamson said October 16 that the probable date would be late next February, but the decision would be made jointly by NASA and ESA. He said that NASA engineers still did not know what caused the near-failure of the engine on the eighth shuttle flight in August. Two test firings in the last 10 days had produced confusing results: one engine lining had almost burned through, the other less than halfway, as it was meant to do. NASA had changed the manufacturing process not long ago, he noted, and the change might have trapped gases in the lining instead of baking them out.

With Columbia waiting for Spacelab, the next Shuttle flight would take place in January as planned. Challenger would deploy two communications satellites, and astronaut Bruce McCandless would demonstrate in space a self-propelled manned maneuvering unit that could go 500 to 600 feet from the Shuttle. (*W Post*, Oct 13/83, A-15; Oct 14/83, A-10; Oct 15/83, A-20; Oct 17/83, A-3; *NY Times*, Oct 13/83, A-16)

October 16-17: Engineers from NASA, TRW Inc., and Spacecom successfully carried out two maneuvers to put TDRS 1 at its permanent station at 41°W. The communications satellite, launched from the shuttle in April, was now over the Atlantic Ocean at the equator just off the north coast of Brazil. (NASA Release 83-156)

October 19: ESA launched Ariane 8 from Kourou, French Guiana, at 12:45 a.m. GMT from *Intelsat 5-F7* as Payload, which it deployed at 1:00 a.m. into an orbit with 36,158-kilometer apogee, 183-kilometer perigee, and 8.5° inclination. Representatives from ESA and France's Centre National d'Etudes Spatiales (CNES) were delighted with a new success for the European space industry. (FBIS, Paris AFP, Oct 19/83)

• The *NY Times* said that "computer enthusiasts" had invaded NASA's electronic mail system, left cartoon images and "Kilroy was here" messages for agency employees, and played pranks on others. A NASA official said that the intruders had destroyed some information but had not "significantly disrupted" the electronic mail service. NASA first noticed the intrusions in mid-July, and they continued into mid-September. Besides reading unclassified NASA messages, the intruders had destroyed some messages and created personal passwords and new files for themselves and their computer friends. Some NASA employees who used Telemail had been inconvenienced, but the system had never been halted.

The Federal Bureau of Investigation (FBI) said that it was investigating a number of youths in connection with the intrusions. To make Telemail easy to use, NASA had told employees to use their first initial and last names as part of an entry code; employee names were available from agency telephone directories sold by the Government Printing Office (GPO). The Office of Management and Budget (OMB) told a House subcommittee that it was trying to increase security for federal computers, and an FBI official asked Congress for a law prohibiting unauthorized entry into a computer. Without such a law, federal authorities were treating the cases as wire fraud, like use of telephone lines to obtain service without paying. (*NY Times*, Oct 19/83, A-16)

Another report said that the FBI had seized computers and other equipment from 15 computer enthusiasts around the United States, mostly teenagers. The bureau said that there was "extensive" penetration into commercial and DOD computers and that intruders had tampered with the files of some corporations. (*NY Times*, Oct 17/83, A-12)

During October: Kurt Debus, who helped develop Germany's World War II V-2 rocket and worked on the Redstone ballistic missile for the U.S. Army in the 1950s, died after a heart attack at his home near Cocoa, Fla., at the age of 74.

He had joined Wernher von Braun's rocket team on the Baltic coast during the war and came to the United States afterwards. Von Braun said of him: "We develop the rockets and it's up to Debus to see they do what they're supposed to do." In 1952, Debus became director of what would later be NASA's Kennedy Space Center; his last official act before retirement was to break ground for a KSC landing strip for Shuttles returning from orbit. (*W Post*, Oct 11/83, B-6)

• MFSC said that the Space Telescope, NASA's future optical orbiting astronomical observatory, had been named the Edwin P. Hubble Space Telescope to honor a foremost U.S. astronomer who had died in 1953.

Scientists had differed on the extent and dimensions of the universe: Earth's solar system was considered part of a larger system of all stars visible to the naked eye. It was not known whether faint spiral nebulae were part of the Milky Way or distant universes, each composed of myriad stars.

Hubble, working with the 100-inch telescope at Mt. Wilson, Calif., looked at individual stars in the Andromeda nebula and by the end of 1924 was able to show that Andromeda was many times farther away than any star in the Milky Way system. He later showed that the universe was expanding (evidence of the Big Bang theory), that external galaxies were moving away from earth, and that the more remote the galaxy the faster it was moving. This was called

Hubble's Law; the coefficient relating distance and velocity of the galaxy was called Hubble's Constant.

The newly named Space Telescope was scheduled for launch from the Space Shuttle in 1986. (MSFC Release 83-70)

November

November 18: The European Space Operations Center (ESOC), at the request of the International Maritime Satellite Organization (INMARSAT), completed a switching operation on board ESA's operational Maritime European Communications Satellite *Marecs-A* that increased the satellite's capacity from 30 simultaneous voice telephone channels to 46. ESOC completed the transfer in less than 10 minutes; thus, avoiding the need to transfer communications to the spare satellite and back again. The satellite provided the total of the Atlantic Ocean region shore-to-ship and ship-to-shore satellite communications.

Marecs-A was providing to INMARSAT its full capacity, one in excess of the contractual requirement of 40 voice telephone channels. The increased capacity seemed to bode well for *Marecs-A* to fulfill its design lifetime of seven years. (ESA Release, Nov 28/83)

November 22: The Infrared Astronomical Satellite (IRAS), launched on January 25, 1983, as a joint project of the United States, the Netherlands, and the United Kingdom, depleted its supply of helium at 1:30 a.m. GMT. The superfluid helium refrigerant cooled the telescope, which would cease operations in about a week, mission officials said. Throughout the mission, the telescope's focal plane was cooled to a temperature of about 2.5° above absolute zero (−455°F), making the instrument the coldest manmade object ever flown in Earth orbit.

The telescope surveyed more than 95% of the sky, pinpointing the locations and intensities of more than 200,000 infrared objects. During its 300 days of observations, IRAS carried out the first complete survey of the infrared sky and made many discoveries, including the detection of a ring of solid material around the star Vega and seven comets and bands of dust around the Sun between the orbits of Mars and Jupiter. More than 200 billion bits of data came from IRAS, and results announced to date represented only a hurried look at a very small proportion of this data. It was evident, however, that IRAS would have a major impact on many areas of astronomy and that astronomers would be making new discoveries from its data for years to come.

On November 9, NASA announced two IRAS findings: a new object in the solar system—possibly an asteroid or a dead comet—that passed closer to the Sun than any planet or known asteroid and three giant rings of dust that circled part of the solar system. The unknown object, temporarily designated minor planet 1983TB, appeared to be less than 2 kilometers (1.2 miles) in diameter and about 30 million kilometers (19 million miles) from Earth. 1983TB passed within 15 million kilometers (9 million miles) of the Sun, closer than any planet or known asteroid and 10 times closer than Earth. And its orbit almost exactly matched that of the Geminid stream of meteoroids, which were visible as a shower of meteors (shooting stars) in December 1982. Astronomers were planning additional observations with photometers and spectrometers in an effort to clear up the mystery of the identify of 1983TB. The three dust rings were 100 million miles wide and were circling the asteroid belt between Mars and Jupiter 200 to 300 million miles from the Sun. The dust bands appeared to defy the laws of physics by encircling the asteroid belt in three extremely stable and symmetrical rings. Particles making up the dust bands "this small can only survive in stable orbits for a few ten-thousands of years before they are pulled apart by the sun," said Dr. Frank Low of the University of Arizona. "There must be something that replenishes the rings because three stable bands that large cannot exist any other way."

In addition, NASA announced that same day that astronomers studying IRAS data at the University of Groningen, the Netherlands, had discovered three giant dust shells that were asymmetrically placed around the star Betelgeuse. It was already known that the red supergiant star lost material, but IRAS data showed evidence of the presence of dust shells that extended more than four light years from the star. At that distance, the material must have left the star 100,000 years earlier. The IRAS observations thus allowed astronomers to study the earliest stages in the episode of mass loss. (NASA Release 83-162, 83-171, 83-172, 83-181; *W Post*, Nov 10/83, A-1)

November 23: Soviet cosmonauts Vladimir Lyakhov and Aleksandr Aleksandrov returned to Earth aboard the *Soyuz T-9* descent module after a 150-day flight on board the *Salyut-7-Soyuz* orbital space station. The two landed at 3:00 p.m. EST (in the middle of the night in the Soviet Union), 16 kilometers east of Dzhezkazgan in that country. U.S. intelligence sources said that the two were expected to return in September, when an exchange crew of cosmonauts was due to visit them. However, they were forced to stay in orbit an additional six weeks when an explosion at the launch pad almost killed the two other crewmen. And at about the same time that the launch pad accident forced the extension of their flight, the two cosmonauts had to deal with a fuel leak aboard the *Salyut* that left the space station with less than half of its normal navigating propellant. The two men had to live in space suits, because the fuel that leaked was nitrogen tetroxide, which was so toxic it might have killed them if it penetrated the cabin of the space station.

Western space observers had noted that the six-week extension in space might cripple the *Soyuz T-9* spacecraft because it had been in orbit longer than 115 days and this length of time could possibly cause its nonrechargeable batteries to burn out, allowing the corrosive nitrogen textroxide fuel the *Soyuz* used to navigate to eat through engine valves and jeopardize the flight home. Western space experts were also interested in the night landing. The cosmonauts, earliest day landing would have been December 15, which might have been too long for them to trust the *Soyuz T-9* to return safely.

The official Soviet news agency Tass said that, during the flight, the crew carried out a large volume of scientific-technical and medicobiological research and experiments and gathered data on the Earth's natural resources, its atmosphere, seasonal changes, and the biological productivity of the world's oceans. New research was carried out under the program of material studies in space. An Elektrotropgraf instrument on board the station provided data on the state of construction materials following exposure to open space. Tass also noted that an important part of the crew's flight program was to carry out complex assembly work on the external surface of the *Salyut 7* station. During two space walks of 5 hours and 45 minutes, the two cosmonauts installed additional solar batteries on the station, in addition to other construction tasks. Over the course of the flight, there were regular medical checkups of the crew, which confirmed the possibility of man's active functioning in weightlessness. (FBIS Moscow *Pravda* in Russian, Nov 25/83; *NY Times*, Nov 3/83, A-8; *W Post*, Nov 12/83, A-2, Nov 24/83, A-12)

November 28: NASA launched at 11:00 a.m. EST the Space Shuttle Columbia (STS-9) from KSC. Columbia carried the largest space crew ever, which consisted of John Young, commander; Brewster Shaw, pilot; Dr. Robert Parker and Dr. Owen Garriott, mission specialists; and Dr. Byron Lichtenberg and West Germany's Dr. Ulf Merbold, payload specialists. The crew would operate in two shifts to permit 24-hour operation of experiments. The mission was originally scheduled to get under way September 30 but was delayed to October 28 to give engineers additional time to check out a communications satellite needed to relay data to Earth from Spacelab, carried on Columbia. The flight was postponed again when an examination of the booster rockets used for the Space Shuttle mission in August revealed serious erosion of the insulation lining one of the rocket nozzles. The rocket was replaced.

Columbia carried Spacelab, designed and built by ESA, which marked Europe's first major entry into a manned space program. Other firsts associated with the flight was that it carried the heaviest payload on a Shuttle, the 33,584-pound Spacelab and pallet, and that it would include more experiments and spacecraft maneuvers than did any previous flight.

Immediately after liftoff, Columbia rolled over and turned northward to put itself into an orbital path that would range from as far north as Scotland and Leningrad to as far south as Tierra del Fuego at the tip of South America in order to take pictures of Europe. The orbit would also take Columbia over Moscow and many militarily sensitive areas of the Soviet Union, the first time a U.S. manned spacecraft had flown over the Soviet Union in daylight. No pictures or other sensing would be taken of the ground while Columbia passed over the Soviet Union.

The $1-billion Spacelab's 23-foot-long laboratory was sealed and pressurized so that the scientists/astronauts could work in shirtsleeves as they carried out more than 70 experiments on 38 sets of equipment. Operating Spacelab were Merbold and Lichtenberg, a new breed of astronaut—payload specialists—who were not career astronauts but scientists trained to operate the science instruments on the mission. Wired with sensors, the scientists were guinea pigs in a number of experiments designed to explore how the body adapted to space and how it performed in the absence of gravity. Blood samples were taken three times so that scientists could study how the ratio of red to white blood cells changed once the body was weightless. Several experiments were conducted to measure eye movements; in another experiment, Garriott was given mild electric shocks to see how the muscles in his body responded to a sudden jolt that was the bodily equivalent of a sudden movement in weightlessness (doctors believed that one of the causes of space sickness might be abrupt movements that disoriented the inner ear). In another experiment, the crew in shifts pushed two balls identical in shape and size, although of different weights, to determine how quickly humans would distinguish weight from size in weightlessness.

Other Spacelab studies were concerned with the growth in space of sunflower seedlings, a fungus, and four types of microbes. Exotic metal mixes were melted, and crystals were grown in three Spacelab furnaces. There were experiments intended to determine the practicality of orbiting factories to produce products not possible in the gravity of Earth.

During the flight, two antennas failed on the TDRS-1 that was used to relay data from Spacelab to Earth. The failure meant that Litchtenberg and Merbold had to share the voice link to Mission Control Center in Houston with the four astronauts in Columbia's cockpit, and it meant that the two scientists got their instructions from the ground via a teleprinter aboard Spacelab. Columbia landed December 8 at Edwards Air Force Base, Calif. (NASA MOR M-977-09-83-01 [prelaunch], Oct 83; NASA Releases 83-163, 83-176; *NASA Dly Actv Rept*, Nov 29/83; *W Post*, Nov 22/83, A-8, Nov 28/83, A-1, Nov 29/83, A-1, Nov 30/83, A-1; *USA Today*, Nov 29/83, 1A; *W Times*, Nov 22/83, C-1; *B Sun*, Nov 29/83, A-1)

November 29: NASA Administrator James M. Beggs announced that NASA and Canada's Department of Communications signed an arrangement to cooperate in the definition of a space program that could lead to the development of commercial satellite service to meet mobile communications needs in both countries. The arrangement would provide a framework for the Department of Communications and NASA to work with telecommunications carriers in both countries to initiate mobile satellite service. This approach could lead quickly to a commercial satellite system that simultaneously allowed for the development of advanced research and development to support second generation systems.

In the event that the program definition activities were successful, the next step would be to agree to cooperate in the implemention and postlaunch phases of the program. Under that arrangement, NASA would invite U.S. carriers to participate in a joint endeavor arrangement through a Notice of Opportunity, under which the carrier would be responsible for the development of commercial markets and, with Telesat Canada, the specification, procurement, and operation of the system.

Succesful completion of this program would result in initiation of new services and industries in both countries to provide two-way radio, radio telephone, and low-speed message and data services to mobile terminals operating in rural and nonmetropolitan areas. Potential users would include radio common carriers, telephone companies, resource industries, trucking companies, federal and state governments, and emergency and law enforcement agencies. (NASA Release 83-186)

During November: NASA announced that it had set up at JSC the Biomedical Research Institute, which would function as part of the Space Adaptation Project within the Space Transportation Systems Program Office, to focus efforts on solving some of the problems space crews had in adjusting to a weightless environment. The Space Adaptation Syndrome was the name that NASA gave to a wide range of physical problems that astronauts sometimes experienced, including nausea, vomiting, and general malaise. Approximately 45% of astronauts who had flown had experienced some of those symptons. Flight data on the problems had been collected over 22 years of manned spaceflight, particularly during the extended Skylab missions. Experiments were performed on Space Shuttle flights with physician astronauts Dr. Norman Thagard on STS-7 and Dr. William Thornton, the principal investigator and designer of much of the experimental hardware and research on STS-8. In an attempt to speed up the process of finding countermeasures and perhaps predict who might be more susceptible to the condition, NASA created the research project and established the institute. Elena Huffstetler was named project manager, and Dr. Sam Pool, chief of medical sciences at Johnson, was director. At NASA Headquarters, the Space Medicine Branch, Life Sciences Division, Office of Space Science and Applications, would be responsible for managing the program of both clinical and applied research in this area. (NASA Release 83-167)

—NASA announced that Robert O. Aller was appointed associate administrator for space tracking and data systems. Aller, then director of the Tracking and Data Satellite System Division, succeeded Robert E. Smylie, who left NASA October 28 to become vice president for government communications services at the RCA American Communications Company in Princeton, N.J. Aller came to NASA in August 1964 from the Philco Corporation in Houston. Prior to joining Philco, he served for 10 years in the United States Air Force. He had held numerous positions in NASA during the Gemini, Apollo, Skylab, Apollo Soyuz Test Project (ASTP), and Space Transportation System (STS) programs. In September 1977 he was appointed deputy director of expendable launch vehicles and in 1979 to his current position, where he was responsible for the planning, direction, execution, and evaluation of the TDRS Program. Aller had twice been awarded the NASA Exceptional Service Medal for his work in the Apollo and Skylab programs, and he also received the NASA Outstanding Leadership Medal while working on the Apollo/Soyuz test project. (NASA anno, Nov 3/83)

December

December 1: NASA announced that its scientists studying motion sickness were focusing on a chemical substance in the fluid core of the brain that might cause vomiting. The fact that there might be a chemical link in motion sickness was discovered through NASA's research into the causes of space motion sickness. The research was being conducted at ARC in the Biomedical Research Division and at the new Biomedical Institute at JSC. Studies by Ames scientist Dr. Nancy Daunton and two colleagues at Wright State University in Dayton, Ohio, showed that blocking the flow of cerebrospinal fluid in the brain stopped motion-induced vomiting and that an incomplete block did not suppress vomiting. The scientists were attempting to isolate the responsible chemical from cerebrospinal fluid.

When a person received sensory cues for motion, the brain responds with its normal, programmed responses to control eye, head, and body movements. But when the responses do not yield the expected results—especially when the visual image does not stabilize and posture control is not easily maintained—humans and animals often experience motion sickness. (NASA Release 83-191)

December 8: The Space Shuttle Columbia (STS-9) landed at 3:47 p.m. PST at Edwards Air Force Base, Calif., after 10 days in space and 167 orbits—the longest Space Shuttle mission ever. The landing followed a delay necessitating 22 more orbits than planned when Columbia's computers failed 3 hours and 49 minutes prior to the planned reentry burn. Six hours after the two computers went off line, Columbia also lost one of its three inertial measurement units that provided orbiter orientation information. The orbiter carried five IBM general purpose computers and three inertial measurement units. Today's reentry was flown with one of each inoperative. A reentry could be flown with only a single computer and single measurement unit. Mission pilots John W. Young and Brewster H. Shaw, Jr., said at the time that they believed that the triggering of an upward firing 870-pound nose reaction control jet, which caused an unusually strong impact to the orbiter, was the likely cause of the computer failures. However, telemetry analysis showed that the thruster activity was coincidental to the computer malfunction. Instead, NASA came to the conclusion that it was a transient hardware internal problem. About 40 minutes after the problems occurred, the crew restored the second computer to operation.

On December 5, President Reagan and West German Chancellor Helmut Kohl, in Athens at the time, held a conference call with the five U.S. crew members and one German payload specialist on Columbia. The U.S.

Information Agency (USIA) used five satellites and thousands of miles of land lines around the world to bounce the signals among Athens, Washington, and JSC to provide live television coverage of the call to seven European cities and the Cable News Network (CNN).

Aside from the computer problems, the ninth Space Shuttle mission was almost flawless and was distinguished by some significant scientific discoveries. One discovery involved the workings of the inner ear, disproving a 77-year-old hypothesis that had won the 1914 Nobel Prize in medicine for Swedish professor, Robert Barany. Barany had said that nystagmus, a flickering of a person's eyes when cold air is blown into one of his ears and hot air into the other, was caused by convection, the motion of fluids under uneven heating. But in space, the lack of gravity meant that convection did not occur. Nevertheless, the astronauts aboard Columbia showed the characteristic eye movements.

The six-man crew completed work on all but one of the 70 scheduled experiments; only a microwave sensing device misfired. Scientists from 14 countries designed the experiments, and the experiments did not end with touchdown. The four scientists were in quarantine, where they would be required to remain motionless so that scientists could observe how their bodies acclimated to gravity. (ESA Release, Dec 9/83; WH annon, Dec 5/83; *W Times*, Dec 6/83, 3A; *W Post*, Dec 6/83, A-3, Dec 8/83, A-3, Dec 9/83, A-1; *NY Times*, Dec 9/83, A-1; *P Inq*, Dec/83, A-1; *AvWk*, Dec 12/83, 23)

December 12: Professor Konstantin Feoktistov, a senior Soviet space official, told a news conference that "work was being done" on the Soviet space shuttle project, which he described as being "more complex" and more "expensive" than Moscow's current orbiting manned-station program, the *Washington Post* reported. Also at the news conference were cosmonauts Vladimir Lyakhov and Aleksandr Aleksandrov, who had just returned from their record-long stay aboard *Salyut-7.* The two confirmed a series of recent mishaps in the Soviet space program, including a fuel leak in their *Salyut 7* orbiting station and a launch pad explosion of a booster rocket September 26 that was to have brought a fresh crew to relieve them. Because of the explosion, the two cosmonauts said that their mission was extended by 50 days. General Vladimir Shatalov, space training chief, told the news conference that there was a leak of toxic propellant on the *Salyut 7* space station but denied reports that the craft was so crippled by this as to endanger the crew's lives. "There was a problem with one of the subsystems and there was a leak of a certain amount of fuel," he said. "That part of the station was switched off and it continues to be viable today." That subsystem was used for space maneuvering, the general added, noting that backup systems were sufficient to deal with the problem.

Another senior Soviet space official said privately that the Soviets were working on a space shuttle and that in "general terms we are considering both types of orbital vehicles—single-use and multiple-use," the *Washington Post* said. (*W Post,* Dec 13/83, A-10)

December 14: Three U.S. biomedical experiments were flying aboard a Soviet spacecraft, *Cosmos 1514,* launched today. In an announcement following the launch, Moscow said only that "scientific experimental systems with various biological objects" were aboard and made no reference to foreign collaboration. However, NASA Administrator James M. Beggs disclosed that NASA had provided three pieces of medical equipment that the Soviets incorporated in the scientific payload of *Cosmos 1514.* Later, NASA said that the experiments had to do with blood system and biorhythm studies in monkeys and fetal development studies in rats. Beggs said that talks that paved the way for the *Cosmos 1514* experiments were held "about five years ago."

Cosmos 1514 was recovered on December 19, 1983, and in May 1984 TASS reported that the rats on the flight were developing normally and that Soviet scientists believed the weightlessness did not affect the normal development of embryos. (GSFC *SSR*; FBIS, USSR, May 9/84; *W Post*, Dec 17/83, A-15)

December 15: Jane's All The World's Aircraft, released today, said that the Soviet Union was developing the world's largest jet airplane, the Antonov 400, the *Washington Post* reported. *Jane's* said that the plane had the ability to transport SS20 nuclear missiles and that new supersonic Soviet fighters carried advanced electronics and weapons that enable them to shoot down cruise missiles and engage Western fighter jets on an equal footing. *Jane's* also said that the AN400, known as the Condor, was specifically designed for the rapid deployment of SS20s, tanks, and other heavy equipment and that it was about 5% larger than the U.S. C5A Galaxy. (*W Post*, Dec 16/83, A-37)

December 19: West German physicist Ulf Merbold, the first European to share flight with U.S. astronauts, said at a news conference that he believed that more Europeans should be assigned to future Space Shuttle flights. "The return to Europe should be better than it was for this particular flight [STS-9]," which had a crew of six. "The politicians in Europe will not be able to sell European participation in the future because there's not enough balance. I think things should be changed." He continued, "The memorandum of understanding signed by the Europeans and Americans called for joint space flights by Europeans and Americans, not one European and many Americans. I think the Americans have to rethink this agreement to make it fairer." (*W Post*, Dec 20/83, A-4)

December 21: An Office of Technology Assessment study released today said that the Soviet Union was nearing construction of a permanent space base that would serve as an eventual springboard for Soviet settlements on Mars and the Moon. "The Soviet space station program is the cornerstone of an official policy which looks not only toward a permanent Soviet human presence in low-Earth orbit but also toward permanent Soviet settlement of their people on the Moon and Mars," the report said. "The Soviets take quite seriously the possibility that large numbers of their citizens will one day live in space." The report pointed out that the United States was still debating NASA's request for as much as $200 million in FY85 to begin development of a U.S. space station. However, the Soviets had committed to a permanent space base.

The report pointed out that, while the United States "seems to have gained a substantial lead over the Soviet Union" in space science and communications, the picture in human spaceflight was "less clear." The report noted that Soviets had flown six models of the Salyut space station in the last 12 years; their cosmonauts had flown more than three times as many hours in space as U.S. astronauts and had accumulated extensive experience "in flight operation, experimentation, and earth observation on trips that last for months." However, U.S. space experts had long criticized the Soviets for sticking with what they believed was essentially outdated technology in the Salyut. It could not fly back to Earth, deploy other satellites, or carry as many people as the Space Shuttle. But the report pointed out that "Salyut may be the penultimate step leading to a permanent, large-scale presence in space." As evidence that the Salyut represented only a stepping stone to larger ventures in space, the report said that there is "unclassified photographic evidence" that the Soviets were developing a small space plane and a larger "heavy-lift" shuttle that would carry "more massive payloads into low-earth orbit" than the U.S. Space Shuttle could lift. (*W Post*, Dec 22/83, A-1; *Salyut, Soviet Steps Toward Permanent Human Presence in Space,* A Technical Memorandum, OTA, Washington, D.C., Dec 83)

December 22: The International Sun-Earth Explorer (ISEE), a spacecraft intended to be the first man-made machine to encounter a comet, came within 72 miles of the Moon's surface in a maneuver designed to carry it through the tail of the comet Giacobini-Zinner in September 1984. Engineers at GSFC stored the five-year-old spacecraft on a horseshoe-shaped path behind the Moon, then down over the Sea of Smyth on the visible side of the Moon, where it picked up speed and sped out oward deep space. Goddard's worldwide tracking network lost contact with the spacecraft when it flew behind the Moon, then regained contact when it flew across the Moon in a flyby as close as any unmanned spacecraft had ever made to another heavenly body without going into orbit around it. The close approach to the Moon was intended to provide a slingshot effect from the brush with lunar gravity that accelerated the spacecraft from 2,900 to 5,145 miles per hour.

The flight through the comet's tail was to take place on September 11, 1985, when Giacobini-Zinner was 44 million miles from Earth. It was planned that the spacecraft would fly through the comet's tail for about 30 minutes at a distance of about 12,000 miles from its head.

On passing the Moon, the ISEE-3 spacecraft was renamed the International

Cometary Explorer to emphasize its new mission. (*NASA Dly Actv Rept*, Dec 28/83; *W Post*, Dec 23/83, A-4)

December 23: NASA published in the Federal Register a proposal on how it would select passengers to ride on the Space Shuttle, possibly as early as 1985. NASA emphasized in the proposal that it was not accepting applications. It had already received more than 2,000 written requests for rides since the 1960s, and it had received so many telephone calls about riding the Space Shuttle that it had to attach a recorded message to its telephone line to request that potential astronauts have patience. All requests that had been received by NASA would be disregarded, said NASA's Sara Keegan.

The proposed selection plan would use a multitiered process to choose Shuttle passengers. All requests would be screened by an outside review panel appointed separately by NASA for each flight and then reviewed by a panel of seven top space agency officials before NASA's administrator made the final selection.

Several months before liftoff of a flight, the agency would announce when it would accept applications and disclose specific requirements for the flight. Such requirements could change according to the Space Shuttle's mission. There were, however, broad requirements for all passengers. Citizen observers/participants would have to be in good health and condition, pass a detailed background investigation, and be willing to undergo rigorous training. NASA was accepting comments from the public on its proposed selection process until mid-February. (NASA Release 83-190; *Federal Register*, Dec 23/83, Vol. 48 No. 248, pages 56770–71. Published in final form in *Federal Register*, Apr 25/84, Vol. 49 No. 81; *NY Times*, Dec 16/83, A-11; *W Post*, Dec 23/83, A-3)

During December: The large number of malfunctions that struck the Space Shuttle Columbia in its final hours of flight during STS-9 forced engineers to inaugurate the most extensive trouble-shooting operations since the Space Shuttles began flying in April 1981. They were not sure how long the undertaking would last, what they might find, or what effect their findings could have on future flight schedules. NASA officials did not rule out the possibility that the Columbia's troubles could cause a delay in the next Space Shuttle mission scheduled for January 30, 1984.

The malfunctions included two computer failures, a navigation instrument shutdown, and an explosive fire in the rear compartment. Early Space Shuttle flights had had troubles with computers and the heat-shielding tiles, but these were straight forward physical defects that were easily identified. The current problems were more perplexing and came when the Space Shuttle was assumed to be a fully tested, operational vehicle. NASA engineers and other aerospace observers had suggested that the Columbia's problems stemmed from a phenomenon not uncommon in any new, complex technology: that is after the initial text phase, when extreme care and attention were given to every step in a project, it was human nature to relax a bit, and it was the nature of machines to misbehave occasionally in unexpected ways.

International Business Machines (IBM), contractor for the computers, would examine the faulty computers; NASA engineers would closely examine data in search of clues to the cause of the two malfunctions, which did not seem to be related to any fundamental design flaw but could have been caused by loose circuitry resulting from vibrations. NASA would ship the inertial measurement unit to its manufacturer, the Singer Kearfott Company in Little Falls, N.J., for examination. (*NY Times*, Dec 15/83, A-1)

—JPL announced that the IRAS had found a ring of planets being born around Fomalhaut, one of the most studied stars in the southern skies. Earlier in the year, the telescope had discovered a primitive solar system around the star Vega. The discovery that Vega and Fomalhaut appeared to have solar systems was the first evidence supporting the theory that Earth's solar system was not the only such in existence. Vega and Fomalhaut might be undergoing the same kind of evolution that Earth's solar system went through three to four billion years ago. "The discovery provides the second direct evidence that solid objects of substantial size exist around a star that is not our sun," said Dr. Gerry Neugebauer, IRAS program scientist at JPL. "These objects could be a solar system in a different stage of development and evolution than our own or the one that we found to be circling Vega," he added. The IRAS detected the two extraterrestrial solar systems by measuring the temperature of the bodies circling the two stars. It found them much cooler than the stars but far too warm and far too large to be rings of interstellar dust. (JPL Release, Dec 16/83; *W Post*, Dec 17/83, A-3)

—Lt. Gen. Charles H. Terhune, Jr., retired December 31 as deputy director, JPL. Following retirement from the Air Force in 1969, he joined JPL as deputy director, functioning as general manager responsible for the day-to-day management of the laboratory's resources and the direction and coordination of its technical, administrative, and service activities. General Terhune received the NASA Distinguished Service Medal in October 1982. He will be replaced as deputy director by Robert J. Parks, JPL associate director. (JPL Release, Dec 12/83)

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January

January 6: The *Washington Post* reported that Air Force Lt. Gen. James A. Abrahamson, NASA associate administrator, said that coded software instruction cards on both computers on the Space Shuttle Columbia's last voyage (STS-9) were contaminated, delaying Columbia's landing at Edwards Air Force Base in California by eight hours. The instruction cards were shaken from their printed circuits when the Shuttle pitched up and down just before reentry; however the up-and-down maneuvers would not ordinarily loosen the software cards unless there was something wrong with them.

Abrahamson said that postflight analysis of the cards at IBM's Owego, N.Y., plant, where the computers were built, showed that one card was contaminated with solder and the other had a carbon chip coated with gold that should not have been there. Abrahamson pointed out that "the most disturbing thing. . . is that both computers were contaminated. I do not like the idea that we flew 10 days in space with contaminated computer parts."

The six-man crew, commanded by astronaut John W. Young, was able to land the Shuttle and its $1 billion European Spacelab safely by relying for navigation on three standby computers. (*W Post*, Jan 6/84, A-8)

January 16: NASA reported on scientific data of the Viking Lander Monitor Mission (VLMM) in the areas of meteorology, radio science, and imaging. The Viking program had explored Mars, using two instrumented orbiters operating in conjunction with two instrumented landers on the planet's surface. Two identical spacecraft, each consisting of a lander and orbiter, were launched in 1975 and began operating at Mars in 1976. A frugal VLMM was conducted from the end of the extended mission in 1980 until June 1983. Based on the data acquired in support of the mission objectives, NASA judged the VLMM successful. Analyses of the data from the mission would continue for some years, supported by the Mars Data Analysis Program of the Solar System Exploration Division. (NASA MOR S-815-75-01/02 [postlaunch] Jan 16/84)

January 23: Japan launched today the *BS-2A* (Broadcasting Satellite) from Tanegashima. The apogee kick motor (AKM) firing occurred successfully on January 26 at 12:14 a.m. EST. Under NASA's Space Tracking and Data Network (STDN) support for Japan, the STDN would provide continuous coverage for 30 hours after AKM firing and contingency support for another 30 days. STDN support to *BS-2A* had been nominal to date. Launch and early orbit support was provided by the STDN on a cost-reimbursable basis. (*NASA Dly Act Rept*, Jan 30/84; GSFC *SSR*)

January 25: President Reagan, in his State of the Union address, endorsed the development of the U.S.'s first permanently manned space station. "We can follow our dreams to distant stars, living and working in space for peaceful, economic and scientific gain. Tonight, I am directing NASA to develop a permanently manned space station and to do it within a decade," he said. "A space station will permit quantum leaps in our research in science, communications and in metals and life-saving medicines which can be manufactured only in space. We want our friends to help us meet these challenges and share in their benefits. . . .Just as the oceans opened up a new world for clipper ships and Yankee traders, space holds enormous potential for commerce today," he said.

NASA presented the agency's plans to the president on the day that he spoke to astronauts in the Spacelab orbiting in the Space Shuttle in December 1983. NASA Administrator James N. Beggs had sought the space station as a science laboratory, astronomical observatory, space manufacturing center, servicing facility for spacecraft, and an assembly site for larger orbiting structures.

Defense Secretary Caspar W. Weinberger and Central Intelligence Agency (CIA) Director William J. Casey had opposed any major commitment to space station funding because they feared it could draw money from their own space programs, government officials said. The officials added that military and intelligence agencies were concerned that they would have to share the space station with civilian agencies such as NASA and sometimes with astronauts of other countries.

NASA also had found little enthusiasm when it turned for support from other agencies. When the National Academy of Sciences space science board was asked whether basic research in science would "require or be enhanced by the space station," Thomas M. Donahue, chairman of the space board, said the answer was no. "I don't think you could ever really justify $20 billion for a space station," he said.

At this early stage, there was no design for the space station, but officials of NASA had previously sketched the broad outlines of the most likely initial design. (*Weekly Compilation of the Papers of Ronald Reagan*, Jan 25/84, 87ff; *NY Times*, Jan 26/84, A-1; *W Post*, Jan 18/84, A-1, Jan 29/84, A-4)

January 27: Johnson Space Center (JSC) spokesman Dave Alter said today that NASA had imposed a $131,250 penalty on contractor Hamilton Standard, Windsor Locks, Conn., for failure of two space suits that it had built for use on the fifth Space Shuttle mission in November 1982. Hamilton Standard was to be paid a $175,000 fee over costs for service from October 1982 through March 1983. However, the failures had prevented space walks by astronauts Joe Allen and Bill Lenoir on November 11-12, 1982. After a lengthy investigation, NASA blamed the contractor for the failure of a fan in Allen's life support backpack and an oxygen pressure regulator on Lenoir's suit. (*W Post*, Jan 28/84, A-7)

January 30: The People's Republic of China (PRC) announced that it had launched on January 29 a space satellite that achieved "important results," and the *New York Times* reported that Western experts speculated that the launch could be the debut of a more powerful Chinese rocket and the nation's first communications satellite. They added that the launching could mean that China had joined the United States, the Soviet Union, and the European Space Agency (ESA) in its capability to loft satellites into geostationary orbits 22,300 miles above the Earth, the orbit favored for commercial and military communications satellites. There were no details of the satellite launched; only "Close observation is being undertaken of the satellite's operations," from China's official Xinhua new agency.

There had been reports as early as 1980 that China was developing a three-stage rocket for boosting heavy payloads. (*NY Times*, Jan 31/84, C-8)

During January: The *Washington Post* reported, according to declassified documents, that the $100 million Tracking and Data Relay Satellite (TDRS) that the U.S. Air Force found unusable in April 1983 had lost its bearings and was unable to determine its position. After being launched from the Space Shuttle, the inertial upper stage (IUS) rocket veered so far from course that the TDRS ended up in an orbit almost 10,000 miles closer to Earth than was intended. It took NASA and its contractors three months to get the satellite into geosynchronous orbit above the equator.

According to the declassified documents, instructions to the gyroscope in the IUS were in error, causing the guidance computer to ignore them just before the rocket misfired. The Air Force said that the software error had been corrected.

At the same time, the guidance computer's memory became confused, rendering it unable to distinguish between right and wrong information about its location in space. Engineers said that they still did not know what caused this failure.

Because of the changes that had to be made in the IUS rocket, the flight of a secret Department of Defense (DOD) satellite aboard the Space Shuttle Challenger would be delayed from July 1 until the end of 1984, sources said. (*W Post*, Jan 31/83, A-2)

—NASA announced that John J. Martin was named associate administrator for aeronautics and space technology. Previously, Martin had served as vice president and general manager at Bendix Advanced Technology Center, Columbia, Md.; at the Institute for Defense Analyses; on the staff of the president's science adviser at the White House; as associate deputy to the director of central intelligence for the intelligence community; as principal deputy assistant secretary of the Air Force; and as assistant secretary of the Air Force for research, development, and logistics. A graduate of the University of Notre Dame and commissioned by the U.S. Navy, Martin is the author of numerous technical papers and reviews and a book on "Atmospheric Reentry," published in 1966. (NASA anno, Jan 30/84)

—NASA announced that C.A. "Sy" Syvertson would retire on January 13 as director of Ames Research Center (ARC). Syvertson had a major part in the first U.S. research in supersonic and hypersonic flight, both in finding new aerodynamic theory and in development of hypersonic wind tunnels. He designed the first lifting body (a vehicle for flight from orbit to airfield landing and the precursor to the Shuttle) and did planning for major NASA missions in both aeronautics and space. During his tenure, ARC merged with NASA's Dryden Flight Research Center (DFRC) and continued advances in aircraft research.

Syvertson received the Lawrence Sperry Award for "fundamental understanding of hypersonic air flow and its application to efficient aircraft design." He received the NASA Exceptional Service Medal in 1971 for work as executive director of the joint Department of Transportation (DOT)—NASA Civil Aviation Research and Development (CARD) policy study, which made a series of recommendations for future civil aviation policy. He was named a fellow of the American Institute of Aeronautics and Astronautics in 1976 and of the American Astronautical Society in 1978 and was elected to the National Academy of Engineering in 1981. (NASA Release 84-01)

Dr. William F. Ballhaus, Jr., director of astronautics at ARC, was named director of the center, succeeding C.A. Syvertson, who retired January 13. Ballhaus is a nationally known expert in computational fluid dynamics—use of supercomputers to stimulate air flow around flight vehicles. As ARC director of astronautics, Ballhaus had been responsible for interplanetary spaceflight projects, operation of a number of airborne observatories used in astronomy and Earth resources research, development of supercomputer systems, research in computational fluid dynamics and computational chemistry, space science, thermophysics, and materials science. Ballhaus came to ARC in 1971, after receiving his doctorate at the University of California at Berkeley (UCB). He joined what is now the Army Aeromechanics Laboratory at ARC and was assigned to the Computational Fluid Dynamics Branch. He has lectured throughout the United States, Europe, and Asia and has published more than 35 technical papers. (NASA Release 84-5)

—Jack Lousma, commander of the Space Shuttle Columbia on its third flight, announced at the state capitol in Lansing, Mich., his campaign for the U.S. Senate. He will seek the Republican nomination to run against Democratic Senator Carl Levin. "Twenty-five years ago, I made a commitment to serve my country—a commitment that has led me from Michigan to the Marine Corps to missions in space," he said. "That same commitment brings me home today." He spent 59 days in orbit as part of Skylab's second manned mission in 1973 and was commander of the Shuttle Columbia in 1982. (*W Post*, Jan 26/84, C-2)

February

February 2: NASA announced the crew assignments for Space Shuttle flights 51-D, scheduled for launch in February 1985, and 61-D, set for January 1986. Brewster H. Shaw, Jr., would command 51-D. Shaw was pilot of the orbiter Columbia on STS-9, the first Spacelab mission flown in November and December 1983. His crew would consist of Bryan D. O'Connor as pilot and mission specialists Mary Cleave, Sherwood C. Spring, and Jerry L. Ross. Mission 51-D would be the 21st Space Shuttle flight and the 9th for the orbiter Challenger. The principal objectives of the six-day flight would be deployment of a SYNCOM communications satellite and retrieval of the free-flying Long Duration Exposure Facility.

John M. Fabian, an Air Force pilot with more than 3,500 hours of flying time, would fly as one of the pilots on 61-D. He flew as mission specialist on STS-7 in July 1983 and was scheduled for 51-A in October as a mission specialist. Flight 61-D mission specialists would be James P. Bagian, M.D., and Rhea Seddon, M.D., who is also scheduled to fly on mission 41-F in August. Mission 61-D would be the fourth Spacelab flight, focusing on experiments in life sciences during its seven days in space. It would be the ninth flight of the orbiter Columbia. A commander and another pilot for 61-D would be named at a later date. (NASA Release 84-11)

—Donald J. Johnston, Canadian Minister of State for Science and Technology, announced that a Canadian would fly as a payload specialist on Space Shuttle mission 51-A, set for launch in October, in addition to two earlier Canadians already scheduled for Shuttle flights. NASA offered Canada the opportunity to fly a payload specialist in keeping with President Reagan's initiative to increase international cooperation. Shuttle flight 51-A would be a six-day flight, carrying Telesat Canada's ANIK C-1 satellite and a Getaway Special experiment designed by two Canadian high school students. The Canadian crew member and backup for the October flight would be announced in March. (NASA Release 84-12)

February 3-10: NASA launched at 8:00 a.m. EST from Kennedy Space Center (KSC) the Space Shuttle Challenger on mission 51-D, what space observers called the most dangerous Space Shuttle mission to date. Commander of the flight was Vance D. Brand, 52, a former Marine pilot and veteran of two spaceflights, and the pilot was Navy Cmdr. Robert L. Gibson, 37, who flew combat missions in Vietnam. The mission specialists were Navy Capt. Bruce McCandless, 46; Lt. Col. Robert L. Stewart, 41, the first Army officer to make a spaceflight; and Dr. Ronald McNair, a physicist.

Seven hours after launch, the astronauts pushed Westar VI, Western Union's $30 million satellite, out of the cargo bay to join two identical satellites already serving North America. However, NASA officials said that the satellite could not be contacted by radio and was considered lost in space. Officials said that the satellite's on-board rocket engine, which was to propel it into higher orbit, either misfired or never fired. Radars operated by the North American Aerospace Defense Command (NAADC) later found the satellite in an erratic orbit above and behind Challenger. The radars found two large pieces in an orbit more than 800 miles high at its peak and just over 200 miles high at its lowest point above Earth.

On February 5, a large balloon that the astronauts were to chase through space exploded just after it had begun to inflate. Plans called for the astronauts to back up to 120 miles away from the balloon, then move in over the next eight hours to contact it. Instead, the crew spent 90 minutes tracking pieces of the balloon and never got farther than 20 or 30 miles from the debris. The astronauts tracked the balloon's largest piece with radar for almost 20 miles and used special binoculars and an optical sextant to follow the same piece more than 20 miles by watching sunlight reflected off the balloon's aluminum surface.

The Indonesian satellite *Palapa-B2*, launched February 6, went into a useless orbit, believed to be caused by the same technical problem that Westar VI suffered. The NAADC located *Palapa-B2* about seven hours after its ejection from the Challenger's cargo bay, but it was in an orbit so low that it "cannot perform its mission," said Richard Brandes of Hughes Aircraft Company, builder of the satellite. He added that both satellites' rocket motors apparently shut down 15 seconds early; they were intended to burn for 80 seconds.

On February 7, astronauts Bruce McCandless and Robert Stewart left Challenger and flew unrestrained for the first time, adding another milepost to man's conquest of space. They unhooked their lifelines and rose up more than 100 yards away from the Space Shuttle. Propelled by $10 million jet-powered backpacks, they traveled at 4.8 miles a second, although they had no sensation of speed. The two reentered Challenger after 5 hours and 55 minutes. The exercise was a rehearsal for the next Shuttle flight, when other astronauts would try to retrieve an ailing satellite, bring it into the cargo bay for repair, and release it to orbit again. On February 9 the two took a second walk in space, which lasted 6 hours and 17 minutes.

The Space Shuttle made its first landing at KSC on February 11, when it touched down at 7:16 a.m. EST. The Florida landing had been a Shuttle program goal because it would save money and time by eliminating sending maintenance crews to California to prepare the vehicle for a return flight to Florida on the back of a Boeing 747. It was the first Florida landing in two attempts and the first of six planned for the year. Challenger was in relatively good shape following the landing, although its windshield, fuselage, and landing gear were damaged. The windows were hazed and pitted; and 31 of its 33,000 protective tiles, two brake assemblies, and all four tires on the main landing wheels would have to replaced. Repairs should not slow the preparation of Challenger for its next flight in April. (NASA MOR M-989-41-B [prelaunch] Jan 30/84; *NASA Dly Actv Rept*, Feb 6/84; *W Post*, Feb 2/84, A-2, Feb 4/84, A-1, Feb 5/84, A-1, Feb 5/84, A-1, Feb 8/84, A-1, Feb 9/84, A-12, Feb 11/84, A-2, Feb 12/84, A-1, Feb 13/84, A-3; *W Times*, Feb 6/84, 2A, Feb 7/84, 1A, Feb 8/84, 1A; *USA Today*, Feb 6/84, A-1)

February 8: Because of the failure of two telecommunications satellites launched by the Space Shuttle, the insurance industry would receive more than $200 million in claims, and premiums would skyrocket when underwriters resumed writing satellite risk policies, the *Washington Post* reported. Analysts said that it was too early to determine what impact the satellites' failures would have on their manufacturer, Hughes Aircraft Company, or McDonnell Douglas Corporation, which built the rocket motors that apparently failed on the two satellites.

Western Union, owner of one satellite, was insured for $105 million to cover the cost of the satellite and potential revenue; Indonesia, owner of the other satellite, had $75 million in insurance to cover the cost of building and launching the payload. Robert J. Tirone, vice president of the large insurance broker Alexander & Alexander, said that underwriters would likely hold off issuing any new policies until they found out what went wrong with the two satellites. "Something went wrong," he said, "and it went wrong twice."

A spokesman for McDonnell Douglas said that the company was puzzled by the apparent failure of the rockets that were supposed to lift both satellites into stationary orbits about 22,300 miles from Earth. The rockets, payload assist modules (PAM), had been successfully used in 16 previous commercial satellite launches—5 from the Space Shuttle and 11 by missiles.

At the end of 1983, the insurance industry had collected $205 million in premiums and paid $210 million in claims. As a result of the two recent failures, claims would rise to about $420 million. An insurance broker, who asked not to be identified, said that he expected premiums to quadruple as a result of the loss of the two satellites. (*W Post*, Feb 8/84, D-2)

—The Soviet Union launched today a three-man crew on board the *Soyuz T-10* spacecraft, which successfully docked with the *Salyut 7* space station on February 9. The crew consisted on Col. Leonid Kizim (commander), Vladimir Solovyev (flight engineer), and Oleg Atkov (cosmonaut-researcher). It appeared that only Kizim had previous space experience, having commanded the *Soyuz T-3* in 1980 in the first three-man mission to test and dock the upgraded *Soyuz-T* and the *Salyut 6*.

Because of the greater amount of instrumentation and power then in place, TASS noted that the current mission "will have broader possibilities for research than any of the previous ones." Scientific, technical, medical, and biological studies were on the schedule of the current mission, and the cosmonauts were reactivating life support, power supply, and heat control systems and were inspecting on-board equipment as part of their "demothballing" process [See Oct 2/84 for return of crew]. (*NASA Dly Actv Rept*, Feb 14/84; FBIS, USSR Feb 9/84, U1)

February 9: Pilot Brooke Knapp landed a Gulfstream III business jet at Washington (D.C.) National Airport today and claimed a new speed record for an around-the-world flight by any type of aircraft. Her unofficial average speed was 512 miles per hour. Knapp had originally intended to break the record for a heavy class of business jet, but she bested by nine miles per hour the old record for all types of planes, set by an Pan American World Airways 747 in 1976. Knapp was president of a California executive charter and aircraft management service.

The flight raised about $500,000 in gifts and pledges for the United Nations Children's Fund (UNICEF) and carried children's letters and art from country to country. At the Novosibirsk Airport in the Soviet Union, children carrying their paintings greeted Knapp. The elaborate welcoming ceremony lost time for the crew, but they believed they could not ignore it.

After refueling stops in London, Moscow, Novosibirsk, Peking, Tokyo, Honolulu, and Los Angeles, Knapp landed the twin-engined jet at National at 9:12 a.m., 45 hours, 32 minutes, and 53 seconds after taking off. The plane flew about 20,300 miles. (*W Post*, Feb 10/84, C-1)

February 10: Inflight refueling tests on the NASA 747 Shuttle Carrier Aircraft had been suspended following a series of preliminary flights intended to check potential buffeting and turbulence levels on the specially equipped widebodied jet, NASA reported. The aircraft carrier with its orbiter cargo was required to travel at low altitude and to avoid bad weather, so it could not travel long distances without frequent stops. Therefore, NASA had hoped to develop airborne refueling techniques that would reduce the number of landings required to travel coast to coast or to international locations.

The preliminary tests had the 747 without the orbiter flying behind two tanker aircraft—first a KC-135 and then a KC-10. Heavy turbulence encountered in the vortices of the tanker aircraft had produced minor cracks in the tail of the 747. Although the cracks were of no serious concern, NASA had decided to suspend the flight tests and to investigate an alternative refueling technique that allowed the 747 carrier to fly in front of the tanker aircraft. If the alternative approach proved feasible, it could likely be adopted with little or no additional flight testing with the carrier aircraft. (JSC Release 84-007)

February 14: The *Washington Post* reported that a secret military payload set for launch July 14 on the Space Shuttle had been canceled and that the mission would be scrubbed without it, according to Air Force and NASA officials. A Pentagon spokesman declined to identify the payload or say when it would be flown. Glynn Lunney, Shuttle program manager, said "if they remove the payload, we won't fly." The canceled mission left astronauts Thomas Mattingly, Loren Shriver, Ellison Onizuka, and James Buchli without a flight for the second time; they were to have flown the Shuttle in the fall of 1983 on a military mission canceled because of rocket problems. (*W Post*, Feb 14/84, A-7)

February 15: NASA Administrator James M. Beggs announced today that JSC was named "lead center" for the agency's Space Station Program. In a letter to center director Gerald D. Griffin, Beggs said that he was requesting the center to form a program office to execute five basic program responsibilities: systems engineering and integration, business management, operations integration, customer integration, and support of NASA Headquarters Space Station Program Office.

Beggs noted that he planned to form a new organization at NASA Headquarters to direct the Space Station Program and that he would make assignments to other centers under overall project management of JSC.

Terry White, a NASA spokesman in Houston, said that space station work would probably not require a large increase in personnel there because people working on the Space Shuttle program would shift over to the Space Station, the *New York Times* reported.

February 29: NASA announced the establishment of seven intercenter teams to conduct advanced development activities for high potential technologies to be used in Space Station design and development. Marshall Space Flight Center (MSFC) would lead three of the intercenter teams; JSC, three of the teams; and a lead center for the seventh team would be assigned later.

The teams would identify emerging technologies for advanced development for Space Station design and establish test beds into which prototype technology hardware could be integrated, tested, demonstrated, and evaluated. MSFC would be the lead center for the Attitude Control and Stabilization System, the Auxiliary Propulsion System, and Space Operations Mechanisms. JSC would be the lead center in the Data Management System, Environmental Control and Life Support System, and the Thermal Management System. The Electronic Power System would have a leader designated later. Assisting on various assignments would be the Jet Propulsion Laboratory (JPL), Langley Research Center (LaRC), Goddard Space Flight Center (GSFC), KSC, ARC, National Space Technology Laboratories (NSTL), and Lewis Research Center (LeRC). (NASA Release 84-31).

During February: The mission of ESA's first preoperational remote-sensing satellite, ERS-1, would be mainly to monitor ice and coastal and ocean zones, the agency announced. Among the instruments in the ERS-1 payload would be an active microwave instrumentation package operating in the C-band and combining the functions of a synthetic aperture radar, a wave scatterometer, and wind scatterometer for the purpose of measuring wind fields and the wave image spectrum and taking all-weather high-resolution images of coastal zones, open oceans, ice areas, and (on an experimental basis) land. Germany, the Netherlands, France, and Canada, each built a C-bank scatterometer for comparison of data in order to evaluate the optimal technical characteristics of the C-band scatterometers on board ERS-1 and to check the mathematical models used for data processing.

This experimental campaign organized by ESA would operate in the North Sea, in conjunction with a German scientific platform supplying "sea truth" data, and about 40 kilometers off the Brittany coast, in conjunction with a French oceanographic vessel supplied by the Centre National d'Exploitation des Oceans (National Center for Ocean Exploitation). This would allow comparison of the data acquired by the various scatterometers and data acquired by conventional means on board the platform and the oceanographic vessel. (ESA Release, Feb 6/84)

March

March 6: Charles Yost, a member of NASA's Space Station task force, speaking at the Shuttle/Space Station business opportunities conference in Washington, said "There's been an overhyping of the commercialization of space idea." He added that it would take years before investments in many of the space-based opportunities being explored showed a significant return. However, he pointed out, "industry must be willing to risk its money up front," and said that nine companies had applied for a joint endeavor agreement with the space agency. At the time, only four companies had actually signed with NASA to use the Space Shuttle for business ventures.

Space industry analysts said that it would cost "a minimum of few million dollars" to begin exploiting the commercial potential of space. Though satellite communication had proved profitable, most space-based efforts faced an uncertain future. A Reagan administration recommendation to turn the nation's Landsat remote-sensing and weather satellite systems over to private industry had met resistance in Congress, and some analysts believed there might not be a market for remote-sensing data. Many attendees at the conference questioned whether any company would make money in space manufacturing before 1990. (*W Post*, Mar 7/84, D–16)

March 7: NASA Administrator James M. Beggs and Professor Ernesto Quagliarello, president of the Italian National Research Council (CNR), signed today in Rome two memoranda of understanding; the separate agreements established the development of the Tethered Satellite System (TSS) and the development and launch of Laser Geodynamics Satellite-2 (Lageos-2).

The TSS would be a data-gathering satellite that would be carried into orbit by the Space Shuttle and released from payload bay on a tether. It would provide an important new reusable, multidisciplinary facility for conducting space experiments in Earth orbit and open the way to several areas of long-term scientific experimentation not otherwise possible. NASA would develop the TSS deploy, perform the system-level engineering and integration, and launch TSS on the shuttle. CNR would develop the two-module (science and service) TSS satellite and provide system-level support to NASA for technical aspects of the satellite.

Eleven countries were conducting laser ranging activities with the passive Laser Geodynamics Satellite-1 (*Lageos-1*) launched by NASA in 1976. The agreement signed today outlined the terms for the development of *Lageos-2*, which would significantly enhance study and understanding of the solid earth and its dynamic processes. *Lageos-2* would be identical in configuration to *Lageos-1* and would be placed in an orbit of similar altitude but with a different inclination (51–53° prograde instead of 70° retrograde). *Lageos-2* would contribute to the study of plate tectonics and the accumulation of crustal strain in areas of high seismicity through very accurate measurements of baseline changes resulting from crustal motion. The two satellites, in essentially opposite orbits, would improve the precision of current laser-determined baselines by a factor of two and would make possible achievements of a precision of one centimeter for baselines of several thousand kilometers. CNR would be responsible for the fabrication of the *Lageos-2* satellite, integration of the apogee stage and the Italian research interim stage, and delivery to NASA. NASA would provide existing ground support equipment, hardware, and software remaining from the *Lageos-1* mission, technical consultation, and launch on the Space Shuttle as a payload of opportunity with a planned launch in 1987. (NASA Release 84-34)

March 11: NASA announced that the fifth group of applicants to be interviewed for possible selection as Space Shuttle astronaut candidates, including 15 mission specialists and 7 pilot applicants, reported to JSC today for a week of interviews and medical evaluations. A total of 4,934 men and women had applied for the approximately 12 positions open.

The selected candidates would begin in July 1984 a year of training and evaluation at JSC and be selected as astronauts after satisfactory completion of the evaluation period.

The selected candidates were: David T. Allen, Ph.D., employed by University of California at Los Angeles (UCLA); Maj. Larry D. Autry, U.S. Air Force; Lt. Commander Dennis N. Bostich, U.S. Navy; Capt. Joseph A. Carretto, U.S. Air Force; Lt. Commander Keith E. Crawford, U.S. Navy; William M. Decampli, M.D., Ph.D., employed by Stanford Medical Center, Stanford, Calif., Jan D. Dozier, employed at MSFC; Lt. Col. William A. Flanagan, U.S. Air Force; Wendy S. Hale, Ph.D., stationed at Edwards Air Force Base, Calif.; Rosario M. Izquierdo, employed by National Security Agency (NSA); Lt. Fred D. Knox, Jr., U.S. Navy; G. David Low, employed by JPL; Lt. Commander Michael J. McCulley, U.S. Navy; Kenneth J. Myers, M.D., employed by the Mayo Clinic, Rochester, Minn.; William S. O'Keefe, employed by Ford Motor Company, Dearborn, Mich.; Donald R. Pettit, Ph.D., employed by Los Alamos National Laboratory; Lt. Commander William F. Readdy, U.S. Navy; Lt. Commander Gregory J. Rose, U.S. Navy; Lonnie Sharpe, Jr., Ph.D., employed by North Carolina A&T State University, Greensboro, N.C.; Kathryn C. Thornton, Ph.D., employed by the U.S. Army Foreign Science and Technology Center, Charlottesville, Va.; C. Lacy Veach, employed by JSC; and Lt. Commander James B. Waddell, U.S. Navy. (NASA Release 84-018)

March 16: NASA announced that it had selected McDonnell Douglas Astronautics Company, Huntington Beach., Calif., and TRW, Inc., Space and Technology Group, Redondo Beach, Calif., for negotiations that would lead to two parallel Space Station study contracts, each contract for a firm fixed price of approximately $2 million, covering a performance period of approximately 27 months, beginning in March. Contracts would be for the development of functional, performance, and technology requirements; the definition of system architecture for the Space Station data system; and the relationship of that system to the overall NASA end-to-end flight and ground information system.

The studies would define the role of the Space Station data system and its relationship, and interfaces to the Space Station information systems elements. They would also define the data system to determine the environment in which both the user and facility subsystems interface and operate; address all avionics and other electrically automated Space Station functions; develop a clear understanding of system functional, operational, and interface requirements; identify major cost items to enable effective management decisions and development control; and define a program plan.

NASA's JSC would negotiate and administer the TRW contract; NASA's GSFC, the McDonnell Douglas contract. (NASA Release 84-36)

March 19: The Soviet Union was developing a large laser-equipped prototype military spacecraft for launch on its heavy Saturn-5–class booster, which was also competing development, *Aviation Week & Space Technology* reported. Soviet scientists were designing the spacecraft to attack U.S. satellites and would launch it on the booster within the next two years. The new booster's primary mission was to place the 300,000- to 400,000-pound Soviet space station elements in orbit, but the U.S. DOD had been concerned for some time that it also could be used for the type of heavy, unmanned, prototype directed-energy weapon known to be under development. (*AvWk*, Mar 19/84, 13)

March 27: Secretary of Defense Caspar W. Weinberger today named Air Force Lt. Gen. James A. Abrahamson, NASA's associate director for space flight, to be manager of what the Reagan administration called the strategic defense initiative, a program to explore the feasibility of building a space-based defense against nuclear ballistic missiles. President Reagan had suggested the program the previous year.

Abrahamson's job would be to direct and coordinate several research programs that had been under way for some time at DOD and in the Department of Energy (DOE). These included research on several kinds of laser and particle beam weapons, work on large mirrors needed for some lasers, advances in high-speed data processing, and methods of generating large amounts of electrical power in space.

Abrahamson had been at NASA since November 1981 and had directed not only the Space Shuttle operation but also commercial sales of Shuttle services and relations with Congress and the space industry. He would begin his new duties on April 15 after the nation's 11th Space Shuttle flight, scheduled for launch on April 6. (*NY Times*, Mar 28/84, A-19)

—NASA announced that Jesse W. Moore would become acting associate administrator for spaceflight on April 15, succeeding Lt. Gen. James A. Abrahamson, who would become director of strategic defense at DOD. Moore, who had been Abrahamson's deputy, had come to NASA Headquarters in 1978 as the deputy director of the Solar Terrestrial Division in the Office of Space Science. He was director of the Spacelab Flight Division until December 1981, when he assumed the position of director, Earth and Planetary Exploration Division in the Office of Space Science and Applications. In February 1983 he was appointed to the position of deputy associate administrator for spaceflight. (NASA Release 84-40)

—U.S. Ambassador to Portugal Allen Holmes and Portuguese Foreign Minister Jaime Gama signed today in Lisbon an accord that would provide for a satellite tracking station in Portugal. Under the accord, the United States would provide Portugal with $60 million annually, of which $20 million would be for military aid and $40 million for economic aid. The United States would use the station to track flying military targets; U.S. plans called for five satellite tracking stations in the world, and stations in New Mexico, Hawaii, and South Korea were completed. (FBIS, Beijing Xinhua in English, Mar 28/84)

During March: In an interview following his around-the-world trip to sell the U.S. Space Station idea to U.S. allies, NASA Administrator James M. Beggs said, "I thought the trip went well, I thought it went extremely well." He added that he had proposed that as much as one-fourth of the proposed $8 billion cost of the Space Station be borne by western Europe, Japan, and Canada. "They didn't exactly stand up and cheer when I said I'd like them to think about contributing a couple of billion dollars, but they didn't blink at the numbers either," he said.

Beggs said that the countries had about a year to decide if they wanted to join in a partnership with the United States, since NASA planned to begin awarding contracts for the Space Station's final design in the spring of 1985. He noted that all of the countries had laid down conditions under which they would agree to participate: the station must provide technological challenges to their industries; they must have what Beggs called a "clearly defined role" in the direction of Space Station operations and selection of flight crews; they must have access to the entire station; and their industries must have the same access that U.S. industry had. (*W Post*, Mar 27/84, A-2)

April

April 3: NASA announced that it awarded to the University Corporation for Atmospheric Research, Boulder, Colo., a cost-plus-fixed-fee contract of $7,076,741 for operation and maintenance of the National Scientific Balloon Facility (NSBF) in Palestine, Tex. The contractor would provide the personnel, materials, supplies, and services to manage, operate, and maintain the NSBF, including flight program operation, engineering activities, and research and developmnet. The NSBF would annually conduct 60 to 70 scientific balloon flights.

GSFC's Wallops Island, Va., facility would administer the contract. (GSFC Release 84-4)

April 3–11: The Soviet Union launched today, aboard the *Soyuz T-11*, two Soviet cosmonauts, Col. Yuri Malyshev and Gennady Strekalov, and the first Indian cosmonaut, Rakesh Sharma, a 35-year-old Air Force pilot, for an eight-day visit to the *Salyut-7* space station to join three other cosmonauts who had been living there since February 8. The joint flight was the 11th in the Intercosmos series that had taken non-Soviet cosmonauts into space along with Soviet counterparts.

On this flight, Sharma would conduct medical experiments in which he would practice yoga as a possible means of coping with space sickness. Experiments would also include detailed space surveys of the Indian subcontinent. The Soviet Union and India televised the launch, and Tass quoted Prime Minister Indira Gandhi as saying that the joint mission gave a "new dimension" to friendship between India and the Soviet Union.

The three returned to Earth April 11 in a perfect parachute landing of their *Soyuz T-10* space capsule near the town of Arkalyk, 1,500 miles southeast of Moscow. Tass reported that the cosmonauts were "feeling fine." The report continued, "New information on peculiarities of the human organism's adaptation to space flight conditions was obtained." Beyond stressing Soviet-Indian cooperation and friendship, the flight also demonstrated the peaceful uses of outer space, Soviet officials commented. (FBIS, USSR, Apr 4/84, U1–4; FBIS, USSR, Apr 11/84, U1–3; *NY Times*, Apr 4/86, A-16; *W Post*, Apr 12/84, A-33)

April 4: The *Washington Post* reported the death of April 4 of Oleg Antonov, 78, one of the Soviet Union's leading aircraft designers. Antonov, whose obituary was signed by Communist Party leader Konstantin Chernenko and other dignitaries, became the head of that country's aircraft design office in 1946. One of his first creations was the AN-2 transport and agricultural biplane, which soon became the national airline's (Aeroflot) workhorse and still was in use. Under his leadership, the office also designed a range of Antonov aircraft, including passenger planes and the long-range AN-22 heavy-transport aircraft. (*W Post*, Apr 6/84, B-6)

April 6–13: NASA launched at 8:58 a.m. EST today from Cape Canaveral the Space Shuttle Challenger (STS-41C) carrying Capt. Robert L. Crippen, commander; Frances R. Scobee, pilot; and mission specialists Terry J. Hart, Dr. James D. Van Hoften, and Dr. George D. Nelson. Challenger flew to an altitude of nearly 300 miles, the highest any Shuttle crew had flown, because the astronauts had to match the orbit of, rendezvous with, and repair the burned out Solar Maximum Observatory satellite that had been out of service for almost four years.

At 12:20 p.m. EST on April 7 the astronauts deployed the Long Duration Exposure Facility (LDEF), a 30-foot-long cylinder carrying 57 varieties of space-age materials. Following retrieval by other astronauts next February, scientists would examine the cargo to determine how it stoop up to the heat, cold, and cosmic rays of space. The Space Shuttle's 50-foot-long robot arm pushed the cylinder out of Challenger's cargo bay.

The initial attempt on April 8 to retrieve the orbiting Solar Max satellite failed when astronaut George (Pinky) Nelson, propelled by a jet-powered backpack, tried unsuccessfully to attach himself to the crippled, slowly spinning observatory. He bounced away from the satellite each time, causing it to spin faster with each bounce. After running low on fuel, Nelson returned to Challenger. However, on April 9 radio commands from ground controllers at GFSC stabilized the satellite just before its batteries went dead. On April 10 Crippen inched Challenger's robot arm up to one end of the 21-foot-tall Solar Max, and then Hart caught the slow-spinning satellite on the first try. They then moved it into flight support system, a berthing area in the back of the Space Shuttle's cargo bay. The following day, Nelson and Van Hoften, wearing space suits, stepped out into the cargo bay and replaced a 500-pound fuse box and fixed a smaller electronics box supplying power to one of seven instruments. The work was completed in slightly less than the alloted six hours. The astronauts redeployed the observatory on April 12. The *Washington Post* reported that, because the repair job was done so well, the observatory would do better in its restored state than in the 10 months it had worked before breaking down almost four years previously.

Challenger landed at 5:38 a.m. local time April 13 at California's Edwards Air Force Base instead of the preferred site at KSC, due to poor weather in Florida. NASA officials pronounced the Space Shuttle to be in excellent condition. "Compared to 10 previous recoveries, the condition of the ship is much better," Fritz Widick, operations manager for the recovery, commented at a news conference. "During the flight there were only something like 12 problems recorded in the ship, which is remarkable." (NASA MOR M-989-41-C, Mar 19/84; *W Post*, Apr 8/84, A-3, Apr 6/84, A-2, Apr 9/84, A-1, Apr 10/84, A-1, Apr 11/84, A-1 Apr 12/84, A-1, Apr 13/84, A-2; *NY Times*, Apr 15/84, 23)

April 6: Engineers at NASA's GSFC completed checkout and activation of the *Landsat-5* Earth resources satellite, launched from the Vandenberg Air Force Base complex in California on March 1, and turned over today operational control of the spacecraft to the National Oceanic and Atmospheric Administration (NOAA). The 1,950-kilogram (4,300-pound) spacecraft was placed in a 705-kilometer (438-statute miles) near-polar orbit. NASA engineers had checked out all computer, communications, telemetry, and other spacecraft systems and declared the spacecraft ready for operational use.

With *Landsat-4* still functioning, data acquisition over the same ground swath was possible on an eight-day repeat cycle. NASA planned to turn over to NOAA operational responsibility for Thematic Mapper operation and data processing in January 1985. (NASA Release 84-49; *NASA Dly Actv Rept*, Apr 9/84)

—NASA announced that it had established an interim Space Station Program office as a result of President Reagan's January 25, 1984, directive to NASA to develop a permanently manned Space Station and to do it within a decade. Philip E. Culbertson, in addition to his duties as associate deputy administrator, would assume the role of acting director of the interim office, with John D. Hodge (former director of the Space Station task force) as acting deputy.

The interim office superseded the former Space Station task force and would be responsible for direction of the Space Station Program and for planning the organizational structure of a permanent Program Office. (NASA anno, Apr 6/84)

April 8: The PRC New China News Agency announced that China had launched on April 8 its first permanently orbiting communications satellite, the *Washington Post* reported. The geosynchronous satellite was positioned over the Moluccan Sea near Indonesia. The news agency reported that all meters and instruments were working normally as the satellite began experiments on telephone communications and radio and television transmissions.

Foreign experts said that the launch was a major achievement that could improve communications in all facets of Chinese life, including the far-flung military. It also had vast implications for China's fledgling nuclear force. The rocketry required to propel the satellite into orbit—a three-stage launcher with a refined guidance system—far exceeded the firing capability of the nation's best intercontinental ballistic missiles (ICBMs).

China also had pending contracts with the United States to launch three larger communications satellites with the Space Shuttle, but no dates were set. (*W Post*, Apr 19/84, A-31)

April 9: NASA named Neil B. Hutchinson manager and John W. Aaron deputy manager of the Space Station Program Office at JSC in Houston, Tex.

Hutchinson was serving in a staff assignment to the Johnson director since his return in January 1984 from a one-year assignment at NASA Headquarters, where he was director, Space Shuttle Operations Office in the Office of Space Flight.

Aaron had been chief of the Spacecraft Software Division at JSC since 1981. He also had served as avionics flight software project manager for the Shuttle approach and landing test and orbital flight test programs. (NASA Release 84-50)

April 13: NASA announced that LeRC awarded a $161 million contract to General Dynamics Corporation, Convair Division, San Diego, Calif., for two Shuttle/Centaur G vehicles for the DOD. A previous contract included two NASA-unique Shuttle Centaur G-Prime vehicles for the Galileo (Jupiter) mission and the International Solar/Polar Mission (ISPM), scheduled for launch in 1986. The two contracts together totaled $414 million.

Centaur was a high-energy upper-stage booster expected to add substantially to the Space Shuttle's ability to deliver heavier payloads from low-Earth orbit to geosynchronous orbit or interplanetary trajectories. (NASA Release 84-44)

April 25: NASA announced that it and its Italian counterpart, the National Space Plan office of the Italian National Research Council (PSN/CNR), had asked scientists from around the world to submit their ideas for experiments to be performed on a joint U.S.-Italian program known as the TSS—Satellite that later in the decade could be reeled into and out of the Space Shuttle's cargo bay on a miles-long tether. NASA and PSN/CNR would evaluate scientists' proposals and decide what experiments would be performed on the system. NASA planned to carry the system aboard the Space Shuttle by sometime in 1987.

On its first flight the satellite, once the Shuttle was in orbit, would be deployed upward about 40 feet by an extendable boom. The satellite would be checked out while at the top of the boom and then released. As it moved upward away from the Shuttle, the reel would unwind until the satellite was at its proper distance for conducting electrodynamic experiments.

As the Shuttle passed through the space plasma, the satellite, with its conducting tether, could become a generator, much as a copper coil moving within a magnet on Earth can produce a flow of electricity. By drawing off the energy from the conducting tether and releasing it into space, scientists would be able to study magnetic lines of flux that surround the Earth. (NASA Release 84-54)

During April: Science reported that the first commercial product manufactured in space, 15 grams of 10-micrometer polystyrene spheres that were produced on the STS-6 mission, would soon be transferred from NASA to the National Bureau of Standards (NBS) for sale to the public. The spheres could be used for calibration of microscopes, laser light scattering equipment, and particle sizing equipment. The spheres also had potential uses in biomedical sciences, particularly for sizing of pores and membranes. The spheres fit the two key criteria for space manufacturing: they could not be made on Earth, and they were very expensive.

NBS would divide the 15 grams of spheres into 1,000 samples, each of which would sell for about $350. Total value of the spheres would thus be about $23,000. (*Science*, Apr 84, 265)

May

May 4: NASA Administrator James M. Beggs said that engineers had determined the problem with two types of rocket motors that had caused the loss of two $75 million satellites and the near-loss of a third and had led to postponements of two Space Shuttle flights, the *Washington Post* reported. A report from McDonnell-Douglas said that a team had found a way to determine which rocket nozzle would fail in space and which would work. Such a procedure might have saved the two communications satellites that gone into useless orbits. However, the solution had come too late to put a Canadian communications satellite on the next Space Shuttle flight scheduled for June 19. (*W Post*, May 4/84, A-2)

—In a continuing series of reports on orbiting cosmonauts Leonid Kizim, Vladimir Solovyev, and Oleg Atkov, who had been in space for 85 days aboard the *Salyut-7*, Tass said that the crew had completed planned operations with the cargo craft *Progess-20*, storing supplies and pumping drinking water into the station's tanks.

Kizim and Solovyev then made their fourth walk in open space. The two removed a heat-resistant coating that had been installed during a previous space walk, assembled a second conduit, and checked it for airtightness. The two then reinstalled the heat-resistant coating, put tools into a container, and returned to the station. Their walk lasted 2 hours and 45 minutes, bringing their total time in open space to 14 hours and 45 minutes during 4 walks in 12 days. (FBIS, Tass in English, May 4/84)

May 16: NASA announced that approximately 200 people representing every NASA installation and the JPL were selected to augment the staff of JSC to help plan the next phase of NASA's Space Station Program. This team had two major objectives: issue a request for proposals to industry for the definition of the specific elements of the Space Station and define a reference configuration or configurations to accompany the request for proposals.

"The purpose of the reference configuration is to provide a framework to help industry understand how the various elements of the Space Station are related," said Dr. Ralph Muraca, deputy head of LaRC, designated a "center of excellence" to help plan this next phase of the program. "In addition, it will help individual companies determine which of the elements or work packages they would be interested in competing for."

The group's guidelines were to develop a configuration that would meet all the requirements associated with the final configuration of the Space Station, expected to be operational in the 1999–2000 time frame, and then scale that back to an $8 billion configuration that would provide maximum mission capability in 1991. (LaRC Release 84-35)

May 18: At a ceremony today in Washington, D.C., NASA transferred ownership of Viking Lander 1, which was on the planet Mars, to the Smithsonian Institution's National Air and Space Museum. It was the first time a museum would own an object located on another planet. The transfer also included loan of the official Viking Lander plaque, which renamed the lander the Thomas A. Mutch Memorial Station in memory of the Viking landing imaging team leader and NASA associate administrator for space science who had died in a climbing accident in the Himalayas in 1980. NASA retained reclaimant rights to the lander for scientific purposes. (NASA Release 84-58; *NY Times*, May 3/84, A-19)

May 22: An Arianespace Ariane I rocket lifted off at 9:33 a.m. EDT to orbit a U.S. communications satellite 22,300 miles above the equator in the world's first strictly commercial space venture. Virginia-based GTE Spacenet Corporation built the satellite, which was intended to relay thousands of simultaneous television, telephone, and data transmission channels to U.S. domestic subscribers over the next 10 years. The corporation would launch other satellites later in the year and early in 1985.

ESA had contracts for 28 launches worth more than $800 million, plus options for another 19. More than 40% of the orders came from outside Europe. (*W Post*, May 22/84, A-24)

During May: NASA and Deere & Company, Moline, Ill., signed a memorandum of understanding to cooperate on the design of metallurgical tests to be conducted aboard a future Space Shuttle flight. In 1981, Deere became the first private company to sign a Technical Exchange Agreement with NASA that permitted the company to perform cast iron solidification experiments on board conventional suborbital NASA aircraft, which simulated microgravity for 30 to 60 seconds.

Deere was already working on the design of additional metallurgical tests, where engineers used data from the low-gravity tests conducted earlier. Based on this work, Deere and NASA engineers concluded that further experimentation would be productive. The Space Shuttle tests would permit experiments in space for longer periods, which could yield new information to aid in the search for stronger irons. These tests could also provide new data about the process for forming iron molecules, leading to improved foundry efficiencies. (NASA Release 84-56)

—NASA announced that astronaut Terry Hart, who had operated the Space Shuttle's mechanical arm to retrieve the *Solar Maximum Satellite* during the April 6–13, 1984, Space Shuttle flight, would leave NASA effective June 15 to work in an engineering management position for the newly formed Military and Government Systems Division of Bell Laboratories in Whippany, N.J.

The division would produce large digital communications networks for government applications. Hart was also a member of the astronaut support crews for Shuttle missions 1, 2, 3, and 7, serving as capsule communicators in mission control for those flights. (NASA Release 84–59)

—Officials at the U.S. Department of State blocked an offer by the Soviet Union to use its rockets to launch Western satellites, the *Christian Science Monitor* reported. The Soviets had offered to "sell" their rockets to *INMARSAT*, the International Maritime Satellite Organization based in London, for launching a new generation of satellites in the 1980s. *INMARSAT* was running a network of communications satellites that routed telephone calls and data among some 2,300 ships and their shore bases. However, it had not decided on the companies that would supply the new satellites, which could number up to nine and cost up to $500 million. Under the Soviet Union plan, satellites would have to travel to the Soviet rocket site prior to launch into space, and the satellites would undoubtedly contain a large proportion of U.S. parts. Such a transfer would be prohibited under the technology control regulations that sought to stop the channeling to unfriendly countries of hardware that could be used in weaponry. The State Department said that "under no circumstances" would it permit the transfer to the Soviet Union of American-made satellite components. Only two organizations had submitted tenders to *INMARSAT* to build the satellites: a joint venture of Hughes Aircraft Corporation and British Aerospace and a consortium of Marconi of the United Kingdom, Aerospatiale of France, and Ford Aerospace of the United States.

The Soviet Union had said that it would make available its Proton rockets for a fee of about $23 million a launch. That was roughly half the comparable charge for a satellite launch by either the Space Shuttle or the Ariane rocket sold by Arianespace, a semipublic company dominated by French interests.

U.S. officials feared shipment to the Soviet Union's main launch site at Baykonur in Central Asia of hardware containing electronic components that could be useful to the Soviet's military buildup. (*CSM*, May 3/84, 1)

—NASA announced that Dr. Hans M. Mark, deputy administrator of NASA since July 1981, would become chancellor of the University of Texas System, effective September 1, 1984. In announcing the appointment, Texas Board Chairman Jon Newton said of Mark: "With his Air Force and NASA background, he has demonstrated the management ability to administer effectively a complex organizational enterprise such as the U.T. System, which involves 119,000 students, 50,000 faculty and staff, and an operational budget for FY84–85 of $1.8 billion."

Mark was born in Mannheim, Germany, and in February 1969, after receiving his doctorate in physics from the Massachusetts Institute of Technology (MIT) in 1954, became director of NASA's ARC. He had also served as a consultant to government, industry, and business, including the Institute for

Defense Analyses and the President's Advisory Group on Science and Technology. (NASA Release 84-65)

—Martin A. Knutson was named director of Flight Operations and Ames Dryden Site manager for ARC. In this position, Knutson would be responsible for the operation of more than 40 highly specialized research and support aircraft at ARC and its Ames Dryden Flight Research Center. He also would be responsible for site management of the Mojave Desert facility that conducted NASA's high-speed flight research and served as one of the prime landing sites for Space Shuttle missions. Knutson joined NASA in 1971 as the ARC's manager of the Airborne Instrumentation Research Project. He was instrumental in creating the project and in acquiring its U-2 aircraft and was a pilot with over 6,000 hours of flight time. (ARC Release 84-11)

June

June 5: NASA announced the selection of four career scientists to fly as payload specialists on the next two missions of Spacelab, a reusable Space Shuttle-based research facility. Dr. Lodewijk van den Berg of EG&G Corporation, Goleta, Calif., and Dr. Taylor G. Wang of JPL were named flight payload specialists for Spacelab 3, scheduled for launch in January 1985. Dr. Mary Helen Johnston of MSFC and Dr. Eugene H. Trinh of JPL would serve as alternates for Spacelab 3.

Dr. Loren W. Acton of Lockheed Palo Alto Research Laboratory, Palo Alto, Calif., and Dr. John-David Bartoe of the Naval Research Laboratory, Washington, D.C., were named flight payload scientists for Spacelab 2, which was slated for launch in April 1985. Alternates named were Dr. Dianne K. Prinz of the Naval Research Laboratory and Dr. George W. Simon of the Air Force Geophysics Laboratory.

Spacelab 3 would be the first operational mission of the research facility with mission emphasis on materials processing in space. Spacelab 3 would use the long version of the laboratory module, in which the scientists would work on a special cargo bay instrument support structure. Spacelab 2, which followed Spacelab 3 due to experiment development delays, included experiments in solar physics, plasma physics, infrared astronomy, high-energy physics, atmospheric physics, and life sciences and technology (NASA Release 84-74)

June 7: The research satellite orbiting Venus, Pioneer Venus Orbiter, briefly tilted to watch passing comet Encke and sent back information showing that the comet was losing water at a rate three times higher than earlier calculations predicted, scientists at Ames Research Laboratory reported. The surprising finding "could be due to the particular arrangement of ice and dust which comprise the comet or to crumbling of steep-sloped hills and mesas that may cover the surface of the 1.2-mile diameter of the comet nucleus," said NASA spokesman Peter Waller. He added that the finding might shed some light on the exact nature and makeup of comets.

Comets were "dirty cosmic snowballs" of dust, rocky materials, and ice, Waller said. "Whether the ice and dust are layered, mixed together in chunks, or form hills and valleys remains a mystery."

Observations of the comet were made with an ultraviolet spectrometer, one of many scientific instruments aboard the orbiter, which detected light in the ultraviolet region of the spectrum. "Because most atoms emit ultraviolet light when they're bathed in sunlight, measuring the wavelength and intensity of the emitted light can give scientists an idea of what elements are in a sample as well as how much of an element or compound is present," said Dr. Ian Stewart of the University of Colorado. His team at the university built the spectrometer and calculated the comet's rate of water loss.

Johann Encke, a German astronomer who calculated the comet's orbit in 1818, noted that the comet was behaving abnormally, with the time it took to travel once around the Sun getting shorter in apparent contradiction to the laws of classical physics. Scientists now explained the phenomenon with the fact that comets spun slowly, like frozen tops. "The ice vaporizes, particularly when the comet is near the Sun and may cause a jet reaction that can change the comet's orbital path," Stewart said. (ARC Release 84-27; *NY Times*, June 10/84, 25)

June 8: Addressing a conference on "Space, Our Next Frontier," sponsored by the Dallas-based think tank National Center for Policy Analysis, retired Lt. Col. Thomas H. Krebs, former chief of the Defense Intelligence Agency's (DIA) space systems branch, said that the Soviet Union had obtained blueprints for the Space Shuttle and would within a year or two launch an orbiter that was an "identical copy." He said that U.S. military experts were not sure how the Soviets obtained the plans but were certain that the Soviet vehicle was made within U.S. blueprints. He indicated that it was likely that they had bought a copy of the Space Shuttle plans. "We've seen the [Soviet] orbiter, and it's identical to ours," Krebs pointed out. "I can't tell how far along they are, but in a year or two you can expect to see one launched.

Krebs said that the Soviets improved on the U.S. design by adding engines to the bottom of the external fuel tank, thereby increasing the tonnage the Shuttle could carry into orbit. "The space shuttle was totally unclassified. Anyone could buy a set of plans. However, no one has been able to find the requisition," he said.

In Washington, DIA sources speaking off the record said that they knew nothing specifically about the Soviets obtaining Shuttle blueprints. (*W Post*, June 8/84, A-4)

June 9-11: Investigations were continuing into why a $30 million international communications satellite, *Intelsat 5*, tumbled out of control after launch June 9 by a new model Atlas-Centaur rocket. NASA launch director Skip Mackey said that attention focused on a thruster jet, 1 of 14 small jets intended to keep the upper stage of the Atlas-Centaur rocket flying straight. Mackey said that a fuel filter in one of the jets may have become clogged, causing the upper stage and the attached satellite to spin out of control 23 minutes after launch. The rocket and satellite were in a looping orbit ranging from 93 to 750 miles high, circling the Earth every 90 minutes.

It had been the 62nd launch of an Atlas Centaur rocket, but it was the first of the new lengthened model. The International Telecommunications Satellite Organization (INTELSAT) had paid NASA $60 million to launch the satellite, which had 12,000 voice channels and 2 color television channels and was to have joined 15 other satellites serving the 108-nation organization. (NASA

Release 84-62; *W Post*, June 10/84, A-13, June 11/84, A-4; *W Times*, June 11/84, 4A)

June 11: NASA announced that it had selected a team of scientists to observe Halley's comet in 1986 using a Space Shuttle-based astronomy observatory called Astro. The scientists were Dr. Michael A'Hearn, University of Maryland, College Park, Md.; Drs. John Brandt, Bertram Donn, and Malcom Neidner, GSFC; Dr. Barry Lutz, Lowell Observatory, Flagstaff, Ariz.; Dr. Chet Opal, University of Texas, Austin; Dr. C. Robert O'Dell, Rice University, Houston; and Dr. Susan Wyckoff, Arizona State University, Tempe. These reseachers, together with a scientist representing each of the three ultraviolet telescope teams, comprised the Astro Halley Science Team that would plan the overall program for observing the comet.

Astro consisted of three specially designed ultraviolet telescopes and two wide-field cameras that would be carried as a Spacelab payload in the Space Shuttle cargo bay.

The observatory was scheduled for assembly and integration into the Space Shuttle at KSC during 1985 for launch in early March 1986. The first seven-day Astro mission was scheduled at a time when several comet probes would intercept Halley, and it was intended to return important scientific data and photography of the comet. ESA, Japan, and the Soviet Union had each designed probes that would fly by the comet and through its tail in early March 1986. (NASA Release 84-72)

June 12: NASA scientist Dr. Hartmut H. Aumann said that the annual meeting of the American Astronomical Society that satellite observation in space had produced evidence of rings around nearby stars that might be the birth sites of new planets. Aumann, of JPL, said that indications of orbiting material around more than 40 stars within 75 light years of Earth came from observations made by the IRAS launched in 1983. Scientists had said that the existence of other planetary systems would increase chances that life similar to that on Earth had evolved elsewhere in the universe. Only in our solar system had scientists confirmed the existence of planets.

Scientist discovered the material circling the stars by measuring infrared light energy. The stars produced more of it than could be accounted for by their number. Scientists would try to obtain a telescope image of the rings around the closer stars for further verification of the theory, Aumann said. If existence of the orbiting material was confirmed, it would take about 500 million years for the material to develop into planets.

In a background report, NASA said that the discovery suggested that stars orbited by solid materials might be almost commonplace in the Milky Way galaxy. (*USA Today*, June 13/84, 4D; *W Post*, June 13/84, A-15)

June 17: Hundreds of spectators gathered to watch giant balloons float overhead in honor of the first American to build a full-scale hot-air balloon and fly the tethered balloon June 16, 1784, 70 feet over a field in Bladensburg, Md. Peter Carnes had been a Bladensburg innkeeper, lawyer, and adventurer and had built the hot-air balloon, the first of its kind in this country. Carnes had had no interest or knowledge of ballooning until he read newspaper accounts of the first flights in France in 1783. Having never seen a balloon, Carnes fashioned his 35 feet in diameter based on sketchy newspaper stories.

One week after his unmanned balloon flight, Carnes took his balloon to Baltimore, where 13-year-old Edward Warren volunteered to ride in the tethered craft, making him the first American to ascend in a hot-air balloon.

Shortly thereafter, at the Philadelphia Commons, spectators watched 234-pound Carnes ascended about 10 to 20 feet in the balloon, when a wind shift pushed him into a wall, breaking the chains and dropping him to the ground.

Tom Crouch, curator of aeronautics at the National Air and Space Museum, said that the balloon construction "was considered a great scientific achievement. It is difficult to realize what an achievement flying that balloon really was. His flight was a demonstration of the fact that while this nation was young, it was a nation with great hope for the future." (*W Post*, June 17/84, B-1; *B Sun*, June 25/84 D-1)

June 28: NASA announced that three of its centers would participate with JSC, named earlier in the year to be the lead center, in definition and preliminary design studies of the Space Station.

MSFC would be responsible for definition of the pressurized Space Station modules that would be built and equipped with appropriate systems for use as laboratories, the ward room and galley, and logistic transports. Development of this single "common" module design, with provisions for data distribution, power, environmental control, thermal control, and communications systems to be used in all pressurized areas in the station would provide significant savings in the overall program.

LeRC would be responsible for the definition of the electrical power generation and conditioning and storage systems. Although most Space Station studies had focused on large solar arrays as the probable power generation system, Lewis would also examine and evaluate a number of alternative systems.

GSFC would be responsible for definition of the automated free-flying platforms that would be part of the overall Space Station program and for provisions to service, maintain, and repair these platforms, as well as other free-flying spacecraft. Goddard would also define the provisions for instruments and payloads to be attached externally to the pressurized sections of the Space Station and the pressurized modules as a laboratory.

In addition to its lead contractor role, JSC would be responsible for the definition of the structural framework to which the various elements of the Space Station would be attached and for the integration and installation of systems into this structure. The center would oversee the interfaces between the Space Station and the Space Shuttle and be responsible for mechanisms such as the remote manipulator systems. JSC would also manage the attitude control, thermal control, communications, and data management systems and the equipping of a common module for crew use as a ward room and galley.

Other NASA centers would support the definition and design activities, particularly in technology areas. KSC would be responsible for preflight and launch operations and be involved in logistic support activities. (NASA Release 84-85)

June 23–27: NASA began on June 23 the countdown at Cape Canaveral for the maiden flight of the Space Shuttle Discovery. This twelfth flight would carry Henry Hartsfield, commander, who was pilot on STS-4; Michael Coats, pilot; mission specialists Judith Resnik, Steven Hawley, and Richard Mullane; and payload specialist Charles Walker of McDonnell Douglas, the first payload specialist for private industry. Originally scheduled for launch on June 22, NASA had delayed liftoff when workers inspecting the orbiter's rocket motors following a test firing found that a heat shield inside a high-pressure pump in engine No. 1 had "debonded" and pulled away slightly from the wall of a chamber that contained superheated gases during launch. This necessitated replacement of one of the main engines, a three-day job that would delay launch until at least June 25.

The flight of Discovery was delayed on June 25 for at least 24 hours when its backup navigating computer failed less than 30 minutes before takeoff. Though it was not operational in space, the fifth backup computer was used during ascent to "watchdog" the other computers during the critical first 10 minutes of flight.

Four seconds from launch on June 26, the flight of Discovery was automatically aborted by a computer due to malfunctioning of a fuel valve on the rear starboard engine, causing the engine to catch fire. The fire was extinguished after three attempts with heavy sprays of water. NASA placed Hartsfield and his five-member crew on leave for two days after experiencing this first launch abort in 12 Space Shuttle missions and only the second launch abort in American manned spaceflight history. Thomas E. Utsman, Shuttle operations manager at KSC, said that he had no idea when the maiden flight of Discovery could be rescheduled. It depended, he said, on how much damage had been done to the malfunctioning engine that caught fire and to the Space Shuttle's protective tiles from the high-speed water jets that extinguished the fire on the aft part of the fuselage. Utsman said that the fire may have burned through the heat shield on the engine nozzle, meaning that the entire engine would have to be replaced.

NASA announced on June 27 that Discovery's maiden flight would not be attempted for at least two weeks in order to verify all three main engines. John Talone at KSC said, "I don't think we're talking about mid-July before we can get to the point of launching again." Talone said that the only serious question remaining about the aborted launch was why the valve stayed closed when commanded to start the liftoff firing sequence. When the valve failed to open, a backup actuator automatically started the opening sequence, and the valve opened soon enough for the engine to build full power, although it did not. He said that Discovery probably would have reached orbit, but mission rules said that a Space Shuttle could not lift off without redundant valve, and when the Shuttle's main computer sensed that one actuator system was out, the computer ordered engine cutoff. Photographic inspection of Discovery showed remarkably little damage from fire that broke out below the main engine nozzles after engine shutdown. The only structural damage to the Space Shuttle' airframe was the speed brake just below the tail and half of the brake's protective enamel was scorched off. (*W Post*, June 23/84, A-3, June 25/84, A-7, June 26/84, A-1, June 27/84, A-3)

During June: ARC Director William F. Ballhaus announced that center aircraft and their operation would be transferred to the Ames Flight Operations Directorate. Martin A. Knutson, director of flight operations and site manager of the Ames Dryden Flight Research Facility, would be responsible for all flight activities at the Ames's Moffett Field location in northern California and at the Ames Dryden Facility in southern California. The Flight Operations Directorate office would continue to be maintained at the Ames Dryden Facility at Edwards Air Force Base, Calif. Factors in the management change were continued safety of flight and continuity of aircraft operations to be assured with all flight operations reporting through a single management chain. And the change served to integrate more fully the Ames Dryden Facility into the day-to-day operations of the parent Ames Center. The Ames Research Center and the former Dryden Flight Research Center, now Ames Dryden, were consolidated in 1981, a move that enhanced the capabilities of both organizations.

Ames officials said that the latest move was a continuing part of the overall Ames-Dryden consolidation and would centralize all flight operations activities in terms of operations procedures, safety, and management philosophy. There were no plans to move any aircraft or personnel involved from either location. (ARC Release 84-15)

July

July 3-11: Workers replaced one of the Space Shuttle Discovery's three engines as NASA reported that loose insulation on a super-cooled fuel line may have been a factor in the aborted liftoff of the Space Shuttle's maiden flight. Officials said that the faulty insulation's inability to insulate nitrogen gas from the cold may have turned the gas to liquid, and the liquid may have dripped on an engine valve, blocking it from opening.

Later, NASA announced that it was considering a plan to continue the 12th and 13th Space Shuttle missions as a way to avoid expensive delays that could push at least one mission scheduled for 1984 into 1985. The problem with combining missions was the inability to combine crews. Five crew members from the aborted flight or from the August flight would have to step down and wait for another turn. The possibility of combining missions arose when technicians at NASA's engine test facility at Bay St. Louis, Miss., were unable to duplicate the failure of Discovery's starboard engine that had aborted the flight. "No matter what we did, we were unable to duplicate the failure," a NASA source said. "And until we understand what went wrong, we don't want to fly."

The failure of a rocket nozzle on a communications satellite during a test in St. Louis then further complicated NASA's rescheduling decision. A final decision awaited analysis on the test of a Star-48 solid-fuel rocket nozzle at the Astronautics Division of McDonnell Douglas Corporation in St. Louis. Star-48 rockets were on two communications satellites that would be part of the cargo on a combined mission.

On July 12 NASA announced that the next Space Shuttle flight would consist of payloads from flights 41-D and 41-F and would be launched from KSC no earlier than August 24. The mission aboard the orbiter Discovery would retain the designation 41-D. The cargo would remain essentially the same, except that the large format camera and spartan would be replaced with the Satellite Business Systems (SBS) and Telstar payloads then scheduled for launch in the same time frame. The crew for mission 41-D would be the six-member team of Commander Henry Hartsfield; pilot Michael Coats; mission specialists Judith Resnik, Steven Hawley, and Richard Mullane; and payload specialist Charles Walker. The crew of 41-F would be scheduled for a later flight. (NASA Release 84-95; *W Post*, July 3/84, A-12, July 10/84, A-5, July 11/84, A-6)

July 5: NASA announced that MSFC had awarded contracts to Martin Marietta Aerospace Company Denver, and Boeing Aerospace Company, Seattle, to study a space vehicle to move payloads from low Earth orbits to higher orbits. The "parallel" studies, concurrent but independent studies in the same area of concentration, for an Orbital Transfer Vehicle (OTV) would run for 15 months at about $1 million each. The companies would conduct conceptual studies to examine the possibilities of both space-based and ground-based transfer vehicles. The space-based version would be maintained and refueled at the Space Station; the ground-based vehicle would be carried into space by the Space Shuttle for deployment.

The transfer vehicle, as it was conceived by Marshall engineers, would be an unmanned upper-stage in the beginning. The ultimate goal, however, would be to develop a manned vehicle capable of ferrying a crew capsule to geosynchronous orbit. The vehicle would then return the crew and capsule for other missions. (NASA Release 84-90)

July 16: ESA's Director, R. Bonnet, and Director General of Arianespace C. Bigot signed a contract for the launch of ESA's scientific spacecraft Giotto, which was designed for observations of Halley's comet, aboard an Ariane 1 launcher. They scheduled the launch for the first day of the July 1985 launch window.

Giotto would go into a heliocentric transfer trajectory that would be very close to the ecliptic plane (the plane in which the planets orbit the Sun). During its flight, which would last eight months, Giotto would be under the command of the European Space Operations Centre in Darmstadt, Germany. Ground-based telescopes would track Giotto, and course corrections would be made with the on-board propulsion system to ensure that the spacecraft passed as close as possible to the comet nucleus during the encounter phase, planned to last four hours. It was expected that the most important data from the mission would come from 10 scientific experiments on board Giotto within a few minutes before and after Giotto's closest approach to the comet's nucleus. It would be during that period that the spacecraft's camera would photograph the comet's nucleus in color, resolving surface structure down to 50 meters (150 feet). (ESA Release, July 16/84)

—NASA and NOAA announced that the *NOAA-8* environmental monitoring satellite appeared to have lost it latitude control system and was tumbling in orbit unable to relay its signal effectively to Earth. Launched board an Atlas E launch vehicle in 1983, the 1,700-kilometer (3,775-pound) satellite had six environmental monitoring instruments and a search-and-rescue payload, provided by Canada and France under an international cooperative space project with NASA known as SARSAT (search-and-rescue satellite-aided tracking).

Much of the environmental monitoring lost by *NOAA-8* could be conducted by *NOAA-6*, launched in 1979. And although the SARSAT capability, which permitted the satellite to relay emergency signals from downed aircraft and ships in distress, was out of service, the SARSAT project would continue operations through use of three Soviet COSPAS search-and-rescue satellites in orbit.

NOAA-8 first showed signs of problems on June 12, when it experienced a "clock interrupt" that caused the spacecraft's gyros to desynchronize. Continued clock disturbances interfered with the meteorological instruments, preventing scientists and engineers from obtaining good data.

The satellite was the first in a series of three Advanced TIROS-N (ATN). NASA planned the next launch of a TIROS-N, NOAA-F, for October 1984. (NASA Release 84-93; *NY Times*, July 14/84, 46)

July 19: MSFC announced that it had awarded Ford Aerospace and Communications Corporation of Palo Alto, Calif., and Lockheed Missiles and Space Company of Sunnyvale, Calif., contracts for the conceptual study of geostationary platforms. Under the contracts, the two firms would envision platforms of the 1990s and report their findings to the MSFC. The platforms would revolve about the equator at the geostationary altitude of 22,300 miles, where they would be in synchronization with the Earth's rotation.

Each contract was for approximately $550 and would run for 21 months. (MSFC Release 84-64)

July 24: NASA announced that it had selected LTV Aerospace and Defense Company, Dallas, Tex.; Martin Marietta Denver Aerospace, Denver, Colo.; and TRW Inc., Redondo Beach, Calif., for negotations leading to contracts for system definition studies of an Orbital Maneuvering Vehicle (OMV) to ferry satellites about in space. MSFC would manage the fixed-price contracts of approximately $5 million each. NASA anticipated that one of the three companies would likely construct the platform upon approval to proceed with the project.

The vehicle would supplement the Space Transportation System (STS), having the ability to retrieve satellites from high orbits and bring them to the Space Shuttle for maintenance and repair. The OMV would then place the repaired satellites in their operational orbits. The OMV would also serve as a means of reboosting satellites as their orbits decayed, thereby avoiding costly, dedicated Space Shuttle missions.

As envisioned, the OMV would be a remotely piloted, unmanned spacecraft approximately 3 meters (15 feet) in diameter and about 1 meter (3 feet) in length. (NASA Release 84-102)

July 25: Svetlana Savitskaya, a Soviet cosmonaut, today became the first woman to walk in space. Savitskaya, 36 years old, performed welding and soldering operations in the course of her walk in space, which lasted 3 hours and 35 minutes. She was also the first woman to make two spaceflights, her first being in August 1982 aboard the *Soyuz T-7*, which like the current flight linked with the *Salyut 7* space station for a brief period.

Savitskaya went into space July 18 along with Vladimir Dzhanibekov and Igor Volk aboard *Soyuz T-12* and linked with the *Salyut-7* space station, where three other cosmonauts had been in orbit for more than five months. Tass said that the main goal of the space walk was to test a new general-purpose hand-operated tool designed "to carry out complex technological operations." Dzhanibekov accompanied her on the space walk.

Savitskaya, along with Dzhanibekov and Volk, returned to Earth July 29 aboard *Soyuz T-12*. They landed in an area 140 kilometers southeast of Dzhezkazgan. The three were reported to be feeling fine after landing. Remaining aboard *Salyut 7* were cosmonauts Leonid Kisim, Vladimir Solovyev, and Oleg Atkov.

Savistskaya was born in Moscow and graduated from the Sergo Ordzhonikidze Aviation Institute in Moscow. She had worked as an instructor pilot and, since 1976, had been a test pilot on 20 types of aircraft, Tass reported. (FBIS, Tass in English, July 17/84; FBIS, Tass in English, July 29/84; *NY Times*, July 26/84, A-24; *W Post*, July 26/84, A-31)

July 29: NOAA's *GOES-5* satellite failed at 8:39 p.m. today, blanking out weather pictures for parts of the eastern United States and the Altantic Ocean, just at the time of the year when hurricanes and severe storms were likely to form there. NOAA had not planned replacement of the satellite for another two years, but would move the satellite covering the western half of the country and the Pacific eastward as a stopgap measure during the hurricane season. It would station the operational satellite midway over the continental United States, leaving Hawaii, Alaska, and the western Pacific uncovered to the west, and half the Atlantic uncovered to the east.

The $100 million satellite, like its four predecessors, failed prematurely. It was intended to operate for five years but lasted only three. In testimony before a Senate subcommittee, NOAA's John McElroy said that government experts and the system contractor, Hughes Aerospace, had calculated that the satellite expected a five-year lifetime, but that had proved optimistic, chiefly because one mechanical system, and in particular one specially made light bulb, kept having problems. Another official at NOAA said that the failure of the custom-made light bulb, which caused five of the six U.S. weather satellites to go blind prematurely, would cost Hughes millions of dollars in penalties. Because Hughes's contract was linked to performance, it stood to lose as much as $3 million for the recent failure plus losses for earlier failures. (*W Post*, July 31/84, A-1, Aug 3/84, A-3; *W Times*, Aug 3/84, 4A)

July 31: The *Washington Post* reported that, in testimony to a House subcommitte on space science and applications, NASA Administrator James M. Beggs said that he feared that an Air Force plan to make more use of large, unmanned rockets to launch Pentagon satellites would undermine NASA's plans for the Space Shuttle program. "The Air Force has said they plan two flights a year starting in 1988 using expendable launch vehicles as an alternate to the shuttle, and if they stick to that it will have no real impact on us," Beggs said. "But if they increase that rate to four or five flights a year, as some people suggest they might, it will have severe impact on us," he pointed out.

Beggs went on to say that the Air Force had asked General Dynamics Corporation and Martin Marietta Corporation to submit plans for increasing the lifting power of their Atlas-Centaur and Titan 34D booster rockets to launch into space large satellites that currently could be carried only by the Shuttle. He pointed out that NASA stood to lose much of the business of one of its main customers and also that, because he disagreed with the Air Force, having an alternate way of putting its satellite in orbit was an improvement in security. "All. . .that means is they'll have another launch pad right on the ocean," he said.

Beggs indicated that he was worried that the Air Force would acquire an alternate launch vehicle to use more frequently to make it cost effective. And he expressed concern that the winner of the Air Force contract to build the larger rocket would try to take commercial business away from the Space Shuttle. "Our commercial business has already begun to fall off a little because our commercial customers tended to overbook when we started to fly," Beggs said. "Our traffic model for 1985 is already down about 10 percent." (*W Post*, Aug 1/84, A-20)

During July: NASA announced the appointment of C. Robert Nysmith as associate administrator of management, effective August 26, 1984. He would succeed John Boyd, who would return to ARC to become associate director. Nysmith had served as assistant associate administrator for management since January 1984. Before that, he was assistant associate administrator for management support in the Office of Aeronautics and Space Technology. (NASA Release 84-107)

—NASA announced the appointment of Jesse W. Moore to associate administrator for space flight, effective August 1, 1984. Moore had been serving as the acting associate administrator for space flight since April 15, 1984. He was appointed deputy associate administrator for space flight in February 1983. Moore came to NASA Headquarters in 1978 as deputy director of the Solar Terrestrial Division in the Office of Space Science. In June 1979 he was appointed director of the Space Flight Division. He assumed the position of director, Earth and Planetary Exploration Division, in December 1981. Prior to these assignments he was employed at JPL. (NASA Release 84-105)

—Effective August 1, 1984, the Interim Space Station Program Office would become the permanent Office of Space Station (Code S), NASA announced. Philip E. Culbertson would be the associate administrator for space station and John D. Hodge would be the deputy associate administrator for space station. The Office of Space Station was responsible for developing the Space Station and conducting advanced development and technology activities, advanced planning, and other activities required to carry out President Reagan's direction to NASA to develop a permanently manned Space Station within a decade. (NASA anno July 27/84; NASA Release 84-104)

—*Intervia* reported that Transpace Carriers Inc. (TCI) was challenging in the United States the pricing policies of the European multinational company Arianespace. TCI, a Washington-based firm, had earlier received the go-ahead to take over the Delta launcher following completion of existing NASA contracts and subject to the provision that TCI secured three new customers before October 1, 1984.

TCI lodged a complaint with the U.S. Trade Representative, alleging that Arianespace was practicing "predatory" pricing by offering users from non-ESA member countries (notably U.S. commercial satellite operators) rates that were up to 33 percent below launch fees quoted for European satellites. So far, both the Space Shuttle and Ariane were generally agreed to have been operating at unprofitable "introductory" prices; NASA had put Delta-class satellites into geostationary orbit for around $15 million, including the PAM-D upper stage. General Telephone & Electronics (GTE) reported paid Arianespace "under $25 million" for the Spacenet 1 launch.

The complaint raised by TCI applied only to contracts for launch after 1985, the earliest date it could begin operations. TCI President Tony L. Savoca said that his company would charge between $26 and $32 million, according to launch requirements. He claimed that he had heard of Arianespace bids as low as $22 million for the same time period and added that Arianespace "should be charging" around $64 million for a dual (SYLDA) launch on Ariane III. (*Intervia*, July 7/84, 643)

—George M. Low, president of Rensselaer Polytechnic Institute and a driving force in the Apollo moon landing program, died July 17 of cancer. The White House announced that he would be awarded the President's Medal of Freedom for his contributions to education and the nation's space program.

In his 27 years with NASA and its predecessor, the National Advisory Committee for Aeronautics (NACA), Low served as an engineer and manager in the Mercury and Gemini programs and was put in charge of redesigning the Apollo spacecraft after a fire on the launching pad killed three astronauts in 1967. Later he became deputy administrator of NASA and acting administrator in the early 1970s when he negotiated the initial agreements leading to the joint American-Soviet mission in August 1975. (*NY Times*, July 18/84, B-8)

August

August 8-26: Soviet cosmonauts Leonid Kizim, Vladimir Solovyev, and Oleg Atkov completed on August 26 their 200th day of work on the *Salyut 7* space station. During the day's activities, there was an assessment of the reaction of the cardiovascular system of the cosmonauts to the initiation of hydrostatic pressure created by means of the vacuum suit "Chibis," and the crew used hand-held cameras and spectrometers to study the natural resources and environment of Soviet territory.

Also on that day the *Progess 23* cargo craft, launched August 14, undocked with the Space Station, following unloading of the cargo craft's contents. *Progress 23* was launched on August 14.

On August 8, Kizim and Solovyev made their sixth space walk. The cosmonauts removed part of the heat insulation cover on the back of the service module and shut off a pipe in the fuel line with a special device. This extravehicular activity lasted 5 hours and was the first time that cosmonauts had made six space walks, for a total of 22 hours and 50 minutes, in the course of one trip. (FBIS, Tass in English, Aug 9/84, Aug 14/84, Aug 16/84, Aug 20/84, Aug 24/84)

August 4: Arianespace launched at 10:32 a.m. local time the satellites *ECS-2* and *Telecom 1* aboard an Ariane vehicle from Kourou, French Guiana. The first data received from both satellites showed satisfactory behavior. They were injected into an orbit with provisional parameters of 199.02-kilometer perigee, 36,091.00-kilometer apogee, and 6.98° inclination.

This 10th Ariane launch was the first flight of an Ariane 3 version of the vehicle, whose main characteristics were a higher thrust of the Viking first and second stage, a stretched third stage; greater liquid oxygen and liquid hydrogen tank capacities, leading to an increased flight time by approximately 30%; and the addition to the first stage of two strap-on rocket boosters.

Ariane 3 could carry 2,580 kilograms into geostationary transfer orbit. (ESA Release Aug 4/84)

August 10: NASA announced that it had awarded an industry team headed by RCA's Astro-Electronics Division, Princeton, N.J., a $260.3 million contract for design, development, and fabrication of the Advanced Communications Technology Satellite (ACTS). Other major participants in the team were TRW Electronics Systems Group, Space Communications Division, Redondo Beach, Calif.; Communications Satellite Corporation (ComSatCorp), Washington, D.C.; Motorola Inc., Government Electronics Group, Scottsdale, Ariz.; Hughes Aircraft Company's Electron Dynamics Division, Torrance, Calif.; and Electromagnetic Sciences Inc., Norcross, Ga.

One of the primary goals of the ACTS program was to develop advanced satellite communications technologies, including satellite switching and processing techniques and multibeam satellite antennas, using the 20- and 30-gigahertz bands. These technologies would be needed for the increased satellite capacity for the mid-1990s.

The ACTS program results would make available to corporations, universities, and government agencies the ACTS spacecraft and ground systems capabilities for experimentation. Organizations that met specified requirements for space communications research would participate in such experiments during the flight phase of the program. NASA had received over 30 expressions of interest in experimental use of the new satellite system.

NASA had scheduled ACTS for launch by the Space Shuttle in 1989. (NASA Release 84-113; LeRC Release 84-54)

August 13: NASA signed an agreement with two insurance organizations, Merrett Syndicates Ltd. and International Underwriters (Intec), to retrieve the *Palapa B-2* spacecraft February 6, 1984, for the government of Indonesia. However, it did not achieve the proper transfer orbit when the perigee kick motor failed.

The agreement called for NASA to retrieve the satellite on Space Shuttle mission 51-A, currently scheduled for launch November 2, 1984. The insurance underwriters would pay NASA for costs, not to exceed to $4.8 million, incurred in preparing for and executing the retrieval.

In the near future the parties would sign a standard Space Shuttle launch services agreement, which would contain details of the rescue plan and a commitment to relaunch the satellite in July 1985, should the underwriters request it. (NASA Release 84-116)

August 15: President Reagan approved today National Space Strategy intended to implement the National Space Policy, which was supplemented by the President's 1984 state of the union address. Concerning the STS, the Strategy pointed out that the STS was a critical factor in maintaining U.S. space leadership, and, therefore, it was NASA's first priority to make the STS fully operational and cost effective in providing routine access to space. The Strategy further noted that the STS was to be fully operational by 1988.

Regarding the civil space program, the Strategy indicated that NASA should develop a permanently manned Space Station within a decade and that the United States should seek agreements with friends and allies to participate in the development and use of the Space Station.

In the area of commercial space programs, the Strategy called for the United States to encourage and facilitate commercial expendable launch vehicle operations and minimize government regulation of these operations.

Concerning national security space programs, it was mandated that the national security sector must pursue an improved assured launch capability to satisfy two specific requirements—"the need for launch system complementary to the STS to hedge against unforeseen technical and operational problems, and the need for a launch system suited for operations and crisis situations." The Strategy further stated that to fulfill this requirement, the national security sector should pursue the use of a limited number of expendable launch vehicles to complement the STS. (*National Space Strategy*, WH Fact Sheet, App F-4, Aug 15/84, 137)

August 16: NASA launched the Active Magnetospheric Particle Tracer Explorers (AMPTE) aboard a three-stage Delta 3294 launch vehicle from the Cape Canaveral Air Force Station. AMPTE consisted of three satellites provided by the United States, Federal Republic of Germany (FRG), and the United Kingdom. The program was designed to supply knowledge about the transfer of mass from the solar wind to the magnetosphere and its further transport and energization within the magnetosphere.

Initial chemical releases in September by the FRG's Ion Release Module (IRM) would be swept toward Earth's magnetosphere by the solar wind. When the released ions reached the magnetosphere, it was expected that ions would spread out along this boundary region in all directions, but some of the ions would pierce the magnetosphere, as do some of the charged particles of the solar wind. These rare ions would act like a "dye" in the plasma of charged particles.

The manueverable United Kingdom subsatellite, located in close proximity to the IRM, and the IRM would acquire data from outside the boundary to the magnetosphere while the Charge Composition Explorer, provided by the United States, would study the activity from within the magnetosphere.

A second series of chemical releases in December would create an artificial comet forming inside the bow-shock region but outside of the magnetosphere, directly in the orbital path of Earth. The third series of chemical releases would occur in 1985 behind Earth in the magnetotail.

The three spacecraft would send data to ground stations at NASA's Deep Space Network at JPL, the German Space Operations Center at Oberphaffenhofen, and the Rutherford Appleton Laboratory in Chilton, England. (NASA MOR E-846-84-01, Aug 2/84; NASA Release 84-109; *NY Times*, Aug 7/84, C-2)

August 17: NASA announced that it had selected United Space Boosters Inc. (USBI), Huntsville, Ala., to receive a $274 million cost-plus-incentive-fee contract to manufacture, assemble, and refurbish solid-fuel rocket boosters for the Space Shuttle. The approximately five-year contract would require USBI to manufacture, assemble, check out, and deliver 84 flight sets of solid-fuel rocket boosters and to refurbish them when returned to Earth after each launch. The contract, to be managed by MSFC, also launched two unpriced options, each for the delivery of 60 flight sets, covering a total additional period of performance of about five years.

Under a separate contract, USBI would build a new facility at KSC for booster assembly and refurbishment, at a cost of $21 million. In the past, refurbishment had taken place at Kennedy's Vehicle Assembly Building (VAB), which was used to assemble the entire configuration of orbiter, boosters, and external tank. (NASA Release 84-118; MSFC Release 84-75)

August 23: The *Far Eastern Economic Review* was quoted as saying that the People's Republic of China had asked the United States to allow a Chinese astronaut to be included in the Space Shuttle program. The Hong Kong-based weekly magazine also said that Beijing had asked the United States to consider providing a launcher for a Chinese manned space vehicle. It was reported that the Reagan administration was giving both requests "sympathetic" consideration (FBIS, Hong Kong AFP in English, Aug 23/84)

August 26: Spacelab 3 investigators, engineers, support personnel, and science crew members completed the first integrated Spacelab 3 mission simulation at MSFC. Mission participants would take part in several such simulations in preparation for the scheduled January 1985 mission. The payload and mission specialists were located at the Marshall Center Payload Crew Training Complex for the simulation. They communicated and worked with mission management and science team members in a simulated Payload Operations Control Center (POCC) at the Huntsville Operations Support Center (HOSC).

Spacelab 3 mission manager Joe Cremin said that the primary purpose of the simulation "was to train the principal investigator operation teams in the Payload Operations Control Center procedures with the Marshall Center POCC cadre." The simulation also provided the participants with communications experience in an operational environment.

An additional simulation would take place at Marshall in September, and in November the Marshall team would begin operations and simulations at the POCC at JSC. "Even then, the flight crew will be at Marshall to use the Payload Crew Training Complex and the HOSC will be active in providing support for the simulation," Cremin said. (MSFC Release 84-70)

August 27: Speaking to 262 winners of the Secondary School Recognition Program and their teachers, President Reagan said that he had directed NASA to carry an elementary- or secondary-school teacher in orbit aboard the Space Shuttle as the nation's first space passenger. "When the shuttle lifts off, all of America will be reminded of the crucial role teachers and education play in the life of our nation," Reagan said in the announcement. This would be the first spaceflight of an American who was neither a scientist nor a trained astronaut. The only physical limitations were that the candidate be free of debilitating disease, have good eyesight, and not have hearing loss or high blood pressure. No age limit was specified.

NASA had thought about the possibility of flying private citizens aboard the Space Shuttle more than a decade ago. The idea was a natural outgrowth of its legislative mandate that called for "the widest practicable and appropriate dissemination of information concerning NASA's activities and the results thereof. . . ."

NASA officials told reporters that they would begin a search for the most qualified teacher candidate and described a program in which each of the fifty states, the District of Columbia, Puerto Rico, and Guam would submit the names of two teachers. A peer-review panel would help pare the applicants to 10, to 5, and finally to a prime and backup candidate.

"When we decide on our final two candidates, we will give them eight weeks of preflight training at Houston's Johnson Space Center right along with the astronaut crew they fly with," said NASA Administrator James M. Beggs. "When the candidate's flight is over, we will insist that he or she give a year of their time to NASA, visiting schools, talking to workshops, lecturing, and appearing on television and radio," he said.

Beggs said that it was impossible to predict how many civilians would be able to fly on Space Shuttle, noting that it depended on how many Space Shuttle flights NASA could schedule. (NASA Release 84-122; NASA anno Aug 27/84; *W Post*, Aug 28/84, A-1)

August 30: The *New York Times* reported that space industry experts and government intelligence officials had said that U.S. Air Force satellite photographs of launching pads in central Asia showed that the Soviet Union was developing a booster rocket for a Soviet version of the Space Shuttle and a new family of big rockets similar to those used by the United States for the Apollo Moon program. A special feature of the new rockets was that they would use liquid hydrogen, a cryogenic (supercooled) type of fuel technology that had eluded Soviet space experts but had been mastered in the United States nearby 20 years ago.

The Pentagon had originally described the Soviet development of new booster rockets and a Space Shuttle in April. The new disclosures gave added detail of the Soviet program, including checkouts on the launching pad and the development of cryogenic fuels.

"It's a major step to go to liquid hydrogen," said James E. Oberg, an expert on Soviet space technology." They've been using the same boosters for 20 years. Now they appear to be trying to build a new family."

The Pentagon's "Soviet Military Power 1984" had originally suggested the existence of a new family of Soviet booster rockets. The publication asserted that the biggest of the new Soviet rockets could lift payloads of up to 150 tons into low orbits around the Earth, about seven times more than the largest operational Soviet booster and five times more than the biggest U.S. booster, the Space Shuttle. The publication also said the Soviet Union's space shuttle differed from the U.S. Shuttle only in the respect that the main engines were not on the orbiter. In addition, the publication published pictures of a small Soviet space plane that had undergone flight tests. (*NY Times*, Aug 30/84, B-13)

—NASA launched at 8:41 a.m. from KSC the Space Shuttle Discovery (STS 41-D) on its maiden voyage after three earlier postponements, another one-day postponement due to computer problems, and a last-minute delay to avoid possible collision with a private line. Discovery carried for mission 41-D a six-member crew of commander Henry Hartsfield; pilot Michael Coats; mission specialists Judith Resnick, Steven Hawley, and Richard Mullane; and payload specialist Charles Walker, a McDonnell Douglas engineer. It also carried the heaviest cargo flown in orbit aboard a Space Shuttle.

About eight hours after liftoff, three of the crew members deployed a U.S. communications satellite, *SBS-4*, which was owned by Satellite Business Systems, McLean, Va., and was designed to relay data, including telephone and television transmissions. About 45 minutes later its on-board engine ignited flawlessly to send it to a position 22,400 miles above the equator just west of South America. The successful launch helped dispel doubts about the solid-fuel rocket motor technology when two satellites last February did not reach orbit.

Also planned for launch from the Space Shuttle were the *Leasat-2*, owned by Hughes Communications Services, Inc., and leased by the U.S. Navy, and the *Telestar 3-C* of AT&T. On board would be NASA's Office of Astronautics and Space Technology OAST01, a collapsible solar array, and the Continuous Flow Electrophoresis System (CFES) of McDonnell Douglas.

On the same day as the liftoff, President Reagan visited GSFC and addressed several hundred of Goddard's employees. In his remarks, Reagan said that "there is nothing that the United States of America cannot accomplish. If the doubting Thomases would just stand aside and get out of our way." He went on to speak of the creation of new jobs, technologies, and medical breakthroughs as a result of the rigors of the space program. (NASA Release 84-112; NASA Press Kit June 84, August 84; *W Post*, Aug 31/84, A-1; *W Times*, Aug 31/84, 3A)

August 31: NASA announced the start of the Extreme Ultraviolet Explorer (EUVE), a new astronomy satellite project that would be launched into Earth orbit from the Space Shuttle in 1988. The purpose of the explorer was to make the first all-sky map in the extreme ultraviolet (EUV) band of the electromagnetic spectrum, a band between ultraviolet and X-ray light.

The EUVE, managed by JPL, with scientific instruments supplied by the University of California, Berkeley, was a true explorer in that it would conduct the first in-depth investigation of that critical band and was expected to discover stars and other celestial objects with unexpected characteristics. The EUVE would orbit Earth at an attitude of 340 statute miles and from that point above the atmosphere would be able to scan the sky for emissions of extreme ultraviolet radiation. EUVE would use four 40-centimeter (15.7-inch) ultraviolet telescopes to conduct the all-sky survey and a spectrometer to carry out detailed observations of the new sources and stars expected to be discovered.

JPL was responsible for overall EUVE project responsibility. The UCB would supply the 1,100-pound science payload, consisting of the extreme ultraviolet telescopes and the spectrometer; and the university's Space Sciences Laboratory would design and fabricate the payload. JPL would control flight operations, and the science operations center would be at the Space Sciences Laboratory at Berkeley. (NASA Release 84-125)

September

September 3–5: NASA officials were concerned that the buildup of two ice blocks, one about 30 by 18 inches and weighing between 8 and 20 pounds and another about 10 pounds, that covered an excess water-dump nozzle, might break off the Space Shuttle Discovery on mission 41-D (a combination of missions 41-D and 41-F) during its return to Earth, causing damage to the orbiter's protective tiles. The agency said that they had three options for removing the ice, the last of which, a space walk, could delay reentry by at least a day. The crew continued their efforts to melt or shake loose the ice, and Discovery's cabin pressure was lowered as a preliminary step in case a space walk was required, although NASA officials said that a space walk was the last option.

Discovery was oriented with the port side in direct sunlight, so when the crew awoke the next morning they found about half of the large ice block had melted. Then, astronaut Henry W. Hartsfield, Jr., switched on heaters in the pipes leading to the nozzle and fired the orbiter's thrusters to see if the vibrations would shake the ice free. Next, Hartsfield, assisted by Judith Resnik, took the controls of the mechanical arm and following procedures outlined by Sally K. Ride on the ground knocked off with little difficulty all but about 5 inches of the ice chunk. The remaining ice apparently then melted in the warmth of the sunlight.

Discovery landed September 5 at Edwards Air Force Base, completing its six-day maiden flight. During the flight, crew deployed three communications satellites, *LEASAT-1* (*SYNCOM-I*), *Telestar-3*, and *SBS-D* in the first three days of the flight; extended an experimental solar-powered array in a test for future Space Station construction; and processed a sample of a hormone that could lead to a commercial pharamaceutical product. Lt. Col. Richard M. Mullane, one of the astronauts on board, said that Discovery "performed superbly," while NASA officials pointed out that all the mission's objectives were accomplished. (*W Post*, Sept 4/84, A-6; *NY Times*, Sept 3/84, A-1, Sept 4/84, A-1, Sept 5/84, A-1; *W Times*, Sept 5/84, 4A)

September 5: Soviet cosmonauts Leonid Kizim, Vladimir Solovyev, and Oleg Atkov aboard *Salyut 7* equaled the record of 211 days in space, set by cosmonauts Anatoliy Berezovoy and Valentin Lebedev in December 1982. The increasingly long flights, coupled with Western intelligence reports that the Soviets were experimenting with rockets capable of lifting heavy payloads into orbit, indicated that the country was moving toward a goal of establishing a permanent, manned space station. Soviet reports said that the flight of *Salyut 7* was proceeding normally and that there was no indication how long the flight would last.

During the flight the cosmonauts had spent 22 hours and 50 minutes outside the craft in 6 space walks, breaking the U.S. record for a single mission by 29 minutes. The three have been visited by six other cosmonauts, including an Indian and the first woman to walk in space, Svetlana Savitskaya, who during her space walk used a welding machine that space analysts said could be used for building large Space Stations.

The three cosmonauts had focused on the psychology of long periods in space as well as carried out important repairs outside the craft, demonstrating the crew's ability to maintain their spacecraft in an extended flight.

In a televised ceremony, Soviet leader Konstantin U. Chernenko honored the cosmonauts taking part in the flight and spoke of the great advances in knowledge and equipment since the first manned spaceflight by Yuri Gagarin, 23 years previously. "In the successes of cosmonautics we see a blend of the daring thinking of scientists, the remarkable skills of engineers, technicians and workers, and the great courage of cosmonauts," he said. (FBIS, Moscow Tass Intl Svc in Russian, Sept 6/84; FBIS, Moscow Tass in Engligh, Sept 7/84; *NY Times*, Sept 6/84, B-10)

September 9: A working meeting, in Paris, of astronauts from the Soviet Union, the United States, and France concluded after participants expressed concern for mankind's future and the need for cooperation, and they emphasized their desire to use their unique experience to promote space exploration and the use of space technology for the good of all people. Participating in the meeting were Soviet cosmonauts A.A. Leonov (*Voskhod-2* and *Soyuz Apollo*), O.G. Makarov (*Soyuz 12*, *Soyuz 27*, *Soyu T-3*), and Yu.V. Romanenko (*Soyuz 26*, *Soyuz 38*); U.S. astronauts R. Schweickart (*Apollo 9*), E. Mitchell (*Apollo 14*), and D. Eisele (*Apollo 7*); and French astronaut J.L. Chretien.

The participants agreed to set up an organization of those who had traveled in space, with the aim of studying the potential and promoting the constructive use of space to improve living conditions on Earth, formulating positive prospects for future generations, and promoting the establishment of broad contacts among people who had been in space to identify opportunities for cooperation and issues of common concern. (FBIS, Moscow TRUD in Russian, Sept 12/84; FBIS Moscow Tass in English, Sept 11/84)

September 10: NASA and ESA changed the name of their International Solar Polar Mission to "Ulysses." They made the change, proposed by ESA and concurred in by NASA, not only in reference to Homer's mythological hero but also for the Italian poet Dante's description (in the 26th Canto of his "Inferno") of Ulysses's urge to explore "an uninhabited world behind the Sun." The reference from the "Inferno" was appropriate because the mission would permit measurements to be made for the first time away from the ecliptic plane and over the poles of the Sun—the mission's trajectory taking the spacecraft into the uncharted third dimension of the heliosphere. (NASA Release 84-127)

September 14: NASA issued a Requet for Proposal (RFP) for definition and preliminary design of a permanently manned Space Station to be operational in low-Earth orbit early in the 1990s. Proposals were due by November 15. The Space Station would support scientific and commercial endeavors in space, stimulate new technologies, enhance space-based operational capabilities, and maintain U.S. leadership in space.

The RFP contained four "work packages" covering definition and preliminary design (Phase B) of Space Station elements. NASA planned to let competing contracts for each of the work packages and scheduled April 1, 1985, as the effective date of the contracts. (NASA Release 84-130)

September 16: U.S. balloonist Joe W. Kittinger crash-landed his 10-story balloon on a mountain in Savona, Italy, after completing the first solo balloon flight across the Atlantic. Kittinger also made the flight in four days, setting a speed-for-distance record. Six other people had tried the solor ocean crossing, but all failed, and two died in the attempt. A three-man U.S. crew of Maxie Anderson, Ben Abruzzo, and Larry Newman was the first to cross the Atlantic by balloon in 1978. Kittinger said, before beginning his flight, that his next goal would be a solo crossing of the Pacific. (*W Times*, Sept 19/84, 1A, 6A)

September 21: NASA launched at 6:18 p.m. EDT the Hughes Communications, Inc., *Galaxy-C* communications satellite from the Eastern Space and Missile Center (ESMC) by Delta 3920 vehicle. The satellite would relay business communications throughout the United States. It was the third in a series, with *Galaxy-A* dedicated to cable television programming and *Galaxy-B* (along with *Galaxy-C*) relaying video, voice, data, and facsimile communications for large corporations, long-haul carriers, and broadcasters. (NASA MOR No. M-492-215-84-03 [prelaunch], Sept. 19/84, [postlaunch], Oct 15/84; NASA Release 84-128)

September 24: At the request of Switzerland and the Federal Republic of Germany, ESA reactivated the *GOES-2* spacecraft. The two countries wanted use of the satellite to obtain data over a complete 11-year solar cycle and to support the Active Magnetospheric Particle Tracer Experiment (AMPTE) project. *GOES-2*, launched in June 1978, completed its planned scientific mission in July 1980. It resumed operations in 1981, continuing these until the end of 1983. In January 1984, *GOES-2* was moved from the densely occupied geostationary orbit into a higher and slightly asynchronous orbit, where it was drifting at a rate of about 3.5° in longitude per day and becoming visible to the European Space Operations Center station at Michelstadt, Germany, for 4 weeks every 3½ months. (ESA Release, Sept 24/84)

September 20: The second and last of two lithium releases from the Federal Republic of Germany's IRM was completed, part of the world's first active probe reaching beyond the Earth's magnetosphere. Data from the first release on September 11 was being analyzed to determine if the U.S. satellite inside the Earth's magnetosphere had detected the lithium released outside. NASA launched on August 16 the AMPTE satellites in a stack aboard a Delta rocket from Cape Canaveral Air Force Station. (NASA Release 84-140)

During September: NASA Administrator James M. Beggs announced the establishment of the new position of assistant administrator for commercial programs, reporting directly to him, to provide a focus for and facilitate efforts within NASA to expand U.S. private-sector investment and involvement in civil space-related activities. Isaac T. Gillam IV, formerly assistant associate administrator, Office of Space Flight, would assume the new position with L.J. (Bud) Evans Jr., formerly assistant to the deputy associate administrator for commercialization, to serve as his deputy. In announcing the position, Beggs said, "In support of the President's policy on commercial uses of space, the commercial programs office will be responsible for providing management direction within the agency for our efforts to establish new links with the private sector to stimulate the development of business in space. It will also be responsible for maintaining existing relationships with industry through the functions of industry affairs, technology utilization, and shuttle marketing." (NASA Release 84-129)

—*USA Today* reported that 2,500 teachers had represented to NASA with requests to be the first observer to ride the Space Shuttle in 1985 or 1986—even though the agency was not yet taking applications. NASA would announce its application process shortly. Dale Boatright, a Chicago teacher, was told by the U.S. Department of Education that his request was the first received, nearly a month before. NASA was notifying the teachers that they would receive a formal application when plans were set. (*USA Today*, Sept 24/84, 1A)

—NASA had embarked on a new research program to show that a transport airplane's metal skin and supporting structure could be replaced with metallic composite material to save weight and manufacturing costs and thereby increase fuel efficiency. Work in the program represented the first application of composite materials in the construction of primary wing and fuselage structures for transport-class aircraft. NASA's long-range goal was to provide commercial air transport manufacturers with the technology to produce composite structures and apply them on new aircraft, or on derivatives of current aircraft, in substantial amounts by the early 1990s. Researchers at LaRC, where the new composites programs was managed, expected by the mid-1990s to see about 75% of the airframe structure of a transport to be made of composites. (LRC Release 84-69)

—Dr. Jerome C. Hunsaker, an aviation pioneer who founded the first college course in aeronautical engineering at MIT and later designed the first aircraft to fly the Atlantic Ocean, died September 8 after a brief illness. He was 98 years old. He had established himself as one of the leading theorists of flight and aircraft design in a career in aviation engineering and air technology that spanned six decades. In addition to designing the flying boat NC-4, which flew from Newfoundland to Portugal and England in the first trans-Atlantic flight in May 1919, Hunsaker supervised the design of the dirigible Shenandoah, the first large rigid airship made in the United States that made its first flight in 1923. (*NY Times*, Sept 12/84, B-6)

October

October 2: Cosmonauts Leonid Kizim, Vladimir Solovyev, and Oleg Atkov returned safely to Earth after 237 days in space. Soviet television broadcast the return, showing a parachute bearing the crew coming down about 500 miles northeast of Tashkent in Kazakhstan at 1:57 p.m. Moscow time. The three crew members had lived on the *Salyut 7* orbiting space station since February 9. In television interviews, the cosmonauts said that they were glad to be back with friends on the "warm earth," although one commented he was sad to leave the empty space station behind.

The Soviet media had indicated recently that the crew was growing weary and to save energy had their working day cut by one hour. However, a medical checkup given the day after their return found the three to be in good health. In an interview in the newspaper *Socialist Industry,* a medical specialist said that recent endurance flights showed humans could live in space a year or more.

The cosmonauts spent their last days on board transferring material to their *Soyuz T-11* spacecraft and mothballing scientific equipment on the Salyut. The space station, launched in April 1982, would continue in orbit.

The Presidium of the Supreme Soviet awarded medals to the three cosmonauts; and Kizim, who headed a crew that linked up with an earlier space station in 1980, would be honored with a bronze bust, the *Washington Post* reported that Tass said. (*W Post,* Oct 3/84, A–23; FBIS, Moscow Tass in English, Oct 1/84, Oct 2/84; FBIS Moscow DomSvc in Russian, Oct 3/84)

October 3: The NASA Army Rotor Systems Research Aircraft (RSRA), a helicopter/airplane testbed in a fixed-wing mode, returned to Ames-Moffett Flight Research Facility following the flight testing of a new helicopter rotor system in a flight environment. The purpose of the flight tests was to demonstrate the fixed-wing capability of the research helicopter/airplane hybrid and to expand its flight envelope in that configuration. The evaluation included taxi tests, acoustic tests, control power/stability tests, and rotor hub drag investigation as well as takeoff and landing technique investigation and envelope development. A total of 13 flights expanded the RSRAs fixed-wing envelope capability to 262 knots (about 300 miles per hour) and its altitude to 10,000 feet. (ARC Release 84-23)

October 5–13: NASA launched on October 5 at 7:03 a.m. EDT from KSC the Space Shuttle Challenger on STS mission 41-G, the sixth flight of Challenger, with a crew consisting of Commander Robert L. Crippen; pilot Jon A. McBride; mission specialists Sally K. Ride, Kathryn D. Sullivan, and David

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C. Leestma; payload specialists Marc Garneau, a Canadian; and oceanographer Paul D. Scully-Power. It was the most crew members to fly on a Space Shuttle mission.

During the first day of flight, crew members deployed NASA's Earth Radiation Budget Satellite (*ERBS*); however, the two solar panels that supplied electricity to the 5,000-pound satellite refused to unfold. Ride corrected the *ERBS* problem by using the Space Shuttle's mechanical arm to place the satellite's solar panels in the sunlight to thaw the hinges. It took almost three hours to get the panels warm enough to respond to commands to unlock. The satellite was placed in orbit off the west coast of Mexico, instead of south of Bermuda.

While trying to determine the source of the *ERBS* problem, Kathryn Sullivan deployed the Shuttle Imaging Radar-B (*SIR-B*), a 35-by-7-foot radar camera, which had difficulty stabilizing when only one of it two "leaves" was erected. The radar antenna would send out thousands of pulses every second, and the large number of echoes the radar antenna received allowed it to draw a photograph-like image of the part of Earth that its beams struck.

During the flight, a storm of cosmic rays apparently caused by sunspots knocked out for about 13 hours NASA's *TDRS*, which affected the imaging radar system. Among the parts of the world that the radar had planned to map but would probably lose were the entire Amazon River basin, the islands that made up Indonesia, and the seas off the Cape of Good Hope. The radar was also to track the progress of tropical storm Josephine, southeast of Florida in the Atlantic Ocean, which would force Challenger's landing from Cape Canaveral to Edwards Air Force Base.

An ice buildup on the exterior of the Space Shuttle's water vents forced the crew to alter slightly the use of the ship's water facilities. The buildup, caused by a slight malfunction of the backup cooling systems, posed only an inconvenience as the astronauts had to heat up the water vents to melt away the small accumulations of ice, raising the temperature inside the cabin to as high as 90°. Crippen corrected the craft's air-conditioning system, and the temperature inside Challenger neared its norm of about 75°.

On October 11, Sullivan became the first American woman to walk in space when for 3 1/2 hours she performed tasks requiring a kind of patience, dexterity, stamina, and strength originally believed in the space program to be unique to men. She stepped into space at 11:44 a.m. EDT along with Leestma. With each held by a single tether, they worked in daylight and darkness to rehearse a critical fuel transfer, stow a troublesome antenna, and photograph their efforts for ground engineers.

Challenger landed at 12:27 p.m. EDT at KSC in the second of four attempts to land there instead of at California's Edwards Air Base and the first in three missions that Crippen was not waved off a Florida landing by bad weather. Dr. Shelby Tilford, NASA director of space science, said that the mission was successful despite disappointments with the imaging radar. Tilford said that all other Challenger experiments worked perfectly. The space-borne mapping camera, carried on a Space Shuttle flight for the first time, took 2,300 frames of film in mapping parts of every continent. Challenger apparently returned to Earth in good condition, except for minor damage to the two rear engine parts suffered during ascent. (NASA MOR E-420-41-G-09 [prelaunch], Sept 28/84, [postlaunch], Oct 5/84; NASA Release 84-132; NASA Fact Sheet, Sept 84; NASA Press Kit, Oct 84; *W Times*, Oct 9/84, 2A, Oct 10/84, 5A, Oct 12/84, 3A; *W Post*, Oct 5/84, A-2, Oct 9/84, A-4, Oct 11/84, A-17, Oct 12/84, A-6, Oct 13/84, A-3, Oct 14/84, A-5; *NY Times*, Oct 11/84, A-18)

October 10: NASA announced that Dr. Richard J. Terrile of JPL and Dr. Bradford A. Smith of the University of Arizona, using a special electronic camera system at the Carnegie Institution's Las Campanas Observatory in Chile, clearly photographed the rings of Uranus, showing them to be made of particles that were possibly the darkest found in the solar system. The camera used a charge-coupled device to record the image. Photographing the rings was difficult because they were darker than charcoal and very close to the much brighter Uranus. Special computer processing was performed on the images in order to make the rings visible. This processing created the false three-dimensional look of the images.

Analysis of the photographs showed that the rings reflected back only about 2% of the sunlight falling on them, making them possibly the darkest material found in the solar system. This raised the question as to what the rings were made of, and two possibilities were suggested. Evidence from meteorites and astronomical observations of asteroids suggested that dark organic materials were prevalent in the outer solar system and could comprise the rings. Another possibility was that the rings were made of frozen methane, another common material in the outer solar system. Studies of the rings were important because they would contribute to preparations for the Voyager 2 encounter with Uranus in January 1986, the first opportunity to view the rings close up. (NASA Release 84-145)

October 13: President Reagan established a National Commission on Space, to be composed of 15 members appointed or designated by the president; not more than 9 advisory, nonvoting members representing federal departments and agencies; 2 advisory, nonvoting members appointed by the president of the Senate from among the members of the Senate; and 2 advisory, nonvoting members appointed by the Speaker of the House of Representatives from among mnembers of that body. The commission was directed to study existing and proposed U.S. space activities; formulate an agenda for the U.S. civilian space program; and identify long-range goals, opportunties, and policy options for civilian space activity for the next 20 years. It was to submit its plan and any recommendations for proposed legislation to the president and Congress within 12 months. (WH anno, Oct 13/84)

October 15: NASA announced that astronomers Dr. Bradford A. Smith of the University of Arizona, Tucson, and Dr. Richard J. Terrile of JPL had photographed a vast swarm of solid particles, called a circumstellar disk, surrounding Beta Pictoris, a star 50 light years from Earth. The disk was the first of its kind to be seen clearly in astronomical photographs and could indicate a possible solar system around Beta Pictoris. To make the observations, the astronomers used a 100-inch telescope at the Las Campanas Observatory near La Serena, Chile, operated by the Carnegie Institution of Washington, D.C. A charged-coupled device electronic camera and a coronagraph were attached to the telescope.

The two astronomers had turned attention to Beta Pictoris because of an IRAS science team's reports earlier in the year that stated that the star, and three others similiar to it, showed abnormal amounts of infrared radiation, implying the existence of solid material orbiting the stars.

Scientists believed that the circumstellar disk was made up of countless particles, ranging in size from tiny grains less than a thousandth of an inch (10 microns) in diameter to the nuclei of comets a few miles across. the most likely composition included ice, silicates, and carbonaceous (organic) compounds, the same materials from which the Earth and other planets of the solar system were believed to have formEd.

Questions to be answered were whether Beta Pictoris had existed long enough for planets to have formed and whether large planetary bodies would necessarily form, even when the required materials were present. (NASA Release 84-146)

October 17: NASA announced that Robert L. Crippen, commander of Space Shuttle mission 41-G earlier in the month, was named deputy director of Flight Crew Operations at JSC, Houston. He would serve as deputy to George W.S. Abbey and remain an active astronaut.

Crippen was pilot on STS-1, the first Space Shuttle flight, and commanded STS-7 and 41-C, the Solar Maximum satellite rescue mission. He joined NASA in September 1969 after three-year assignment with the Air Force's Manned Orbiting Laboratory program. (JSC Release 84-050)

October 21: The first Space Shuttle external fuel tank for use at Vandenberg Air Force Base, California, arrived there after a 5,000-mile journey, marking a major milestone in activation of the West Coast space launch complex. Plans called for the initial launch from the new complex in October 1985.

Most of the major faciliteis at Space Launch Complex-Six were completed, including the facility for storage and preparation of the external tank. The U.S. Army Corps of Engineers had been responsible since 1979 for building and facility construction at the launch site, while Martin Marietta Aerospace had responsibility for design, procurement, installation, and checkout of Space Shuttle ground support systems. Space Shuttle missions from Vandenberg would carry both DOD and NASA payloads.

At the facility, the tank would undergo a thorough four-week inspection by the Air Force and its Shuttle processing contractors. Early in 1985, it would be mated with two inert solid-fuel rocket boosters and the Shuttle orbiter Enterprise for testing and compatibility between the Space Shuttle and ground facilities.

Martin Marietta Aerospace manufactured the tank at MSFC's Michoud Assembly Facility. (MSFC Release 84-85)

October 25: MSFC announced that Morton Thiokol's Wasatch Division near Brigham City, Utah, had successfully static-fired a new, lightweight version of the Space Shuttle's solid-fuel rocket booster at its northern Utah facility. Preliminary results from the two-minute firing indicated that all objectives were met and that the system operated as expected. The case of the new motor was made from a composite material of plastic reinforced with graphite fibers wound into a cylinder. Each of these filament-wound cases weighed about 30,000 pounds less than the current steel case that made up most of the length of the Space Shuttle's solid-fuel focket booster. Use of the lighter cases could increase the Space Shuttle payload carrying capacity about 4,600 pounds.

Two more of the filament-wound booster motors would be test fired by Motron Thiokol in the spring and summer of 1985. Also in the spring of 1985, flight motor segments containing filament-wound cylinders would be shipped to Vandenberg Air Force Base, California, for use by NASA and the U.S. Air Force in the first Space Shuttle launch from Vandenberg planned for October 1985.

The test was conducted under the direction of MSFC, Huntsville, Ala. (MSFC Release 84-86; *Marshall Star,* Oct 31/84, 1)

During October: The astronauts of western Europe formed an Association of European Astronauts (AEA), to which all European astronauts who had flown or been selected to train for a specific mission were eligible to join. The group would hold its first meeting on October 5 and 6. The purpose of the association was to encourage get-togethers for the exchange of views on training experiences and the projects concerned. The AEA had seven members: three ESA astronauts, Claude Nicollier, Ulf Merbold, and Wubbo Ockels; two French astronauts, Patrick Baudry and Jean-Loup Chretien; and two German astronauts, Reinhard Furrer and Ernst Messerschmid. During meetings they planned to exchange experiences, compare USSR, U.S., and European approaches, and discuss future plans for Europe in manned spaceflight. (ESA Release, Sept 24/84)

—Dan Germany, crew systems manager at JSC, observed that, after five years and $12 million, the Space Shuttle toilet still did not work, with failures on 10 out of 11 missions. "It's very disappointing," he said. On one mission, Robert Gibson had to use a crowbar to free the toilet mechanism; Sally Ride and Fred Hauck employed a camera bracket. NASA would test a new solution in August 1985 in which a bag would fit inside the commode and be removed after every flight. This reminded observers that NASA once spent $1 million to develop a pen to use in weightlessness. An engineer asked later, "Why didn't you use a lead pencil?" (*SF*, Sept/Oct 84)

—A commemorative envelope sold in the gift shop at JSC gave details and drawings of a U.S. Navy space program so secret that its name could not be used on the telephone, the *Washington Post* reported *Aviation Week & Space Technology* magazine as saying. The publication said that the envelopes, called postal cover, carried the words "Project Whitecloud," accurate drawings of a mother satellite, and drawings of three smaller spacecraft. The envelopes said that the satellite disperses the smaller craft to cover more ocean surface and that it used radar-frequency antennae to detect shipboard radar and communications signals. The Navy had no immediate comment. (*W Post*, Oct 23/84, A-15) It was later revealed that the information had been taken from the May 1976 issue of *Aviation Week & Space Technology*.

November

November 2: NASA announced that larger main parachutes, designed to slow the solid-fuel rocket boosters' final rate of descent prior to impact into the ocean, would be part of the mission 51-A Space Shuttle flight scheduled for launch November 7 from KSC. The new parachutes would be 136 feet in diameter compared to previously used chutes of 115 feet in diameter. The larger chutes would reduce the velocity of the boosters at water impact from 88 feet per second, or 60 miles per hour, to 75 feet per second, or 51 miles per hour. The reduced velocity would relieve the structural loads on the boosters at impact by about 25%; thus reducing the amount of impact damage sustained by the boosters. Following launch and separation from the Space Shuttle, the boosters were recovered from the ocean, refurbished, and used on a later flight.

According to Keith Henson, booster recovery subsystem manager in the Shuttle Projects Office at MSFC, the larger chutes were tested during mission 41-D in August on the Space Shuttle's right booster. Beginning with mission 51-B, scheduled for January 1985, all future steel case boosters would have the larger chutes. Smaller main chutes would continue to be used on some Space Shuttle missions, including the 51-C mission in December and on missions where lighter-weight filament-wound booster motor segments were used. First use of those segments was planned for October 1985. Martin Marietta Corporation, Denver, Colo., under the direction of MSFC, designed the booster's deceleration system. Pioneer Parachute Company, Manchester, Conn., provided the parachutes. (MSFC Release 64-90)

November 5: NASA announced the delay of the 51-C Space Shuttle mission originally scheduled for launch from KSC on December 8, 1984. The agency had decided to replace up 2,800 thermal protection tiles on the underside of the orbiter Challenger due to the degradation of the bonding material.

When Challenger returned from space on its last mission, a black tile from the left wing chine area just behind and below the crew door area was missing. About 100 tiles were removed from Challenger, and it was found that the adhesive substance known as "screed," used to smooth irregularities in the surface of the orbiter, had softened. Screed was applied directly over the aluminum skin of the orbiter. All other areas were covered with a primer called red RTV-560 (room temperature vulcanizing), which was used as an adhesive for bonding the strain isolation pads (SIP) to the body and the tile to the SIP. The 51-C mission was the first completely dedicated DOD mission. The 51-A mission continued on schedule for launch November 7. (MSFC Release 84-91)

November 8-16: NASA launched on November 8 from KSC the Space Shuttle Discovery on STS mission 51-A with a five-member crew consisting of commander Frederick H. Hauck; pilot David M. Walker; and mission specialists Anna L. Fisher, Dale A. Gardner, and Joseph P. Allen.

During the flight, the crew recovered the satellites *Palapa B2* and *Westar VI*, which had not operated properly following their earlier deployment from the Space Shuttle. The *Palapa B2* recovery was the first retrieval ever of a satellite from space, although astronauts previously had caught and repaired the Solar Maximum satellite. Astronauts Allen and Gardner had to move *Palapa B2* into the Discovery's cargo bay themselves when an unforeseen obstacle prevented use of the spacecraft's mechanical arm. This resulted in some damage to the power-generating solar cells surrounding the seven-foot-wide satellite, but the damage was not expected to interfere with a successful relaunching of the satellite. Later in the flight the same two astronauts took 5 hours and 42 minutes to retrieve *Westar VI*, a 2,300-pound communications satellite, and bolt it down next to *Palapa B2*—possibly the shortest $35 million salvage operation ever undertaken, the *Washington Post* reported. Insurance companies had to pay the owners of the two satellites, the government of Indonesia (*Palapa B2*), and Western Union Telegraph Company (*Westar VI*) $180 million. The insurance brokers paid NASA $5.5 million for the satellites' retrieval and Hughes Aircraft Company $5 million for technical help in the retrieval operation. Stephen Merrett, chairman of Merrett Syndicates, an affiliate of Lloyds of London, that helped underwrite the insurance on the satellites, said "I'm proud to be a part of the crowd that put this mission together in just six months." He added, "We expect Palapa to be resold for between $30 and $40 million and Westar for $30 million, and we expect those sales to be concluded very soon." Merrett declined to identify potential buyers of the two satellites.

In interviews later, Allen and Gardner noted that the task of retrieving the satellites was easier than dealing with small items such as tools and the tether wires that tied them to the Space Shuttle's cargo bay. "As objects get smaller in space, they become more difficult to handle. It's really extraordinary how much easier it is to move massive objects like satellites." Allen pointed out that the only trouble they had in retrieving the satellites resulted from their tendency to grip the satellites too hard and move them too quickly in an effort to get them back and secured in the cargo bay in a limited amount of time. "Once you get over that difficult spot where you think you have to have the satellite in a death grip, things are a lot easier," he said.

In addition to the salvage missions, the crew during the flight deployed the Canadian *Telesat-H* and Hughes *Syncom-IV-1* communications satellites. The Radiation Monitor Experiment and the Aggregation of Red Blood Cells experiments were carried out in the orbiter's middeck.

Discovery landed November 16 at 7 a.m. local time at KSC. "Two landings in a row at Kennedy, and this time with a cargo bay as full as it was when it took off," said Jesse W. Moore, NASA associate administrator for space flight. "It's hard to believe those two satellites are sitting out there on the runway after being in space for more than eight months." (NASA MOR E-420-51-A-11 [prelaunch] Nov 8/84; NASA Release 84-144; MSFC Release 84-90; JSC Release 84-051; *W Post*, Nov 13/84, A-11 and D-1, Nov 14/84, A-1, Nov 17/84, A-10, Nov 18/84, A-19, Nov 28/84, A-18; *NY Times*, Nov 18/84, 3A; *H Chron*, Nov 11/84, 24)

November 8: In conjunction with the Council of Chief State School Officers, NASA released the Announcement of Opportunity (AO), specifying the eligibility and requirements for selection of a teacher in NASA's Space Flight Participation Program. Through the program, NASA would extend Space Shuttle flight opportunities to a wide segment of private citizens with the purpose of communicating the experience of spaceflight to the public through educational and information programs. NASA intended eventually to fly various categories of space flight participants two to three times per year.

The AO was open to elementary and secondary level teachers in all public, private, and parochial schools in the United States and U.S. territories; in DOD overseas dependents' schools; in Department of State overseas schools; and in the Bureau of Indian Affairs. Teachers applying for the flight opportunity would submit an application to illustrate their qualifications and excellence as an educator and demonstrate how they would share the experience with the public. Review panels would select two teachers' nominees for each of the states and organizations identified above for forwarding to a National Review Panel. This panel would select 10 teachers as semifinalists, who would go to JSC for thorough medical examinations, in-depth briefings, and interviews. NASA would receive the names of five finalists and select the primary and backup candidates to undergo training for spaceflight. NASA's goal was to fly the first teacher on a mission in early 1986. (NASA Release 84-155)

November 10: Arianespace launched at 1:14 a.m. GMT Ariane VII varying *Spacenet 2*, for the GTE's Spacenet, and the second ESA European Space Agency maritime communications satellite, *Marecs B-2*. *Marecs B-2* was placed in geostationary transfer orbit with a perigee of 199.9 kiometers and an apogee of 36,022 kilometers. Following firing on November 11 of its apogee boost motor, *Marecs B-2* was injected into a near circular orbit at 135.5°E with a perigee of 35,600 kilometers, apogee of 35,900 kilometers, and inclination of 3.190°E.

Ariane VII was the second flight of the more powerful version of the European launcer, Ariane 3, developed by ESA. Ariane 3 was 49 meters high and weighed about 237 tons at liftoof. It had three stages, the first povided with two strap-on boosters that ignited just after liftoff. Ariane 3 could place payload of up to 2,580 kilograms into geostationary transfer orbit. (ESA Release Nov 12/84)

November 13: The congressional Office of Technology Assessment released a report, "Civilian Space Stations and the U.S. Future in Space," which said that the kind of Space Station that NASA was planning could not be justified on scientific, economic, or military grounds. It went on to say that not just Congress, but the entire nation, ought to consider what the country wanted to do in the second quarter-century of the space era. The Space Station envisioned by NASA, the report said, "is only one alternative in a wide range of options."

Thomas F. Rogers, director of the two-year study, said that the time had come for the general public to play a greater role in space program goals. "We've been spending $7.5 billion a year, every year; we can do anything want to do," he said. "It's great, it's exciting, but we're missing large numbers of important activities by allowing all this to go on under technological drive—not policy drive, economic drive, social drive, the way everything else is done in this country at that level of public expenditure."

The report characterized the nation's goals in space as shortsighted and narrow, reflecting the views only of the science and technology communities and not of the general public, which foots the bills. The study also said, "There is no compelling, objective, external case" for building a Space Station "to be used to support over 100 conceptual uses, few of which have been sharply defined or gained wide acceptance as important objectives of the space program."

The report concluded by spelling out the "kinds" of goals the nation should set: increase the efficiency of space activities and reduce their costs; involve the public; reap scientific, economic, social, and political benefits; increase international cooperation; and "spread life, in a responsible fashion, throughout the solar system." (*Civilian Space Stations and the U.S. Future in Space*, (D.C.: OTA, 1984; *W Post*, Nov 14/84, A-4; *NY Times*, Nov 14/84, B-20)

November 17: NASA technicians today began preparing the Space Shuttle Discovery for a top-secret DOD flight in January 1985. Discovery was towed into a processing hangar just a few hours after the ship and its crew had recovered two satellites from useless orbits. Jesse Moore, director of the Shuttle program, reported that Discovery "looks like she's in excellent shape," and there should be little trouble getting it ready for the next mission scheduled to start January 21 or 22, 1985.

The Space Shuttle Challenger was originally scheduled to fly the secret DOD payload on December 8, but that spacecraft was undergoing extensive repairs to thermal tiles damaged in its last mission in October and would not be ready for several weeks. Because of the high priority the Pentagon placed on the mission, it was decided to shift Discovery to the assignment, and the Spacelab flight that Discovery originally had been scheduled to fly in January was being delayed.

Moore said that the retrieved satellites, *Palapa B2* and *Westar VI*, would be removed from Discovery's cargo bay and taken to a nearby facility for servicing. Later in the month they would be flown to Hughes Aircraft Company plant in El Segundo, Calif., for refurbishing. (*NY Times*, Nov 18/83, A–3)

November 28: The White House approved a policy that would free the Federal Communications Commission (FCC) to begin processing several applications from companies hoping to provide satellite telecommunications services, thereby breaking INTELSAT's 20-year monopoly on such service. President Reagan signed a "finding" that it was in the national interest to have alternatives to INTELSAT. The announcement came after the State and Commerce departments had fought for months over who would define the new international telecommunications policies. And, of course, INTELSAT and its U.S. representative, ComSatCorp, tried to block entry of private competitors into the international market.

David Markey, assistant secretary of commerce for telecommunications and information policy, said that the new policy would not permit private satellite networks to mount full-fledged competition against INTELSAT. "It will be clear that [such networks] should be restricted to non-public switched voice services," he added. (*W Post*, Nov 28/84, C–1)

During November: Upon the departure at the end of November of Dr. Donald P. Hearth from NASA, Richard H. Petersen will move from deputy director to director of LaRC. Hearth had been center director at Langley since September 1975. He joined NASA in 1962 and had held various agency positions, inlcuding deputy director of Planetary Programs at NASA Headquarters. Petersen had served as deputy center director at LaRC since July 1980. He began his career at ARC in 1957 and was chief of the Aerodynamics Division there from 1975 until he joined Langley. (NASA Release 84-163)

—*USA Today* reported that Miss Baker, the squirrel monkey that joined another monkey, Able, in the U.S.'s first spaceflight May 28, 1959, died November 27 of kidney failure. She was buried in the Space and Rocket Center in Huntsville, Ala. (*USA Today*, Nov 31/84, 3A)

December

December 1: A four-engine Boeing jetliner in a radio-controlled test of an aircraft fuel mixture called "antimisting kerosene" crashed on Rogers Dry Lake, California. A huge fireball engulfed three-fourths of the plane immediately after it crashed. The fireball lasted about six seconds and was followed by an outpouring of black smoke that often accompanies landing crashes. Flames from what officials called a "secondary fire" were visible through the smoke. The Federal Aviation Administration (FAA) and NASA sponsored the $11.8 million crash primiarly to test the new fuel mixture, which was designed to prevent an explosive burst of flames in case of an accident. Safety specialists emphasized that it would take a long time to reconstruct precisely the sequence of events that left the Boeing 720 a much more devastated wreck than had been expected. An initial examination of the plane showed that the interior had been totally gutted by the fire that the crash produced. Despite the outcome, government and industry officials appeared willing to continue efforts to produce a practical way to minimize the fire risk from fuel spilled in accidents. (*W Post*, Dec 2/84, A–1; *NY Times*, Dec 3/84, A–21; *Time*, Dec 10/84, 32; *WTimes*, Dec 3/84, 3A)

December 12: NASA launched from the Vandenberg Air Force Base, Calif., aboard an Air Force Atlas launch vehicle *NOAA-9*, a 3,775-pound Advanced Tiros-N spacecraft that also carried search-and-rescue equipment. The satellite was placed in a 540-statute-mile, circular, near-polar orbit with an inclination of 98.86° to the equator. Total orbital period was 102.12 minutes, with an average of 72 minutes in sunlight and 30 minutes in the Earth's shadow. Because the Earth rotated 25.59° beneath the orbiting spacecraft during each orbit, the satellite would observe a different portion of Earth's surface with sufficient overlap from orbit to orbit. NOAA satellites collected meteorological readings and transmitted the data directly to users around the world for local weather analysis and forecasting. Information from the satellites was also used for hurricane tracking and warnings, agriculture, commercial fishing, forestry, maritime, and other industries. *NOAA-9* was the latest in a series of RCA-built TIROS weather satellites dating back nearly 25 years to TIROS-1, launched on April 1, 1960. It was the 6th in the current series of 11 satellites developed to give scientists the most comprehensive meteorological and environmental information since the start of the nation's space program. The satellite cost $43.5 million; launch vehicle costs were $11.4 million.

NOAA-9 also carried the second set of Earth Radiation Budget Experiment instruments, an atmospheric experiment that would increase knowledge of

Earth's climate and weather systems, particularly how climiate was affected by radiation from the Sun. (NASA MOR E-615-84-05 [prelaunch], Nov 5/84, NASA Mission Summary, Nov 8/84; NASA Release 84-150; LaRC Release 84-89)

December 13: Grumman test pilot Chuck Sewell flew for its first flight the experimental X29 forward swept-wing jet over Edwards Air Force Base, Calif. He kept the landing gear extended and held the plane to 270 miles per hour for the flight, which was intended to determine that everything worked properly, not to see how fast or high the plane could fly. The flight lasted 58 minutes and remained confined to an area around Edwards at an altitude of 15,000 feet.

The X29, which had the nose of an F5 fighter, would never fly as a fighter in its own right but was supposed to help the United States design fighter planes of the future. Not until space age materials like graphite became practical for aircraft construction could wings be built light enough and strong enough to reach into the oncoming flow of air as the plane sped along. It was hoped that the forward sweep would give the X29 and it successors advantages in maneuvering for the kill in a dogfight. (*W Post*, Dec/84, A-9)

December 15-21: The Soviet Union launched the automatic interplanetary station *Vega-1* as part of a program for the exploration of outer space and planets of the solar system. The multipurpose flight provided for exploration of Venus and Halley's comet. The first portion of the flight of *Vega-1* would continue the study of the atmosphere, cloud layer, and surface of Venus by means of a descent module that would carry out new experiments with an aerostat probe. Scientists and technicians from Austria, Bulgaria, Hungary, the German Democratic Republic, Poland, France, the Federal Republic of Germany, and Czechoslovakia joined Soviet scientists, designers, engineers, and technicians to create the package of research equipment and apparatuses. The station was due to reach the vicinity of Venus in mid-June 1985 and pass near Halley's comet in March 1986.

The Soviet Union launched December 21 *Vega-2*, which should, like *Vega-1*, reach the area of Venus in the middle of June 1985 and travel close to Halley's comet in March 1986. The *Vega-2* station should drop landing craft and balloons into the Venusian atmosphere. (FBIS, Tass in English, Dec 15/84; FBIS, Moscow DomSvc in Russian, Dec 21/84)

December 18: NASA announced that Administrator James M. Beggs and U.R. Rao, chairman of the Indian Space Reseach Organization (ISRO), signed a launch services agreement covering the reimbursable launch of the Indian National Satellite, INSAT 1C, scheduled for mid-1986 aboard the Space Shuttle. INSAT 1C was a multipurpose satellite that would provide communications and meteorological service to India. An ISRO scientist/engineer would serve as a payload specialist aboard the Space Shuttle during the INSAT 1C mission. Discussions were also held concerning experiments the Indian payload specialist would perform during the mission and concerning potential cooperation between NASA and ISRO in the areas of space applications and space science. (NASA Release 84-175)

December 19: The Soviet Union launched a scale model of what U.S. experts called a small, reusable, winged spaceplane. It orbited the Earth once, glided back into the atmosphere, and splashed down in the Black Sea. The apparently successful unmanned flight, the fourth in a new shuttle program, was seen as further evidence of the growing competition among superpower countries to develop advanced instruments for using space for military as well as peaceful operations. U.S. intelligence analysts speculated that the Soviet spaceplanes, when fully developed and flown by pilots, could be used to deliver small payloads or to inspect or attack other satellites in low-Earth orbit. The Soviet Union was also reported to be close to conducting the first tests of a larger, manned space vehicle comparable to the U.S. Space Shuttle.

In what had become a characteristic of the space race between the Soviet Union and United States, one nation, the Soviet Union in this case, was trying to catch up with the other in developing the large shuttle but was also trying to move ahead with another technology, the small spaceplane. And equally characteristic, this had apparently prompted the other, in this case the United States, to step up its efforts to design a spaceplane of its own. (*NY Times*, Dec 19/84, A-1)

December 20: Scientists at the University of Chicago announced that a U.S. experiment to analyze the dust of Halley's comet was riding aboard the Soviet Union's *Vega-1* spacecraft. It was the first known Soviet-U.S. cooperative space venture since the docking of the manned Apollo and Soyuz spacecraft in 1975. The cosmic dust analyzer—and a twin that would be launched aboard *Vega-2*—were built by university scientists under the leadership of John Simpson, one of the preeminent astrophysicists in the United States, who had designed experiments for more than 30 space missions over the past 25 years. The joint project was born at an international symposium in Holland in September 1983, where Simpson outlined vastly improved comet dust measuring methods. About a month later, he said, the Soviets surprised him by inviting him to put the analyzer aboard their Vega. Simpson received Reagan administration approval and about $300,000 in NASA funds, which touched off a frantic search for components. "We scoured the U.S. and within two weeks got all the pieces," Simpson said.

Plugging U.S. electronics into a Soviet spacecraft required unusual cooperation. Moscow shared telemetry coding data, and Simpson was able to conduct high-speed computer analysis of Soviet rocket launch characteristics to aid in designing the dust analyzer so it could survive blastoff and flight. "On May 7, we walked into the Soviet space lab with working instruments," which were then bolted aboard the Soviet spacecraft by U.S. scientists, he said. Simpson said that he had received computer tapes from the instrument during Soviet tests of the device while it awaited launch from the Baykonur cosmodrome and added that the Soviets had invited him to br on hand in Moscow when the comet encounter would begin in March 1986. (*W Post*, Dec 21/84, A-1; *NY Times*, Dec 21/84, A-1)

December 21: NASA announced that a six-member team from GSFC was helping to establish the first satellite data link to the South Pole that would make possible real-time collection of scientific data from the pole, which was not possible in the past. The effort was in support of a joint program with the National Science Foundation; the Applied Research Laboratory of the University of Texas, Austin; NOAA; and a number of other government, private, and education institutions. To establish a real-time communications link by any means other than by satellite would cost as much as $35 million compared with approximately $250,000 via satellite. "The project could revolutionize communications in the region," said Goddard engineer Michael Comberiate. "Currently, scientific data collected from the Pole during the winter months must be stored and shipped out by aircraft during Astral Summer" (November 1-February 1). The link would use existing polar-orbiting satellites to relay data from the pole to McMurdo Sound, which would retransmit the data to a geostationary satellite that, in turn, would transmit the information to the continental United States. This routing was necessary because signals from the transmitter at the Pole (90°S latitude) were too far below the horizon to be acquired by a geostationary satellite. The McMurdo station, however, was located on the edge of the Antarctic (77°S) and was barely in view of the geostationary satellite. The link with polar orbiting *Landsat 4* and *Landsat 5*, with Dynamics Explorer 1 (*DE-1*), and with *Nimbus 7* would allow reliable transmission of routine, high-volume data from scientific investigations being conducted at the Pole by 20 different institutions. (NASA Release, Dec 21/84)

—A Titan 34-D rocket with a top-secret payload was launched at 7:02 p.m. local time from the Cape Canaveral Air Force Station in what might be the final military space mission of the year. An Air Force statement did not indicate whether the payload reached the planned orbit. The next announced DOD launching was scheduled for January 23, 1985, when the Space Shuttle would carry an intelligence satellite into orbit. (*NY Times*, Dec 23/84, A-14)

During December: NASA announced that a publication of infrared celestial objects, presented in a series of catalogs and maps of 96% of the entire sky, was completed by the international science team of the IRAS. This was a milestone in the history of astronomy and would provide a wealth of new information about the universe in a wavelength region that was nearly impossible to study from the Earth's surface.

The IRAS catalogs printed nearly a quarter-million infrared sources—stars, galaxies, and newly forming stars—in addition to entirely new classes of objects. The catalogs and sky maps would be used for decades by astronomers investigating the nature of celestial objects that emitted much of their energy in infrared wavelengths as well as by astronomers seeking to understand objects at other wavelength regions of the electromagnetic spectrum. The catalog contained roughly 130,000 stars, 20,000 galaxies, 50,000 dense condensations within the infrared cirrus, and 40,000 objects of all types within the plane of the Milky Way galaxy. The catalogs were presented in several formats, including a five-volume book containing 5,000 pages of computer printout information on the location and infrared characteristics of 245,839 individual point sources found by the telescopes. The catalogs were also available on microfiche (24 cards) and magnetic tape comprising 60 megabytes of data.

IRAS was a joint project of the space agencies of the United States, United Kingdom, and the Netherlands. The telescope satellite was launched by January 25, 1983, and conducted a 10-month all-sky survey of infrared objects from Earth orbit until its supply of liquid helium coolant was depleted November 23, 1984. (NASA Release 84-169)

—Paul F. Holloway would become deputy director of LaRC, effective February 3, 1985, succeeding Richard H. Petersen. Holloway had been director for space at LaRC since May 1975 and had joined NASA in June 1960 as an aerospace research engineer. Since that time he had held various agency positions, including acting deputy associate administrator of the Office of Aeronautics and Space Technology at NASA Headquarters and chief of the Space Systems Division at Langley. He received the NASA Outstanding Leadership Medal in 1980 and the NASA Exceptional Service Medal in 1981. (NASA anno, Dec 10/84; LaRC Release 84-114)

—Krafft A. Ehricke, 67, father of the space-launched Centaur interplanetary vehicle and a leading space scientist for more than 40 years, died December 11 in La Jolla, Calif. Born in Berlin, Ehricke was brought to the United States with other members of the German V-2 rocket team after World War II to launch the U.S. space program. Ehricke worked briefly for Bell Aircraft Company in Buffalo, N.Y., after the war and later for Consolidated Vultee Corporation, which had a contract with the Air Force to develop the Atlas intercontinental ballistic missile. Vultee eventually became part of General Dynamics. The Atlas project produced the United State's first ICMB, and versions of it were still flying as space boosters. (*W Times*, Dec 13/84, 8C; *W Post*, Dec 13/84, D-7; *NY Times*, Dec 13/84, D-30)

—Vladimir N. Chelomei, 70, a rocketry expert who designed the Soviet Union's first jet engine, died December 8 in Moscow. Tass, which carried the news of his death, did not report the cause. His work was closely connected with the Soviet space program and aircraft design, and he is credited by The Great Soviet Encyclopedia with the 1942 design of the Soviet's first jet engine. He had headed a major scientific research, design, and development organization for 29 years. (*W Post*, Dec 13/84, D-7)

Appendix A

SATELLITES, SPACE PROBES, AND MANNED SPACE FLIGHT, 1979-1984

World space activity in the years 1979 through 1984 included 106 launches in 1979, 105 launches in 1980, 151 launches in 1981, 141 launches in 1982, 144 launches in 1983, and 147 launches in 1984.

Of the 106 launches (with 123 payloads) attemped in 1979, 86 (with 101 payloads) were for Soviet programs; 15 (with 17 payloads), one successful, were for U.S. programs; 2 were for Japanese; 1 each was from European Space Agency (ESA) (launched on an Ariane), India (launched by the Soviet Union), and the United Kingdom (launched by NASA). Of 83 USSR launches, 79 (with 97 payloads) were unmanned, and 4 were manned (3 Soyuz and 1 Soyuz-T). Of the 97 unmanned payloads, 79 were in the Cosmos series and 18 were of other types (5 Molniya, 3 Ekran, 3 Progress supply, 1 Raduga, 2 Horizont communications satellites, and 2 Intercosmos and 3 Meteor scientific satellites). Of the 14 successful U.S. launches, 7 (with 9 payloads) were Department of Defense (DoD), and 7, NASA. Japan had 1 launch, and ESA launched its Ariane carrying a test vehicle called *CAT* (capsule Ariane technologique) to monitor performance.

Of the 105 launches (with 127 payloads) attempted in 1980, 89 (with 110 payloads) were for Soviet programs; 13 (with 14 payloads) were from the United States; 2 were from Japan; and 1 was from India. Of 89 USSR launches, 79 (with 100 payloads) did not have crews and 10 had crews (4 Soyuz, 2 Soyuz-T, and 4 Progress supply ships). Of the 100 unmanned payloads, 89 were in the Cosmos series and 11 were of other types (4 Molniya, 1 Ekran, 1 Horizont, 2 Raduga communications satellites, 1 Prognoz, and 2 Meteor scientific satellites). Of the 13 U.S. launches, 6 (with 7 payloads) were by DOD, and NASA had 7 launches, including 2 for DOD. Japan had 3 launches, and India had 1 launch.

Of the 151 launches (with 168 payloads) attempted in 1981, 120 (with 143 payloads), 4 unsuccessful, were for Soviet programs; 19 (with 18 payloads), 2 unsuccessful, were for U.S. programs; 3 were for Japanese; 3 for the ESA (launched on an Ariane); 3 were by the People's Republic of China; and 1, unsuccessful, was by India. Of USSR launches, 120 (with 141 payloads) were unmanned, and 3 were manned (Soyuz T-4, 39, and 40). Of the 122 unmanned payloads, 94 were in the Cosmos series and 28 were of other types (8 Molniya, 1 Ekran, 3 Raduga, 1 Progress, 2 Intercosmos, 2 Meteor, 2 Iskra, 1 Aureole, 2 Venera, and 6 Radio). Of the 19 U.S. launches, 15 (with 18 payloads) were successful unmanned launches; 2, unsuccessful unmanned NASA launches; and 2, manned launches. Japan launched 3 unmanned satellites, each with 1 payload; India tried unsuccessfully to launch one payload; the ESA had three launches with three payloads, 1 for India. The People's Republic of China had 1 launch with three payloads.

Of the 141 launches (with 152 payloads) attempted in 1982, 119 (with 128 payloads), 2 unsuccessful, were for Soviet programs; 18 (with 22 payloads) were for U.S. programs; 1 was by the Japanese; 1 was by the People's Republic of China. Of USSR launches, 114 (with 128 payloads) were unmanned, and 3 were manned (Soyuz T-5, T-6, and T-7). Of the unmanned payloads, 96 were in the Cosmos series and 18 were of other types (1 Salyut, 5 Molniya, 2 Horizont, 2 Ekran, 1 Raduga, 4 Progress, 2 Meteor, 1 Iskra). Of the 18 U.S. launches, 15 (with 18 payloads) were successful unmanned launches; 3 were manned launches. Japan launched 1 unmanned satellite; and the People's Republic of China had 1 launch (with 1 payload).

Of the 144 launches (with 161 payloads) attempted in 1983, 115 (with 125 payloads) were for Soviet programs; 22 (with 33 payloads) were for U.S. programs; 3 were by the Japanese; 1 was by the People's Republic of China; 1 was by India; 1 (with 2 payloads) was by ESA; and 1 was by ITSO. Of USSR launches, 114 (with 125 payloads) were unmanned, and 3 were manned (Soyuz T-5, T-6, and T-7). Of the unmanned payloads, 94 were in the Cosmos series, and 20 were of other types (7 Molniya, 2 Ekran, 2 Raduga, 2 Progress, 1 Meteor, 2 Horizont, 1 Prognoz, 2 Venera, and 1 Astron). Of the 22 U.S. launches, 18 (with 28 payloads) were successful unmanned launches, and 4 were manned launches. Japan launched 3 unmanned satellites; the People's Republic of China, 1 launch (with 1 payload); India, 1 launch; ESA, 1 launch; and ITSO (Intelsat), 1 launch.

Of the 147 launches (with 152 payloads) attempted in 1984, 115 (with 115 payloads) were for Soviet programs; 18 (with 21 payloads) were for U.S. programs; 3 were by the Japanese; 3 were by the People's Republic of China; 3 (with 4 payloads) were by ESA. Of USSR launches, 112 (with 112 payloads) were unmanned, and 3 were manned (Soyuz T-10, T-11, and T-12). Of the unmanned payloads, 94 were in the Cosmos series, and 18 were of other types (4 Molniya, 2 Ekran, 2 Raduga, 5 Progress, 1 Meteor, 2 Horizont, and 2 Vega). Of the 23 U.S. launches, 18 (with 22 payloads) were successful unmanned launches, and 5 were manned launches. Japan launched 3 unmanned satellites; the People's Republic of China, 3 launches; and ESA, 3 launches.

Data from the accompanying tables came from the United States National registry of spaceflights; the Satellite Situation Reports issued by Goddard Space Flight Center; press releases of NASA, DOD, National Oceanic and Atmospheric Administration, and other U.S. government agencies; and press releases from the Communications Satellite Corporation. Data on Soviet launches came from statements in the USSR press service, international news service reports, and announcements and briefings by Soviet officials. Data on satellites of other nations came from announcements by their governments and by international news services.

SATELLITES, SPACE PROBES, AND MANNED SPACE FLIGHTS, 1979

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Launch Date	Spacecraft, Country, Int'l Designation, Vehicle Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
Jan. 11	*Cosmos 1070* USSR 1979-1A A-2 Plesetsk	Total weight: 5900 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	316	214	89.5	62.8	Probable military photo reconnaissance satellite; reentered Jan. 20, 1979
Jan. 13	*Cosmos 1071* USSR 1979-2A A-2 Plesetsk	Total weight: 6300 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	360	190	89.7	62.8	Probable military photo reconnaissance satellite; reentered Jan. 26, 1979
Jan. 16	*Cosmos 1072* USSR 1979-3A C-1 Plesetsk	Total weight: 650 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	1014	958	104.8	82.9	Probable navsat, 3rd-gen. "B" type
Jan. 18	*Molniya 3-11* USSR 1979-4A A-2-e Plesetsk	Total weight: 1890 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	39 382	972	717.8	64.1	Comsat; replacement for Molniya 3-8; carried TV and multichannel-radio transmission equipment
Jan. 25	*Meteor 1-29* USSR 1979-5A A-1 Baykonur-Tyuratam	Total weight: 3475 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	646	581	97.0	97.7	Metesat; second USSR weathersat in retrograde sun-synchronous orbit
Jan. 30	*Cosmos 1073* USSR 1979-6A A-2 Plesetsk	Total weight: 6300 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	350	187	89.6	62.8	Probable military photo reconnaissance satellite; reentered Feb. 12, 1979

	SCATHA U.S. 1979-7A Delta ESMC	Total weight: 360 kg Objective: Investigate buildup of elec. charges on s/c in magnetosphere Description: Cylinder, 2m long/wide; 5 booms for experiment deployment; 100m electric-field antenna	42 894	27 852	1415	4.3	*S*pacecraft *C*harging *AT* *H*igh *A*ltitudes
Jan. 31	*Cosmos 1074* USSR 1979-8A A-2 Baykonur-Tyuratam	Total weight: 7000 kg? Objective: Test flight of prototype supply transport vehicle Description: Unavailable	258	203	88.8	51.6	Probable manned-flight precursor (for Soyuz T); reentered April 1, 1979
Feb. 6	*ECS 1 (Ayame)* Japan 1979-9A N-1 Tanegashima	Total weight: 260 kg Objective: Experimental comsat Description: Cylinder	34 583	190	607.16	24.1	Japan-built and -launched experimental communications satellite damaged by collision with last stage of launcher; no longer operating
Feb. 8	*Cosmos 1075* USSR 1979-10A C-1 Plesetsk	Total weight: 1000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	516	172	94.5	65.8	Probable radar calibration satellite; reentered Oct. 19, 1981
Feb. 12	*Cosmos 1076* USSR 1979-11A C-1 Plesetsk	Total weight: 1000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	622	594	96.9	82.5	Reported in press as Soviet environmental satellite to study oceans and assoc. physical processes
Feb. 13	*Cosmos 1077* USSR 1979-1A A-1 Plesetsk	Total weight: 2500 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	589	583	96.4	81.2	Possible meteorological mission (cf. 1979-5A)
Feb. 18	*SAGE* U.S. 1979-13A Scout WFC	Total weight: 147 kg Objective: Study dust and liquid droplets in upper atmosphere; measure filtering effect on sunlight Description: Hexagonal prism with booms	532	470	94.6	54.9	*S*tratospheric *A*erosol and *G*as *E*xperiment

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
Feb. 21	*Corsa B* Japan 1979-14A Mu-36 Kagoshima	Total weight: 100 kg Objective: Observe celestial X-ray sources in the wideband range with short time resolution Description: Cylinder	323	313	90.9	29.9	Japanese scientific satellite (nickname Hachuko, "Swan") carried 2 experiments, detecting soft X-rays from 0.1 to 2 Kev and from 1.5 to 30 Kev
	Ekran 3 USSR 1979-15A D-1-E Baykonur-Tyuratam	Total weight: 2000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	36,402	35,152	1435.6	4.1	Domestic TV-relay satellite carried instruments for TV transmission
Feb. 22	*Cosmos 1078* USSR 1979-16A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	306	180	89	72.9	Possible military maneuverable reconnaissance satellite. Object separated from it Mar. 1 may have been the maneuvering engine. Reentered March 2
Feb. 24	*Solwind* U.S. 1979-17A Atlas F ESMC	Total weight: Unavailable Objective: Study nature & extent of solar wind effects on earth's ionosphere and magnetosphere Description: Unavailable	541	515	95.2	97.6	Air Force research satellite
Feb. 25	*Soyuz 32* USSR 1979-18A A-2 Baykonur-Tyuratam	Total weight: 6600 kg? Objective: Carry crew to occupy *Salyut 6* orbital station Description: Unavailable	283	244	89.6	51.6	Lt. Col. Vladimir Lyakhov, commander, and Valery Ryumin, civilian flight engineer, dockedFeb. 26 and entered *Salyut 6* to begin reactivating station systems. Unmanned capsule recovered June 13
Feb. 27	*Cosmos 1079* USSR 1979-19A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	337	171	89.6	67.1	Probable military photo reconnaissance satellite; reentered March 11

	Intercosmos 19 USSR 1979-20A C-1 Plesetsk	Total weight: 550 kg? Objective: Supplement ionosphere/ magnetosphere studies of *Intercosmos 18* and *Magion* (1978-99A&C) Description: Unavailable	879	483	98.4	74.0	Soviet international experimental satellite carrying equipment from Bulgaria, Czechoslovakia, Poland, and USSR
March 1	*Meteor 2-4* USSR 1979-21A A-1 Plesetsk	Total weight: 2750 kg? Objective: Cloudcover photography Description: Unavailable	885	832	102.1	81.2	Fourth launch of this 2d-generation Soviet weather satellite configuration carried "meteorology electro-supply system"
March 12	*Progress 5* USSR 1979-22A A-2 Baykonur-Tyuratam	Total weight: 7000 kg? Objective: Carry food, fuel, equipment to crew aboard *Salyut 6* Description: Unavailable	269	191	88.8	51.6	Automatic unmanned cargo spacecraft docked March 14 at aft port of *Salyut 6*. Supplies included TV receiver to pick up pictures from the ground. Reentered on command over Pacific April 5
March 14	*Cosmos 1080* USSR 1979-23A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	320	180	89.2	72.9	Maneuverable reconnaissance satellite; 2 objects separated from it March 22, another upon its reentry March 28 and recovery
March 15	*Cosmos 1081* USSR 1979-24A C-1 Plesetsk	Total weight: 40 kg? Objective: "Continuation of outer space investigations Description: Spheroid?	1463	1402	114.5	74.0	Multiple launch (8 satellites) probably for Soviet military communications
	and						
	Cosmos 1082 USSR 1979-24B C-1 Plesetsk	Total weight: 40 kg? Objective: "Continuation of outer space investigations" Description: Spheroid?	1464	1421	114.7	74.0	
	and						
	Cosmos 1083 USSR 1979-24C C-1 Plesetsk	Total weight: 40 kg? Objective: "Continuation of outer space investigations" Description: Spheroid?	1464	1440	114.9	74.0	

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
	and						
	Cosmos 1084 USSR 1979-24D C-1 Plesetsk	Total weight: 40 kg? Objective: "Continuation of outer space investigations" Description: Spheroid?	1464	1460	115.2	74.0	
	and						
	Cosmos 1085 USSR 1979-24E C-1 Plesetsk	Total weight: 40 kg? Objective: "Continuation of outer space investigations" Description: Spheroid?	1502	1464	115.6	74.0	
	and						
	Cosmos 1086 USSR 1979-24F C-1 Plesetsk	Total weight: 40 kg? Objective: "Continuation of outer space investigations" Description: Spheroid?	1480	1464	115.4	74.0	
	and						
	Cosmos 1087 USSR 1979-24G C-1 Plesetsk	Total weight: 40 kg? Objective: "Continuation of outer space investigations" Description: Spheroid?	1521	1464	115.8	74.0	
	and						
	Cosmos 1088 USSR 1979-24H C-1 Plesetsk	Total weight: 40 kg? Objective: "Continuation of outer space investigations" Description: Spheroid?	1545	1464	116.1	74.0	

March 16	DOD satellite U.S. 1979-25A Titan 3D WSMC	Total weight: 13,300 fueled? Objective: Unavailable Description: Cylinder?	245	159	88.6	96.4	Reconnaissance spacecraft with a ferret subsatellite. Reentered Sept. 22
	and						
	DOD satellite U.S. 1979-25B Titan 3D WSMC	Total weight: 13,330 fueled? Objective: Unavailable Description: Cylinder?	245	159	88.6	96.4	
March 21	*Cosmos 1089* USSR 1979-26A C-1 Plesetsk	Total weight: 700 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	998	966	104.7	83.0	Probable navsat
March 31	*Cosmos 1090* USSR 1979-27A A-2 Plesetsk	Total weight: 5500 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	329	201	89.9	72.9	Probable military photo reconnaissance satellite; reentered Apr. 13
April 7	*Cosmos 1091* USSR 1979-28A C-1 Plesetsk	Total weight: 700 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	1006	962	104.8	82.9	Probable navsat
April 10	*Soyuz 33* USSR 1979-29A A-2 Baykonur-Tyuratam	Total weight: 6600 kg? Objective: Ferry international crew to join commands aboard *Salyut 6*; unsuccessful Description: Unavailable	261 (354) intended parameters	194 (289)	89.0 (90.6)	51.6	Nikolai Rukavishnikov, commander, and Georgy Ivanov, the Bulgarian flight engineer, had problem April 11 with approach-maneuvering engine of *Soyuz 33* and abandoned the plan to dock. Capsule landed safely April 12
April 11	*Cosmos 1092* USSR C-1 Plesetsk	Total weight: 700 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	1002	961	104.7	82.9	Probable navsat

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
April 12	*Molniya 1-43* USSR 1979-31A A-2-e Plesetsk	Total weight: 1000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	38 543	1810	717.8	64.9	Probable domestic comsat to replane *Molniya 1-32* (1976-6A)
April 14	*Cosmos 1093* USSR 1979-32A A-1 Plesetsk	Total weight: 2500 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	587	575	96.3	81.2	
April 18	*Cosmos 1094* USSR 1979-33A F-1-m Plesetsk	Total weight: Unavailable Objective: "Continuation of outer space investigations" Description: Unavailable	445	427	93.3	65.0	Probable ocean reconnaissance satellite like *Cosmos 954* (nuclear-powered craft that crashed in Canada). *Cosmos 1094* carried microthruster for orbit adjustment and traveled about 200 km higher than *Cosmos 954* did. Reentered Nov. 7
April 20	*Cosmos 1095* USSR 1979-34A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	416	355	92.3	72.9	Reentered May 4
April 25	*Raduga 5* USSR 1979-35A D-1-E Baykonur-Tyuratam	Total weight: Unavailable Objective: Communications Description: Unavailable	36 762	35 176	1445.5	4.0	Geostationary comsat at Statsionar position (over the Indian Ocean)
	Cosmos 1096 USSR 1979-36A F-1-m Baykonur-Tyuratam	Total weight: Unavailable Objective: "Continuation of outer space investigations" Description: Unavailable	444	430	93.3	65.0	Probable ocean reconnaissance satellite like *Cosmos 1094* (see note): launched into same orbital plane but would travel about 23 min. ahead of *Cosmos 1094*. Reentered Nov. 24

April 27	*Cosmos 1097* USSR 1979-37A A-2 Plesetsk	Total weight: 5500 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	336	174	89.6	62.8	Recovered May 27, 1979 (per *SSR*)
May 4	*FltSatCom 2* U.S. 1979-38A Atlas Centaur ESMC	Total weight: 1884 kg fueled Objective: Military comsat for use by ships and field personnel Description: Hexagonal cylinder	36 320	35 255	1436.2	2.3	Launched by NASA for USN; second in series
May 13	*Progress 6* USSR 1979-39A A-2 Baykonur-Tyuratam	Total weight: 7000 kg? Objective: Carry food, fuel, materials to crew aboard *Salyut 6* Description: Unavailable	247 (340)	190 (322)	88.8 (91.1)	51.6	Unmanned supply spacecraft docked May 15 with *Salyut 6*, undocked June 8; flew alongside during docking of unmanned *Soyuz 34*; reentered over Pacific Ocean June 9
May 15	*Cosmos 1098* USSR 1979-40A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	356	168	89.8	72.9	Reentered May 28
May 17	*Cosmos 1099* USSR 1979-41A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	233	208	89.0	81.4	Maneuverable reconnaissance satellite carrying earth sources package; reentered May 30
May 22	*Cosmos 1100* USSR 1979-42A D-1 Baykonur-Tyuratam and *Cosmos 1101* USSR 1979-42B D-1 Baykonur-Tyuratam	Total weight: 7000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	210	195	88.5	51.6	Dual launch of spacecraft on single booster; recovered after one orbit (May 23)

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
May 25	*Cosmos 1102* USSR 1979-43A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	259	211	89.3	81.3	Reconnaissance satellite carrying an earth resources package; reentered June 7
May 28	DOD satellite U.S. 1979-44A Titan 3D WSMC	Total weight: 13,300 fueled? Objective: Unavailable Description: Unavailable	291	133	88.8	96.4	Reconnaissance satellite launched to work in conjunction with similar craft (1979-25A) launched March 16
May 31	*Cosmos 1103* USSR 1979-45A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	416	325	92.01	62.8	Reentered June 14
	Cosmos 1104 USSR 1979-46A C-1 Plesetsk	Total weight: 700 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	1006	954	104.7	82.9	Navsat
June 2	*Ariel 6* U.K. 1979-47A Scout D WFC	Total weight: 154 kg Objective: High-energy astrophysics research; study celestial and cosmic X-rays Description: Cylinder with dome and 4 solar-cell panels	567	535	95.7	55.0	(Switched off Feb. 25, 1982, when pointing accuracy no longer adequate.) NASA launched U.K.-built scisat carrying cosmic-ray and X-ray detectors plus 2 technological experiments to study solar-cell performance and space effects on semiconductors
June 5	*Molniya 3-12* USSR 1979-48A A-2-e Plesetsk	Total weight: 1550 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	39,058	1288	717.6	64.1	Domestic comsat, to replace *Molniya 3-7*

June 6	*Soyuz 34* USSR 1979-49A A-2 Baykonur-Tyuratam	Total weight: 6800 kg? Objective: Unmanned substitute to replace unsuccessful *Soyuz 33* as ferry craft since *Soyuz 32* had exceeded safe age for manned reentry Description: Unavailable	254 (363)	192 (351)	88.9 (91.6)	51.6	Unmanned Soyuz docked June 8 with *Soyuz 6*; on June 14, crew undocked it from rear port and redocked it at forward port to make room for *Progress 7* supply craft. *Soyuz 34* was recovered Aug. 19; crew had flown for 175 days, 36 min
	Ams 4 U.S. 1979-50A Thor Burner 2 WSMC	Total weight: 513 kg Objective: Unavailable Description: Unavailable	837	818	101.5	98.8	Advanced meteorological satellite as part of U.S. defense meteorological satellite program; craft resembled *Tiros 11* and *NOAA 6*
June 7	*Bhaskara* India 1979-51A C-1 Kapustin Yar	Total weight: 360 kg Objective: Earth observation Description: 26-faced polyhedron	428	420	93.1	50.7	USSR-launched India-built satellite to work with backup *Aryabhata* craft
June 8	*Cosmos 1105* USSR 1979-52A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	232	209	89.0	81.4	Reentered June 21
June 10	DOD satellite U.S. 1979-53A Titan 3C ESMC	Total weight: Unavailable Objective: Undisclosed Description: Unavailable	35 858	35 729	1436.3	1.92	Geostationary orbit at 134°W
June 12	*Cosmos 1106* USSR 1979-54A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	236	214	89.1	81.4	Reentered June 25
June 15	*Cosmos 1107* USSR 1979-55A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	384	166	90.0	72.9	Reentered June 29

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
June 22	*Cosmos 1108* USSR 1979-56A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	244	213	89.1	81.3	Reentered July 5
June 27	*NOAA 6* U.S. 1979-57A Atlas F WSMC	Total weight: 723 kg Objective: Meteorological observation Description: Irregular box with solar panel	814	798	101.0	98.5	NASA launched second of latest metesat configuration for NOAA into orbit 90° longitude from twin craft *Tiros 11* (1978-96A), doubling amount of data available to Natl. Meteorological Center
	Cosmos 1109 USSR 1979-58A A-2-e Plesetsk	Total weight: 1000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	39 739	627	718.0	62.9	Probable early warning satellite (antimissile)
June 28	*Progress 7* USSR 1979-59A A-2 Baykonur-Tyuratam	Total weight: 7000 kg? Objective: Carry food, fuel, supplies to crew aboard *Salyut 6* Description: Unavailable	391	353	91.6	51.6	Unmanned supply craft docked with *Salyut 6* June 30. Among items carried was a 10m-dia radio telescope installed outside to observe separation of *Progress 7* on July 18. *Progress 7* reentered over Pacific Ocean July 20
	Cosmos 1110 USSR 1979-60A C-2 Plesetsk	Total weight: 750 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	804	782	0.7	74.0	
June 29	*Cosmos 1111* USSR 1979-61A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	413	327	92.0	62.8	Reentered July 14

July 5	*Horizont 2* USSR 1979-62A D-1-E Baykonur-Tyuratam	Total weight: 5000 kg? Objective: Communications Description: Unavailable	35 828	35 766	1436.7	3.2	Geostationary comsat at 14°W, the *Statsionar 4* position, after July 16
July 6	*Cosmos 1112* USSR 1979-63A C-1 Kapustin Yar	Total weight: 550 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	544	345	93.4	50.7	Reentered Jan. 21, 1980
July 10	*Cosmos 1113* USSR 1979-64A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	351	167	89.7	65.0	Reentered July 23
July 11	*Cosmos 1114* USSR 1979-65A C-1 Plesetsk	Total weight: 900 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	550	504	95.2	74.0	Reentered Dec. 26
July 13	*Cosmos 1115* USSR 1979-66A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	221	220	89.0	81.4	Reentered July 26
July 20	*Cosmos 1116* USSR 1979-67A A-1 Plesetsk	Total weight: 2500 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	583	544	95.9	81.2	Military satellite, possibly an electronic ferret
July 25	*Cosmos 1117* USSR 1979-68A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	324	179	89.5	62.8	Reentered Aug. 7

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
July 27	*Cosmos 1118* USSR 1979-69A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	246	211	89.1	81.4	Reentered Aug. 9
July 31	*Molniya 1-44* USSR 1979-70A A-2 Plesetsk	Total weight: 1000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	39 202	1144	717.6	63.8	
Aug. 3	*Cosmos 1119* USSR 1979-71A A-2 Plesetsk	Total weight: 5500 kg? Objective: Undisclosed Description: Unavailable	240	214	89.1	81.1	Reentered Aug. 18
Aug. 10	*Westar 3* U.S. 1979-72A Delta ESMC	Total weight: 572 kg Objective: Commercial domestic comsat Description: Cylinder	35 789	35 784	1436.1	0.0	Geostationary orbit at 91 °W. NASA-launched comsat, owned by Western Union Telegraph Co. and built by Hughes Aircraft, on a reimbursable basis
Aug. 11	*Cosmos 1120* USSR 1979-73A A-2 Baykonur-Tyuratam	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	361	169	89.9	70.6	Maneuverable reconnaissance satellite; reentered Aug. 24
Aug. 14	*Cosmos 1121* USSR 1979-74A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	305	165	89.2	67.1	Reentered Sept. 13

Aug. 17	Cosmos 1122 USSR 1979-75A A-2 Plesetsk	Total weight: 5500 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	238	212	89.1	81.3	Reconnaissance satellite carried an earth resources package. Reentered on Aug. 30
Aug. 21	Cosmos 1123 USSR 1979-76A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space Description: Unavailable	232	210	89.0	81.4	Reentered Sept. 3
Aug. 28	Cosmos 1124 USSR 1979-77A A-2-e Plesetsk	Total weight: 1000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	37 130	3186	717.0	65.5	Probable military early warning satellite
	Cosmos 1125 USSR 1979-78A C-1 Plesetsk	Total weight: 750 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	802	785	100.7	74.0	
Aug. 31	Cosmos 1126 USSR 1979-79A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	394	378	92.3	72.9	Reentered Sept. 14
Sept. 5	Cosmos 1127 USSR 1979-80A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	273	262	90.0	81.3	Reentered Sept. 18
Sept. 14	*Cosmos 1128* USSR 1979-81A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	330	174	89.6	62.8	Reentered Sept. 27
Sept. 20	*HEAO 3* U.S. 1979-82A Atlas Centaur ESMC	Total weight: 3150 kg Objective: High-energy astronomy Description: Hexagonal cylinder	500	484	94.4	43.6	Third and last of this series would measure cosmic and gamma radiation, instead of X-rays like its 2 predecessors; reentered Dec. 7
Sept. 25	*Cosmos 1129* USSR 1979-83A A-2 Plesetsk	Total weight: 6000 kg? Objective: International cooperation in biological experiments Description: Unavailable	377	218	90.5	62.8	Recovered Oct. 15. Soviet intl. biosat carried experiments from USSR and USA plus Czechoslovakia, France, GDR, Hungary, Romania, and Poland. Experiments were in radiation medicine and embryo development in weightlessness

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
Sept. 25	*Cosmos 1130* USSR 1979-84A C-1 Plesetsk	Total weight: 40 kg? Objective: "Continuation of outer space investigations" Description: Spheroid?	1477	1396	114.6	74.0	Multiple launch (8 satellites) probably for Soviet military communications
	and						
	Cosmos 1131 USSR 1979-84B C-1 Plesetsk	Total weight: 40 kg? Objective: "Continuation of outer space investigations" Description: Spheroid?	1480	1409	114.8	74.0	
	and						
	Cosmos 1132 USSR 1979-84C C-1 Plesetsk	Total weight: 40 kg? Objective: "Continuation of outer space investigations" Description: Spheroid?	1480	1424	114.9	74.0	
	and						
	Cosmos 1133 USSR 1979-84D C-1 Plesetsk	Total weight: 40 kg? Objective: "Continuation of outer space investigations" Description: Spheroid?	1481	1437	115.1	74.0	
	and						
	Cosmos 1134 USSR 1979-84E C-1 Plesetsk	Total weight: 40 kg? Objective: "Continuation of outer space investigations" Description: Spheroid?	1482	1452	115.3	74.0	

	Cosmos 1135 USSR 1979-84F C-1 Plesetsk	Total weight: 40 kg? Objective: "Continuation of outer space investigations" Description: Spheroid?	1491	1459	115.4	74.0	
	and						
	Cosmos 1136 USSR 1979-84G C-1 Plesetsk	Total weight: 40 kg? Objective: "Continuation of outer space investigations" Description: Spheroid?	1495	1470	115.6	74.0	
	and						
	Cosmos 1137 USSR 1979-84H C-1 Plesetsk	Total weight: 40 kg? Objective: "Continuation of outer space investigations" Description: Spheroid?	1513	1470	115.8	74.0	
	Cosmos 1138 USSR 1979-85A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	409	362	92.3	72.9	Reentered Oct. 12
Oct. 1	DOD satellite U.S. 1979-86A Titan 3-C ESMC	Total weight: Unavailable Objective: Undisclosed Description: Unavailable	Elements not available				Probably an early warning mission
Oct. 3	*Ekran 4* USSR 1979-87A D-1-e Baykonur-Tyuratam	Total weight: 2000 kg? Objective: Television relay Description: Unavailable	36 810	34 778	1436.5	1.0	Domestic TV-relay satellite, stationed at 99°E
Oct. 5	*Cosmos 1139* USSR 1979-88A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	333	201	89.5	72.9	Reentered Oct. 18

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
Oct. 11	*Cosmos 1140* USSR 1979-89A C-1 Plesetsk	Total weight: 750 kg Objective: "Continuation of outer space investigations" Description: Unavailable	794	772	100.5	74.1	
Oct. 16	*Cosmos 1141* USSR 1979-90A C-1 Plesetsk	Total weight: 700 kg Objective: "Continuation of outer space investigations" Description: Unavailable	1000	952	104.6	82.9	Probable navsat
Oct. 20	*Molniya 1-45* USSR 1979-91A A-2-e Plesetsk	Total weight: 1000 kg? Objective: Communications Description: Unavailable	38 032	2320	717.7	64.7	Domestic comsat
Oct. 22	*Cosmos 1142* USSR 1979-92A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	417	352	92.4	72.9	Reentered Nov. 4
Oct. 26	*Cosmos 1143* USSR 1979-93A A-1 Plesetsk	Total weight: 2500 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	614	592	96.8	81.2	Military satellite, probably an electronic ferret
Oct. 30	*Magsat* U.S. 1979-94A Scout G WSMC	Total weight: 181 kg Objective: Measure near-earth magnetic field and crustal anomalies Description: Octagonal prism with 4 solar panels and boom	561	354	93.8	96.8	NASA scientific satellite using parts left over from small astronomical satellite (1975-37A) and designed for 4mo lifetime; reentered June 11, 1980

Oct. 31	*Meteor 2-5* USSR 1979-95A A-1 Plesetsk	Total weight: 2750 kg? Objective: Return meteorological data and cloudcover photographs Description: Unavailable	882	864	102.4	81.2	Fifth of second-generation Soviet metesats
Nov. 1	*Intercosmos 20* USSR 1979-96A C-1 Plesetsk	Total weight: 500 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	510	465	94.4	74.0	Eastern-bloc cooperative launch of a scientific satellite, reentered March 5, 1981
Nov. 2	*Cosmos 1144* USSR 1979-97A A-2 Plesetsk	Total weight: 6000 kg? Objective: Undisclosed Description: Unavailable	357	167	89.8	67.2	Maneuverable reconnaissance satellite; reentered Dec. 4
Nov. 21	DOD satellite U.S. 1979-98A Titan 3C ESMC	Total weight: 550 each Objective: U.S. military comsats Description: Cylindrical	35 792	35 780	1436.1	2.0	Geostationary orbit
	and						
	DOD satellite U.S. 1979-98B Titan 3C ESMC		35 793	35 782	1436.2	2.0	
Nov. 27	*Cosmos 1145* USSR 1979-99A A-1 Plesetsk	Total weight: 2500 kg? Objective: "Continuation of outer space investigations Description: Unavailable	597	586	96.5	81.2	Probable electronic ferret
Dec. 5	*Cosmos 1146* USSR 1979-100A C-1 Plesetsk	Total weight: 1000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	494	444	94.0	65.9	Reentered Nov. 25, 1981

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
Dec. 7	*RCA-Satcom* U.S. 1979-101A Delta ESMC	Total weight: 895 kg Objective: Commercial domestic comsat Description: Box 1.2 × 1.2 × 1.6m carrying solar panels and antennas	35 798	162	630	23.9	Launched by NASA for Radio Corporation of America; satellite lost when apogee motor fired to inject it into geostationary orbit
Dec. 12	*Cosmos 1147* USSR 1979-102A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	418	352	92.3	72.9	Reentered Dec. 26
Dec. 16	*Soyuz T* USSR 1979-103A A-2 Baykonur-Tyuratam	Total weight: 7000 kg Objective: Test flight of recoverable transport craft for use with orbiting space stations Description: Unavailable	378	364	91.9	51.6	*Soyuz T* docked with *Salyut 6* on Dec. 19. Previous tests of similar craft were *Cosmos 1001* and *Cosmos 1074* (1978-36A and 1979-8A). Recovered March 26, 1980
Dec. 24	*CAT* ESA 1979 104A Ariane Kourou	Total weight: 1602 kg (incl. ballasat) Objective: "Capsule Ariane Technologique" carrying instrumentation to measure Ariane performance Description: Cylinder	24 527	157	424.9	17.8	
Dec. 28	*Horizont 3* USSR 1979-105A D-1-E Baykonur-Tyuratam	Total weight: 3000 kg? Objective: Communications Description: Unavailable	35 792	35 781	1436.1	3.4	Geostationary comsat to carry TV relays of 1980 Olympic games in Moscow from Statsionar 5 position at 58°E
	Cosmos 1148 USSR 1979-106A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	342	173	89.7	67.0	Maneuverable long-life reconnaissance satellite; reentered Jan. 10, 1980

SATELLITES, SPACE PROBES, AND MANNED SPACE FLIGHTS, 1980

SATELLITES, SPACE PROBES, AND MANNED SPACE FLIGHTS, 1980

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
Jan. 9	*Cosmos 1149* USSR 1980-1A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	418	353	92.3	72.9	Reentered Jan. 23
Jan. 11	*Molniya 1-46* USSR 1980-2A A-2-e Plesetsk	Total weight: Unavailable Objective: Communications Description: Unavailable	39 785	556	717.5	64.1	Domestic comsat
Jan. 14	*Cosmos 1150* USSR 1980-3A C-1 Plesetsk	Total weight: 700 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	1012	964	104.9	82.9	Navsat
Jan. 18	*FltSatCom 3* U.S. 1980-4A Atlas Centaur ESMC	Total weight: 1884 kg (including fuel) Objective: To provide links between small ground stations in 200 to 400 MHz band Description: Hexagonal cylinder	35 791	35 781	1436.1	2.0	Third of this series of military comsats, on station at 172 °E; launched by NASA for DOD
Jan. 23	*Cosmos 1151* USSR 1980-5A C-1 Plesetsk	Total weight: 700 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	641	613	97.3	82.5	Ocean survey satellite
Jan. 24	*Cosmos 1152* USSR 1980-6A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	177	115	87.4	67.1	Reentered Feb. 6

Jan. 25	*Cosmos 1153* USSR 1980-7A C-1 Plesetsk	Total weight: 700 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	1015	959	104.9	82.9	Probable navsat
Jan. 30	*Cosmos 1154* USSR 1980-8A A-1 Plesetsk	Total weight: 2500 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	613	603	96.9	81.2	Probable electronic reconnaissance satellite
Feb. 7	*Cosmos 1155* USSR 1980-9A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	414	355	92.4	72.9	Reentered Feb. 21
	DOD satellite U.S. 1980-10A Titan 3D WSMC	Total weight: 13 300 kg (including fuel) Objective: Undisclosed Description: Cylinder	502	224	91.9	97.0	Maneuverable reconnaissance satellite; reentered Oct. 30, 1982
Feb. 9	*NavStar 5* U.S. 1980-11A Atlas F WSMC	Total weight: 433 kg? Objective: Undisclosed Description: Cylinder with 4 vanes	20 146	20 083	715.2	63.7	Navigation satellite
Feb. 11	*Cosmos 1156* USSR 1980-12A C-1 Plesetsk	Total weight: 40 kg? Objective: "Continuation of outer space investigations" Description: Spheroid?	1473	1396	114.5	74.0	Multiple launch (8 satellites) probably for military communications
	and						
	Cosmos 1157 USSR 1980-12B C-1 Plesetsk	Total weight: 40 kg? Objective: "Continuation of outer space investigations" Description: Spheroid?	1475	1413	114.8	74.0	

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
	and						
	Cosmos 1158 USSR 1980-12C C-1 Plesetsk	Total weight: 40 kg? Objective: "Continuation of outer space investigations" Description: Spheroid?	1475	1431	115.0	74.0	
	and						
	Cosmos 1159 USSR 1980-12D C-1 Plesetsk	Total weight: 40 kg? Objective: "Continuation of outer space investigations" Description: Spheroid?	1476	1449	115.2	74.0	
	and						
	Cosmos 1160 USSR 1980-12E C-1 Plesetsk	Total weight: 40 kg? Objective: "Continuation of outer space investigations" Description: Spheroid?	1480	1464	115.4	74.0	
	and						
	Cosmos 1161 USSR 1980-12F C-1 Plesetsk	Total weight: 40 kg? Objective: "Continuation of outer space investigations" Description: Spheroid?	1500	1466	115.6	74.0	

	and						
	Cosmos 1162 USSR 1980-12G C-1 Plesetsk	Total weight: 40 kg? Objective: "Continuation of outer space investigations" Description: Spheroid?	1517	1470	115.8	74.0	
	and						
	Cosmos 1163 USSR 1980-12H C-1 Plesetsk	Total weight: 40 kg? Objective: "Continuation of outer space investigations" Description: Spheroid?	1541	1469	116.1	74.0	
Feb. 12	*Cosmos 1164* USSR 1980-13A A-2-e Plesetsk	Total weight: 1250 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	40 858	435	736.9	62.8	Reentered Jan. 12, 1981
Feb. 14	*SMM* U.S. 1980-14A Delta ESMC	Total weight: 2315 kg Objective: Observe the sun and solar corona during 1980–81 maximum of the sunspot cycle, to measure gamma-ray, X-ray, and ultraviolet emissions and the solar constant Description: Cylindrical box with 2 solar panels	497	496	94.5	28.5	*S*olar *M*aximum *M*ission spacecraft designed for retrieval from orbit by a Space Shuttle mission
Feb. 17	*Tansei 4* Japan 1980-15A Mu 3S Kagoshima	Total weight: Unavailable Objective: Scientific observations Description: Unavailable	604	518	95.8	36.7	Japan-built and -launched scisat; reentered May 12, 1983
Feb. 20	*Raduga 6* USSR 1980-16A D-1-E Baykonur-Tyuratam	Total weight: Unavailable Objective: Communications relay Description: Unavailable	35 792	35 748	1435.3	3.6	Geostationary comsat, at the Statsionar 2 position, 35°E

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
Feb. 21	*Cosmos 1165* USSR 1980-17A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	350	155	89.6	72.9	Reentered March 5
Feb. 22	*ECS 2 Ayame* Japan 1980-18A Nu Tanegashima	Total weight: 260 kg Objective: Communications Description: Cylinder	35 592	213	627.0	24.5	Japan-built and -launched experimental comsat; contact lost when apogee motor should have fired. *ECS 1* (1979-19A) lost also
March 3	DOD satellite U.S. 1980-19A Atlas F WSMC	Total weight: Unavailable Objective: Undisclosed Description: Unavailable	1147	1060	107.3	63.5	
March 4	*Cosmos 1166* USSR 1980-20A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	430	356	92.5	72.9	Reentered March 18
March 14	*Cosmos 1167* USSR 1980-21A F-1-m Baykonur-Tyuratam	Total weight: Unavailable Objective: "Continuation of outer space investigations" Description: Unavailable	444	428	93.3	65.0	Probable ocean survey reconnaissance satellite; reentered Oct. 1, 1981
March 17	*Cosmos 1168* USSR 1980-22A C-1 Plesetsk	Total weight: 700 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	1011	956	104.8	82.9	Probable navsat

March 27	*Cosmos 1169* USSR 1980-23A C-1 Plesetsk	Total weight: Unavailable Objective: Undisclosed Description: Unavailable	515	476	94.5	65.8	Probable interception test or radar calibration target; reentered March 3, 1983
	Progress 8 USSR 1980-24A A-2 Baykonur-Tyuratam	Total weight: 7000 kg? Objective: Carry replacement parts and materials to *Salyut 6* in preparation for visit of *Soyuz 35* Description: Unavailable	354	338	91.4	51.6	Docked with *Salyut 6* March 29; *Progress 8* engine served to propel the Salyut/Progress complex to a higher orbit April 13. Undocked April 25, reentered atmosphere over the Pacific April 26
April 1	*Cosmos 1170* USSR 1980-25A A-2 Baykonur-Tyuratam	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	345	166	89.7	70.4	Reentered April 12
April 3	*Cosmos 1171* USSR 1980-26A C-1 Plesetsk	Total weight: Unavailable Objective: "Continuation of outer space investigations" Descriptions: Unavailable	1006	965	104.8	65.8	Probable target for *Cosmos 1174* satellite interception test
April 9	*Soyuz 35* USSR 1980-27A A-2 Baykonur-Tyuratam	Total weight: 6500 kg? Objective: Carry cosmonants to orbiting space stations Description: Unavailable	346	336	91.3	51.6	Capsule carrying Lt. Col. Leonid Popov and Valery Ryumin docked with *Salyut 6* April 10 at forward airlock; crew transferred supplies from *Progress 8*. *Soyuz 35* returned safely June 3 with *Soyuz 36* crew
April 12	*Cosmos 1172* USSR 1980-28A A-2-e Plesetsk	Total weight: 1000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	37 986	2409	718.6	66.0	Probable early warning satellite
April 17	*Cosmos 1173* USSR 1980-29A A-2 Baykonur-Tyuratam	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	355	155	89.6	70.3	Reentered April 28

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
April 18	*Cosmos 1174* USSR 1980-30A F-1-m Baykonur-Tyuratam	Total weight: Unavailable Objective: Satellite intercept Description: Unavailable	1560	384	104.5	66.1	Satellite-interception test using *Cosmos 1171* (1980-26A) as primary target
	Cosmos 1175 USSR 1980-31A A-2-e Plesetsk	Total weight: 1500 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	459	252	91.7	62.8	Probable failed Molniya 3-type satellite; reentered May 28
April 26	*NavStar* U.S. 1980-32A Atlas F WSMC	Total weight: 450 kg? Objective: Form part of U.S. global positioning system Description: Cylinder with four vanes	20 451	19 912	718.0	63.8	U.S. navsat
April 27	*Progress 9* USSR 1980-33A A-2 Baykonur-Tyuratam	Total weight: 7000 kg? Objective: Unmanned vehicle carrying supplies to crew aboard *Salyut 6* Description: Unavailable	362	333	91.4	51.6	Docked with *Salyut 6* (occupied by Popov and Ryumin) April 29; undocked May 20. Reentered May 22 over Pacific Ocean
April 29	*Cosmos 1176* USSR 1980-34A F-1-m Baykonur-Tyuratam	Total weight: Unavailable Objective: "Continuation of outer space investigations" Description: Unavailable	949	889	103.4	64.8	Radar-equipped ocean survey satellite powered by a nuclear reactor: microthruster would assist orbit maneuvers

	Cosmos 1177 USSR 1980-35A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	341	165	89.6	67.2	Maneuverable reconnaissance satellite; reentered June 12
May 7	*Cosmos 1178* USSR 1980-36A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations Description: Unavailable	413	354	92.3	72.8	Reentered May 22
May 14	*Cosmos 1179* USSR 1980-37A C-1 Plesetsk	Total weight: 700 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	1003	281	97.6	82.9	Possibly part of a navsat system; positioned near *Cosmos 1181* (1980-39A)
May 15	*Cosmos 1180* USSR 1980-38A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	290	238	89.8	62.8	Reentered May 26
May 20	*Cosmos 1181* USSR 1980-39A C-1 Plesetsk	Total weight: 700 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	1002	970	104.8	82.9	Probable navsat
May 23	*Cosmos 1182* USSR 1980-40A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	250	210	89.1	82.4	Reentered June 5
May 26	*Soyuz 36* USSR 1980-41A A-2 Baykonur-Tyuratam	Total weight: 6600 kg? Objective: Carry crew to orbiting space station *Salyut 6* Description: Unavailable	354	333	91.4	51.6	Vehicle carrying Valery Kubasov, commander, and Bertalan Farkas of Hungary, flight engineer, docked at rear port of *Salyut 6* May 27, to join Ryumin and Popov; *Soyuz 36* crew returned to earth in *Soyuz 35* capsule, landing June 3. (*Soyuz 36* capsule was recovered July 31, with crew of *Soyuz 37* aboard)

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
May 28	*Cosmos 1183* USSR 1980-42A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	415	356	92.3	72.9	Reentered June 11
May 29	*NOAA B* U.S. 1980-43A Atlas F WSMC	Total weight: 1405 kg Objective: U.S. meteorological satellite Description: Irregular box with solar panel	1447	265	102.1	92.2	Launched by NASA for NOAA, metesat intended for an 87 km orbit at 99° inclination; booster failed to inject it into correct orbit; satellite inoperable; reentered May 3, 1981
June 4	*Cosmos 1184* USSR 1980-44A A-1 Plesetsk	Total weight: 2500 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	616	592	96.8	81.2	Probable electronic ferret
June 5	*Soyuz T 2* USSR 1980-45A A-2 Baykonur-Tyuratam	Total weight: 7000 kg? Objective: Manned test flight of modified Soyuz vehicle; followup of unmanned tests Description: Unavailable (modifications announced were solar arrays, plus computerized docking system making cosmonauts independent of ground control)	348	333	91.3	51.6	The crew of Yuri Malyshev, commander, and Vladimir Aksyonov, flight engineer, docked with aft airlock of *Salyut 6* on June 6. New space suits tested, as well as new on-board systems. Reentry module soft-landed June 9
June 6	*Cosmos 1185* USSR 1980-46A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	283	259	90.0	82.4	Probable earth resources satellite; reentered June 20
	Cosmos 1186 USSR 1980-47A C-1 Plesetsk	Total weight: 550 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	518	471	94.6	74.0	Reentered Jan. 1, 1982

June 12	*Cosmos 1187* USSR 1980-48A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	518	417	94.6	74.0	Reentered June 26
June 13	*Horizont 4* USSR 1980-49A D-1-E Baykonur-Tyuratam	Total weight: 5000 kg? Objective: Communications Description: Unavailable	35 810	35 765	1436.2	3.0	Comsat intended for Statsionar 4 location at 14 °W
June 14	*Cosmos 1188* USSR 1980-50A A-2-e Plesetsk	Total weight: 1250 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	37 712	2353	717.2	67.3	Probable early warning satellite
June 18	*Meteor 1-30* USSR 1980-51A A-1 Baykonur-Tyuratam	Total weight: 2200 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	602	544	96.1	97.8	Combined earth resources and meteorological satellite
	DOD satellite U.S. 1980-52A Titan 3D WSMC	Total weight: 13 330 kg? Objective: Undisclosed Description: Cylinder	265	168	88.9	96.5	Maneuverable reconnaissance satellite carrying piggyback payload with its own motor; reentered March 6, 1981
	and						
	DOD satellite U.S. 1980-52C Titan 3D WSMC	Total weight: Unavailable Objective: Undisclosed Description: Unavailable	1331	1330	112.3	96.6	
June 21	*Molniya 1-47* USSR 1980-53A A-2-e Plesetsk	Total weight: 1000 kg? Objective: Communications Description: Unavailable	38 916	1439	717.8	64.8	*Domestic comsat*
June 26	*Cosmos 1189* USSR 1980-54A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	331	225	90.1	72.9	Reentered July 10

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
June 29	*Progress 10* USSR 1980-55A A-2 Baykonur-Tyuratam	Total weight: 7000 kg? Objective: Unmanned craft carrying supplies to crew aboard manned space station Description: Unavailable	340	325	91.1	51.6	Vehicle docked with aft airlock of *Salyut 6* July 1; deorbited July 19 over Pacific Ocean
July 1	*Cosmos 1190* USSR 1980-56A C-1 Plesetsk	Total weight: 750 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	779	783	100.7	74.0	
July 2	*Cosmos 1191* USSR 1980-57A A-2-e Plesetsk	Total weight: Unavailable Objective: Undisclosed Description: Unavailable	37 358	2953	716.9	65.3	Probable early warning satellite
July 9	*Cosmos 1192* USSR 1980-58A C-1 Plesetsk	Total weight: 40 kg? Objective: "Continuation of outer space investigations" Description: Ellipsoid?	1474	1395	114.5	74.0	Multiple launch (8 satellites) probably for military communications; launch announcement said remote sensing was included in mission, meaning possibly more than one type of payload
	and						
	Cosmos 1193 USSR 1980-58B C-1 Plesetsk	Total weight: 40 kg? Objective: "Continuation of outer space investigations" Description: Ellipsoid?	1473	1411	114.7	74.0	
	and						
	Cosmos 1194 USSR 1980-58C C-1 Plesetsk	Total weight: 40 kg? Objective: "Continuation of outer space investigations" Description: Ellipsoid?	1472	1430	114.9	74.0	

and						
Cosmos 1195 USSR 1980-58D C-1 Plesetsk	Total weight: 40 kg? Objective: "Continuation of outer space investigations" Description: Ellipsoid?	1474	1447	115.1	74.0	
and						
Cosmos 1196 USSR 1980-58E C-1 Plesetsk	Total weight: 40 kg? Objective: "Continuation of outer space investigations" Description: Ellipsoid?	1474	1465	115.3	74.0	
and						
Cosmos 1197 USSR 1980-58F C-1 Plesetsk	Total weight: 40 kg? Objective: "Continuation of outer space investigations" Description: Ellipsoid?	1490	1469	115.5	74.0	
and						
Cosmos 1198 USSR 1980-58G C-1 Plesetsk	Total weight: 40 kg? Objective: "Continuation of outer space investigations" Description: Ellipsoid?	1506	1472	115.7	74.0	
and						
Cosmos 1199 USSR 1980-58H C-1 Plesetsk	Total weight: 40 kg? Objective: "Continuation of outer space investigations" Description: Ellipsoid?	1528	1471	116.0	74.0	
Cosmos 1200 USSR 1980-59A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	340	225	90.2	72.9	Reentered July 23

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
July 14	*Ekran 5* USSR 1980-60A D-1-e Baykonur-Tyuratam	Total weight: 2000 kg? Objective: Television relay Description: Unavailable	69 711	1953	1438.4	9.6	Domestic comsat to make television available to remote communities; on station at 99°E
July 15	*Cosmos 1201* USSR 1980-61A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	246	211	89.1	82.3	Reentered July 28
July 18	*Rohini 1* India 1980-62A SLV-3 Sriharikota Is.	Total weight: 40 kg Objective: Test satellite launching Description: Spheroid 0.5 dia.	919	306	96.9	44.8	First India-built and -launched small satellite; booster also of India design and manufacture; reentered May 20, 1981
	Molniya 3-13 USSR 1980-63A A-2-e Plesetsk	Total weight: 1500 kg? Objective: Communications Description: Unavailable	38 265	2090	717.8	3.7	
July 23	*Soyuz 37* USSR 1980-64A A-2 Baykonur-Tyuratam	Total weight: 6500 kg? Objective: Carry crew to orbiting space station Description: Unavailable	351	336	91.4	51.6	Vehicle carrying an Intercosmos crew of Viktor Gorbatko and Pham Tuan of Viet Nam docked with *Salyut 6* on July 24. This crew returned to earth July 31 in *Soyuz 36* vehicle. The *Soyuz 37* capsule returned Oct. 11 bringing Popov and Ryumin back from flight of 184 days, 20 hr, 12 min.
July 24	*Cosmos 1202* USSR 1980-65A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	289	226	89.7	72.8	Reentered Aug. 7

July 31	*Cosmos 1203* USSR 1980-66A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	273	259	89.9	82.3	Reentered Aug. 14
	Cosmos 1204 USSR 1980-67A C-1 Kapustin Yar	Total weight: 550 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	538	345	93.3	50.7	Reentered Feb. 23, 1981
Aug. 12	*Cosmos 1205* USSR 1980-68A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	293	225	89.7	72.8	Reentered Aug. 26
Aug. 15	*Cosmos 1206* USSR 1980-69A A-2 Plesetsk	Total weight: 2500 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	606	604	98.6	81.2	Probable electronic reconnaissance satellite
Aug. 22	*Cosmos 1207* USSR 1980-70A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	228	217	89.0	82.3	Reentered Sept. 4
Aug. 26	*Cosmos 1208* USSR 1980-71A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	336	171	89.6	67.1	Photo reconnaissance satellite; reentered Sept. 24
Sept. 23	*Cosmos 1211* USSR 1980-77A A-2 Plesetsk	Total weight: 5500 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	240	215	89.1	82.4	Probable earth resources satellite; reentered Oct. 4

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
Sept. 26	*Cosmos 1212* USSR 1980-78A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	247	208	89.1	82.3	Possible earth resources satellite; orbit very close to that of *Cosmos 1211*; recovered Oct. 9
Sept. 28	*Progress 11* USSR 1980-79A A-2 Baykonur-Tyuratam	Total weight: 7000 kg? Objective: Unmanned cargo craft carrying supplies to *Salyut 6* Description: Unavailable	339	333	91.2	51.6	Supplies intended to extend orbital lifetime of *Salyut 6* beyond recovery of *Soyuz 37* Oct. 11; undocked from *Salyut 6* Dec. 9; reentered over Indian Ocean Dec. 11
Oct. 3	*Cosmos 1213* USSR 1980-80A A-2 Plesetsk	Total weight: 6000 kg Objective: "Continuation of outer space investigations" Description: Unavailable	296	230	89.8	72.9	Reentered Oct. 17
Oct. 5	*Raduga 7* USSR 1980-81A D-1-e Baykonur-Tyuratam	Total weight: 5000 kg? Objective: Communications Description: Unavailable	35 795	35 781	1436.2	3.2	First Soviet comsat positioned at the Statsionar 1 location, 84°E
Oct. 10	*Cosmos 1214* USSR 1980-82A A-2 Plesetsk	Total weight: Unavailable Objective: "Continuation of outer space investigations" Description: Unavailable	345	172	89.7	67.2	Long-life maneuverable reconnaissance satellite; reentered Oct. 23
Oct. 14	*Cosmos 1215* USSR 1980-83A C-1 Plesetsk	Total weight: 750 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	549	496	95.1	74.0	Reentered May 12, 1983

Oct. 16	*Cosmos 1216* USSR 1980-84A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	415	354	92.3	72.9	Recovered Oct. 30
Oct. 24	*Cosmos 1217* USSR 1980-85A A-2-e Plesetsk	Total weight: 1000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	38 198	2131	7.3	66.9	Probable early warning satellite
Oct. 30	*Cosmos 1218* USSR 1980-86A A-2 Baykonur-Tyuratam	Total weight: 6000 kg? Objective: "Continuation of outer spacc investigations" Description: Unavailable	354	171	89.8	64.9	Reentered Dec. 12
Oct. 31	*FltSatCom 4* U.S. 1980-87A Atlas Centaur ESMC	Total weight: 1884 (including fuel) Objective: Provide 2-way communications between small ground stations on 200 to 400 MHz frequencies	35 797	35 777	1436.2	1.2	Launched by NASA for DOD; military comsat stationed at 172°E
	Cosmos 1219 USSR 1980-88A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	321	237	90.1	72.9	Reentered Nov. 13
Nov. 4	*Cosmos 1220* USSR 1980-89A F-1-m Plesetsk	Total weight: Unavailable Objective: "Continuation of outer space investigations" Description: Unavailable	864	571	99.2	65.0	Reconnaissance satellite controlled by microthruster; working with *Cosmos 1167* (1980 21-A); ground tracks repeating every 4 days lie precisely halfway between those of *Cosmos 1167*
Nov. 12	*Cosmos 1221* USSR 1980-90A C-1 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	414	356	92.3	72.9	Reentered Nov. 26
Nov. 15	*SBS 1* U.S. 1980-91A Delta ESMC	Total weight: 550 kg Objective: Establish commercial communications system covering continental U.S. Description: Cylinder 6.6m high, 2.2 dia	35 790	35 782	1436.1	0.0	Launched by NASA, first of 3 for Satellite Business Systems Inc.; first mission using solid-fuel Payload Assist Module instead of usual Delta third stage; satellite orbiting at 106°W

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
Nov. 16	*Molniya 1-48* USSR 1980-92A A-2-e Plesetsk	Total weight: 1000 kg? Objective: Communications Description: Unavailable	38 256	2096	717.8	64.5	Domestic comsat
Nov. 21	*Cosmos 1222* USSR 1980-93A A-1 Plesetsk	Total weight: 2500 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	609	606	96.9	81.2	Probable electronic ferret
Nov. 27	*Soyuz T3* USSR 1980-94A A-2 Baykonur-Tyuratam	Total weight: 6600 kg? Objective: Carry 3-man crew to orbiting space station, refurbish Salyut Description: Standard Soyuz T design	354	283	90.8	51.6	Second manned flight of Soyuz T craft, first to carry 3 cosmonauts since *Soyuz 11* in 1971. Vehicle carrying Leonid Kizim, commander; Oleg Makarov, flight engineer; and Gennady Strekalov, research engineer. Docked with *Salyut 6* Nov. 28
	Cosmos 1223 USSR 1980-95A A-2-e Plesetsk	Total weight: 1000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	37 924	2445	718.1	63.4	Probable early warning satellite
Dec. 1	*Cosmos 1224* USSR 1980-96A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	415	355	92.3	72.9	Reentered Dec. 15
Dec. 5	*Cosmos 1225* USSR 1980-97A C-1 Plesetsk	Total weight: 700 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	1026	943	104.8	92.9	Navsat

Dec. 6	*Intelsat 5A-F2* U.S. 1980-98A Atlas Centaur ESMC	Total weight: 1065 Objective: Orbit latest model Intelsat, 3-axis-stabilized w/control thrusters Description: Box with 2 solar panels	35 801	35 774	1436.2	0.0	Launched by NASA for INTELSAT; first launch of new Intelsat capable of 12,000 simultaneous telephone calls and 2 TV channels; stationed over Atlantic Ocean
Dec. 10	*Cosmos 1226* USSR 1980-99A C-1 Plesetsk	Total weight: 700 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	1009	959	104.8	82.9	Soviet navsat
Dec. 13	DOD satellite U.S. 1980-100A (Vehicle & launch site unavailable)	U.S. military launch: no details available					
Dec. 16	*Cosmos 1227* USSR 1980-101A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	306	227	89.9	72.8	Reentered Dec. 28
Dec. 23	*Cosmos 1228* USSR 1980-102A C-1 Plesetsk	Total weight: 40 kg? Objective: "Continuation of outer space investigations" Description: Spheroid?	1462	1392	114.4	74.0	Multiple launch (8 satellites) probably for military communications
	and						
	Cosmos 1229 USSR 1980-102B C-1 Plesetsk	Total weight: 40 kg? Objective: "Continuation of outer space investigations" Description: Spheriod?	1462	1413	114.6	74.0	
	and						
	Cosmos 1230 USSR 1980-102C C-1 Plesetsk	Total weight: 40 kg? Objective: "Continuation of outer space investigations" Description: Spheroid?	1461	1399	114.5	74.0	

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
	and						
	Cosmos 1231 USSR 1980-102D C-1 Plesetsk	Total weight: 40 kg? Objective: "Continuation of outer space investigations" Description: Spheroid?	1462	1405	114.5	74.0	
	and						
	Cosmos 1232 USSR 1980-102E C-1 Plesetsk	Total weight: 40 kg? Objective: "Continuation of outer space investigations" Description: Spheroid?	1462	1411	114.6	74.0	
	and						
	Cosmos 1233 USSR 1980-102F C-1 Plesetsk	Total weight: 40 kg? Objective: "Continuation of outer space investigations" Description: Spheroid?	1462	1417	114.7	74.0	
	and						
	Cosmos 1234 USSR 1980-102G C-1 Plesetsk	Total weight: 40 kg? Objective: "Continuation of outer space investigations" Description: Spheroid?	1462	1408	114.6	74.0	

	and						
	Cosmos 1235 USSR 1980-102H C-1 Plesetsk	Total weight: 40 kg? Objective: "Continuation of outer space *investigations*" Description: Spheroid?	1462	1412	114.6	74.0	
Dec. 25	*Prognoz 8* USSR 1980-103A A-2-e Baykonur-Tyuratam	Total weight: 950 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	197 364	978	5687.8	65.8	High-altitude magnetospheric observatory
Dec. 26	*Ekran 6* USSR 1980-104A D-1-E Baykonur-Tyuratam	Total weight: 2000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	35 822	35 780	1436.9	3.0	Domestic comsat stationed at 99°E
	Cosmos 1236 USSR 1980-105A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	364	170	90.0	67.1	Long-life recoverable reconnaissance satellite, reentered Jan. 21, 1981

SATELLITES, SPACE PROBES, AND MANNED SPACE FLIGHTS, ***1981***

SATELLITES, SPACE PROBES, AND MANNED SPACE FLIGHTS, 1981

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle *Launch Site*	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
Jan. 6	*Cosmos 1237* USSR 1981-1A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space Description: Unavailable	415	355	92.3	72.9	Reentered Jan. 20
Jan. 9	*Molniya 3-14* USSR 1981-2A A-2-e Plesetsk	Total weight: 2000 kg? Objective: Communications Description: Unavailable	39 325	1024	717.7	63.4	Comsat
Jan. 16	*Cosmos 1238* USSR 1981-3A C-1 Plesetsk	Total weight: 550 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	1872	401	108.1	83.0	
	Cosmos 1239 USSR 1981-4A A-2 Plesetsk	Total weight: 5500 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	234	213	89.0	82.3	Reentered Jan. 28
Jan. 20	*Cosmos 1240* USSR 1981-5A A-2 Baykonur-Tyuratam	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	361	167	89.8	64.9	Reentered Feb. 17
Jan. 21	*Cosmos 1241* USSR 1981-6A C-1 Plesetsk	Total weight: 700 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	1006	976	104.9	65.8	Target for *Cosmos 1243* in test of satellite-interception system; later target for *Cosmos 1258* (1981-24A)

Jan. 24	*Progress 12* USSR 1981-7A A-2 Baykonur-Tyuratam	Total weight: 7000 kg? Objective: Carrying supplies to orbiting space station Description: Unavailable	319	294	90.6	51.6	Unmanned cargo vehicle docked with *Salyut 6* on Jan. 26
Jan. 27	*Cosmos 1242* USSR 1981-8A A-1 Plesetsk	Total weight: 2500 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	634	611	97.2	81.2	Probable electronic ferret
Jan. 30	*Molniya 1-49* USSR 1981-9A A-2-e Plesetsk	Total weight: 1800 kg? Objective: Communications Description: Unavailable	38 465	1862	717.2	63.3	Comsat
Feb. 2	*Cosmos 1243* USSR 1981-10A F-1-m Baykonur-Tyuratam	Total weight: Unavailable Objective: Test satellite-interception systems Description: Unavailable	1015	296	97.9	65.8	Using *Cosmos 1241* as target, *Cosmos 1243* made intercept at beginning of third orbit and moved into reentry trajectory
Feb. 6	*Intercosmos 21* USSR 1981-11A C-1 Plesetsk	Total weight: 550 kg? Objective: Study surface of earth and its oceans Description: Unavailable	514	473	94.5	74.0	USSR-built and -launched scisat carrying instruments from Czechoslovakia, East Germany, Hungary, and Romania, reentered July 7, 1982
Feb. 11	*Kiku 3* Japan 1981-12A N-2 Tanegashima	Total weight: 640 Objective: Test technical equipment Description: Cylinder 2.8m long, 2.1 dia	31 272	265	546.7	28.4	Japan-built and -launched technical-experiment satellite carrying plasma engine and other test equipment
Feb. 12	*Cosmos 1244* USSR 1981-13A C-1 Plesetsk	Total weight: 700 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	1005	960	104.8	83.0	Navsat

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
Feb. 13	*Cosmos 1245* USSR 1981-14A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	415	354	92.3	72.8	Reentered Feb. 27
Feb. 18	*Cosmos 1246* USSR 1981-15A A-2 Baykonur-Tyuratam	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	265	195	89.1	64.9	Recoverable maneuverable reconnaissance satellite; reentered March 13
Feb. 19	*Cosmos 1247* USSR 1981-16A A-2-e Plesetsk	Total weight: 1900 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	37 378	2647	711.1	64.7	Probable first of new series of early warning satellites
Feb. 21	*Hinotori (Astro 1)* Japan 1981-17A Mu-3S Kagoshima Is.	Total weight: Unavailable Objective: Solar studies Description: Cylinder 1m long, 1m dia	594	543	96.0	31.3	Japan scisat carrying X-ray telescope and spectrograph
	Comstar D-4 U.S. 1981-18A Atlas Centaur ESMC	Total weight: 1516 kg Objective: Communications Description: Cylinder 6.1m long, 2.4 dia	35 785	35 793	1436.2	0.1	Launched by NASA for ComSatCorp; to be stationed at 127°W
Feb. 28	DOD satellite U.S. 1981-19A Titan 3D WSMC	Total weight: Unavailable (13 330 kg?) Objective: Undisclosed Description: Cylinder 15m long, 3m dia	332	134	89.2	96.4	Reconnaissance satellite; reentered June 20

March 5	*Cosmos 1248* USSR 1981-20A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" *Description*: Unavailable	345	171	89.7	67.1	Maneuverable reconnaissance satellite; reentered April 4
	Cosmos 1249 USSR 1981-21A F-1 Baykonur-Tyuratam	Total weight: Unavailable Objective: Ocean survey Description: Unavailable	976	907	103.9	65.0	Radar-carrying satellite powered by nuclear reactor; mission complete June 19; nuclear reactor boosted into higher orbit
March 6	*Cosmos 1250* USSR 1981-22A C-1 Plesetsk	Total weight: 40 kg? Objective: Communications Description: Spheroid?	1469	1388	114.4	74.0	Multiple launch (8 satellites) of comsats
	and						
	Cosmos 1251 USSR 1981-22B C-1 Plesetsk	Total weight: 40 kg? Objective: Communications Description: Spheroid?	1471	1401	114.6	74.0	
	and						
	Cosmos 1252 USSR 1981-22C C-1 Plesetsk	Total weight: 40 kg? Objective: Communications Description: Spheroid?	1470	1416	114.7	74.0	
	and						
	Cosmos 1253 USSR 1981-22D C-1 Plesetsk	Total weight: 40 kg? Objective: Communications Description: Spheroid?	1494	1466	115.6	74.0	

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
	and						
	Cosmos 1254 USSR 1981-22E C-1 Plesetsk	Total weight: 40 kg? Objective: Communications Description: Spheroid?	1471	1429	114.9	74.0	
	and						
	Cosmos 1255 USSR 1981-22F C-1 Plesetsk	Total weight: 40 kg? Objective: Communications Description: Spheroid?	1470	1443	115.0	74.0	
	and						
	Cosmos 1256 USSR 1981-22G C-1 Plesetsk	Total weight: 40 kg? Objective: Communications Description: Spheroid?	1475	1454	115.2	74.0	
	and						
	Cosmos 1257 USSR 1981-22H C-1 Plesetsk	Total weight: 40 kg? Objective: Communications Description: Spheroid?	1478	1466	115.4	74.0	

March 12	*Soyuz T-4* USSR 1981-23A A-2 Baykonur-Tyuratam	Total weight: 7000 kg? Objective: Ferry crew to orbiting space station, preparing for further flights of international crews Description: Unavailable	350	338	91.4	51.6	Vehicle carrying Col. Vladimir Kovalyonok and flight engr. Viktor Savinikh docked at forward port of *Salyut 6* March 13. Savinikh was world's 100th space traveller: 50 earlier USSR cosmonauts; 43 U.S. astronauts; and 1 each from Czech., EGer., Pol., Hung., Bulg., Cuba, and Vietnam. T-4 crew returned safely May 26 in T-4 descent module.
March 14	*Cosmos 1258* USSR 1981-24A F-1-m Baykonur-Tyuratam	Total weight: Unavailable Objective: Test satellite-intercept system Description: Unavailable	1024	301	98.0	65.8	Using *Cosmos 1241* as target (previous attempt was Feb. 2) *Cosmos 1258* used a radar seeker to intercept the vehicle. It exploded on orbit 2 and damaged the target. Third such test in 10 mo, but first operational test of homing device since 1977
March 16	DOD satellite U.S. 1981-25A Titan 3C ESMC	Total weight: Unavailable Objective: Communications Description: Unavailable	Elements not available				Geostationary orbit at 71°E
March 17	*Cosmos 1259* USSR 1981-26A A-2 Baykonur-Tyuratam	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	415	348	92.2	70.4	Reentered March 31
March 18	*Raduga 8* USSR 1981-27A D-1-E Baykonur-Tyuratam	Total weight: 2000 kg? Objective: Communications Description: Unavailable	48 604	31 012	1646.4	0.8	Comsat on station at Statsionar 2 location, 35°E
March 20	*Cosmos 1260* USSR 1981-28A F-1 Baykonur-Tyuratam	Total weight: Unavailable Objective: "Continuation of outer space investigations" Description: Unavailable	447	428	93.3	65.0	Reconnaissance satellite, possibly working *Cosmos 1220* (1980-89A), reentered May 22, 1982

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
March 22	*Soyuz 39* USSR 1981-29A A-2 Baykonur-Tyuratam	Total weight: 6500 kg? Objective: Ferry international crew to orbiting space station Description: Unavailable	350	336	91.3	51.6	Vehicle carrying Vladimir Dzhanibekov and Jugderdemidyn Gurragcha of Mongolia (8th non-Soviet cosmonaut) to dock with *Salyut 6* March 23; recovered March 30
March 24	*Molniya 3-15* USSR 1981-30A A-2-e Plesetsk	Total weight: 2000 kg? Objective: Communications Description: Unavailable	39 616	735	717.7	64.8	
March 31	*Cosmos 1261* USSR 1981-31A A-2-e Plesetsk	Total weight: 2000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	36 663	2669	717.3	64.0	Probable early warning satellite
April 7	*Cosmos 1262* USSR 1981-32A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	324	216	89.9	72.9	Reentered April 21
April 9	*Cosmos 1263* USSR 1981-33A C-1 Plesetsk	Total weight: 700 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	1879	392	108.0	83.0	

April 12	*STS 1* U.S. 1981-34A Columbia KSC	Total weight: 68 800 kg? Objective: Test flight of Space Transportation System Description: Unpowered flight vehicle 37m long, 24m span	250	238	89.3	40.4	Crew (astronauts John Young and Robert Crippen) landed April 14 on dry lakebed at Edwards AFB, Calif.
April 15	*Cosmos 1264* USSR 1981-35A A-2 Baykonur-Tyuratam	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	416	362	92.4	70.4	Reentered April 29
April 16	*Cosmos 1265* USSR 1981-36A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	356	224	90.4	72.8	Reentered April 28
April 21	*Cosmos 1266* USSR 1981-37A F-1 Baykonur-Tyuratam	Total weight: Unavailable Objective: "Continuation of outer space investigations" Description: Unavailable	965	891	103.6	64.8	Probable ocean survey satellite
April 24	DOD satellite U.S. 1981-38A Titan 3B/Agena D WSMC	Total weight: Unavailable Objective: Communications (DOD's satellite data system) Description: Unavailable	*No information available*				Military comsat
April 25	*Cosmos 1267* USSR 1981-39A D-1 Baykonur-Tyuratam	Total weight: 15 000 kg? Objective: Test flight of "Star" space station module Description: Unavailable	260	192	89.0	51.6	Initial orbit plane 10°E of *Salyut 6*; distance reduced gradually to permit docking at rear port of *Salyut 6* June 19
April 28	*Cosmos 1268* USSR 1981-40A A-2 Baykonur-Tyuratam	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	282	224	89.6	70.4	Reentered May 12

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
May 7	*Cosmos 1269* USSR 1981-41A C-1 Plesetsk	Total weight: 750 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	803	788	100.8	74.1	
May 14	*Soyuz 40* USSR 1981-42A A-2 Baykonur-Tyuratam	Total weight: 6800 kg Objective: Ferry international crew to orbiting space station Description: Unavailable	345	331	91.2	51.6	Vehicle carrying commander Leonid Popov (on second visit to *Salyut 6*) and flight engineer Dmitru Prunariu of Romania (last E. bloc country unrepresented) docked with rear port of *Salyut 6* May 15; recovered May 22
	Meteor 2-7 USSR 1981-43A A-1 Plesetsk	Total weight: 2500 kg? Objective: Weather observations Description: Unavailable	887	847	102.3	81.3	Metesat
May 15	*NOVA 1* U.S. 1981-44A Scout WSMC	Total weight: Unavailable Objective: Test U.S. Navy's improved Transit navigation satellite Description: Unavailable	1203	1173	109.2	90.0	NASA launched first of a series of advanced navigation satellites, built for the Navy by RCA
May 18	*Cosmos 1270* USSR 1981-45A A-2 Baykonur-Tyuratam	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	348	173	89.7	64.9	Long-life maneuverable reconnaissance satellite, reentered June 17

May 19	*Cosmos 1271* USSR 1981-46A A-I Plesetsk	Total weight: 2500 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	632	611	97.1	81.2	Probable electronic ferret
May 21	*Cosmos 1272* USSR 1981-47A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	415	360	92.4	70.4	Reentered June 4
May 22	*Cosmos 1273* USSR 1981-48A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	249	211	89.2	82.3	Reentered June 4
	GOES 5 U.S. 1981-49A Delta ESMC	Total weight: 400 kg Objective: Geostationary operational environmental satellite Description: Cylinder 3m long, 2 dia	35 788	35 780	1435.9	0.1	Launched by NASA for NOAA into synchronous orbit at 75°W
May 23	*Intelsat 5-2* INTELSAT 1981-50A Atlas Centaur ESMC	Total weight: 1065 kg Objective: Communications Description: Box with 2 polar panels	35 800	35 778	1436.2	0.0	Internationally owned comsat launched by NASA for INTELSAT into synchronous orbit at 1°W; principal Atlantic comlink (first Intelsat 5 launched Dec. 1980, encountering hardware problems)
May 31	*Rohini 2* India 1981-51A SLV-3 Sriharikota	Total weight: 40 kg Objective: Scientific satellite Description: Spheroid 0.5m dia	418	187	90.5	46.3	India-built and -launched small satellite; failed to achieve intended orbit; reentered June 8
June 3	*Cosmos 1274* USSR 1981-52A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	353	170	89.8	67.2	Long-life maneuverable reconnaissance satellite; reentered July 3

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
June 4	*Cosmos 1275* USSR 1981-53A C-1 Plesetsk	Total weight: 700 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	1006	959	104.8	83.0	Navsat
June 9	*Molniya 3-16* USSR 1981-54A A-2-e Plesetsk	Total weight: 2000 kg? Objective: Communications Description: Unavailable	39 621	730	717.7	63.4	Comsat
June 16	*Cosmos 1276* USSR 1981-55A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations Description: Unavailable	237	214	89.1	82.4	Reconnaissance satellite carrying an earth-resources package; reentered June 29
June 17	*Cosmos 1277* USSR 1981-56A A-2 Baykonur-Tyuratam	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	416	360	92.4	70.4	Reentered July 1
June 19	*Meteosat 2* ESA 1981-57A Ariane Kourou	Total weight: 312.5 kg? Objective: Weather research Description: Cylinder 3.2m long, 2.4 dia	35 794	35 781	1436.1	0.1	European metesat launched June 20 into synchronous orbit over Greenwich meridian (0°) by ESA's Ariane L03/apogee motor
	and						
	Apple India 1981-57B Ariane Kourou	Total weight: 380 kg Objective: Communications Description: Cylinder with nozzle, carrying 2 solar panels	36 478	35 548	1447.7	0.8	India-built experimental comsat (an Ariane passenger-payload experiment) launched by Ariane L03/apogee motor into synchronous orbit at 102°E; one solar panel failed to deploy

	Cosmos 1278 USSR 1981-58A A-2-e Plesetsk	Total weight: 2000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	38 527	1876	718.8	66.1	Early warning satellite
June 23	*NOAA 7* U.S. 1981-59A Atlas F WSMC	Total weight: 723 kg (empty) Objective: Weather research, including cloudcover photography, other atmospheric data Description: Irregular box 3.7m long, 1.9 dia, with solar panel	854	837	101.8	99.1	Metesat launched by NASA for NOAA; in polar orbit
June 24	*Molniya 1-50* USSR 1981-60A A-2-e Plesetsk	Total weight: 1800 kg? Objective: Replacement or backup for *Molniya 1-42* (1978-80A), providing telegraph and long-distance telephone services as well as Orbita system TV to remote areas Description: Unavailable	39 376	969	717.6	64.8	Comsat
June 25	*Ekran 7* USSR 1981-61A D-1-E Baykonur-Tyuratam	Total weight: 2000 kg? Objective: TV relay Description: Unavailable	35 810	35 780	1436.6	2.6	Comsat in geostationary orbit at Statsionar T position, 99°E
July 1	*Cosmos 1279* USSR 1981-62A A-2 Baykonur-Tyuratam	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	398	379	92.3	70.4	Military photo reconnaissance satellite; reentered July 15
July 2	*Cosmos 1280* USSR 1981-63A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	273	256	89.9	82.3	Probable military photo reconnaissance satellite; reentered July 15

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
July 7	*Cosmos 1281* USSR 1981-64A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	414	357	92.3	72.8	Probable Soviet military photo reconnaissance satellite; reentered July 21
July 10	*Meteor Priroda* USSR 1981-65A A-1 Baykonur-Tyuratam	Total weight: 2200 kg? Objective: Earth-resources and meteorology research using multispectral TV scanner and microwave radiometer, plus equipment from Bulgaria 1300 program	658	609	97.4	97.8	*Priroda* carried small maneuvering engine to ensure coverage of specific targets
	and						
	Iskra USSR 1981-65C A-1 Baykonur-Tyuratam	Total weight: Unavailable Objective: Undisclosed Description: Unavailable	661	636	97.8	98.0	Piggyback payload on *Meteor Priroda*, built by student design office of Moscow Aviation Institute, reentered Oct. 7
July 15	*Cosmos 1282* USSR 1981-66A A-2 Baykonur-Tyuratam	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	334	172	89.6	64.9	Probable military photo reconnaissance satellite; recovered Aug. 14
July 17	*Cosmos 1283* USSR 1981-67A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	371	325	91.6	82.4	Probable military photo reconnaissance satellite; recovered July 31

July 29	*Cosmos 1284* USSR 1981-68A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	370	325	91.5	82.3	Probable military photo reconnaissance satellite; recovered Aug. 12
July 30	*Raduga 9* USSR 1981-69A D-1-E Baykonur-Tyuratam	Total weight: 2000 kg? Objective: Communications relay providing 24 hr telephone and telegraph links plus color and monochrome TV from Central system (domestic TV network covering mid-USSR) Description: Unavailable	36 095	35 464	1435.8	2.5	Comsat in geostationary orbit at Statsionar 2 position, 35°E
Aug. 3	*Dynamics Explorer 1* U.S. 1981-70A Delta WSMC and	Total weight: 403 kg (105 kg instruments) Objective: Study energy coupling, plasmas, and electric fields and currents by simultaneous measurements from 2 spacecraft at different altitude Description: 16-sided polygonal cylinder covered with solar cells, 1.1m high and 1.4 dia	23 330	506	410.5	89.7	Spacecraft built for NASA by RCA Astro-Electronics; launch vehicle second stage lacked 250 lb propellant because of ground error, resulting in orbits not as intended
	Dynamics Explorer 2 U.S. 1981-70B Delta WSMC	Total weight: 415 kg (111 kg instruments) Objective: See *Dynamics Explorer 1* Description: See *Dynamics Explorer 1*	996	298	97.7	90.0	Reentered Feb. 19, 1983
Aug. 4	*Cosmos 1285* USSR 1981-71A A-2-e Plesetsk	Total weight: 2000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	38 192	2612	726.9	63.9	Probable part of early warning satellite system; reported not stabilized in mid-Nov.; possible failure
	Cosmos 1286 USSR 1981-72A F-1 Baykonur-Tyuratam	Total weight: Unavailable Objective: "Continuation of outer space investigations" Description: Unavailable	444	431	93.3	65.0	Probable ocean surveillance satellite to replace *Cosmos 1220* (1980-89A) reentered Oct. 16, 1982

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
Aug. 6	*FltSatCom5* U.S. 1981-73A Atlas Centaur ESMC	Total weight: 1000 kg Objective: Provide UHF and S-band communications between U.S. military forces using small ground equipment Description: Hexagonal cylinder 1.3m long, 2.3 dia; 2 solar panels; 3.8m helical antenna and 4.9 dia dish for UHF, plus horn antenna for S-band	35 860	35 721	1436.3	4.5	Built for DOD by TRW; on station at 92 °W; last of 5 comsats in system replacing DOD-leased channels on civilian Marisat system
	Cosmos 1287 USSR 1981-74A C-1 Plesetsk	Total weight: 40 kg? Objective: Communications Description: Spheroid?	1511	1462	115.7	74.0	Multiple launch (8 spacecraft) for tactical military communications; previous launch of this type, 1981-22A through H
	and						
	Cosmo 1288 USSR 1981-74B C-1 Plesetsk	Total weight: 40 kg? Objective: Communications Description: Spheroid?	1491	1462	115.5	74.0	
	and						
	Cosmo 1289 USSR 1981-74C C-1 Plesetsk	Total weight: 40 kg? Objective: Communications Description: Spheroid?	1462	1424	114.7	74.0	
	and						
	Cosmo 1290 USSR 1981-74D C-1 Plesetsk	Total weight: 40 kg? Objective: Communications Description: Spheroid?	1462	1440	114.9	74.0	

	and						
	Cosmo 1291 USSR 1981-74E C-1 Plesetsk	Total weight: 40 kg? Objective: Communications Description: Spheroid?	1462	1456	115.1	74.0	
	and						
	Cosmo 1292 USSR 1981-74F C-1 Plesetsk	Total weight: 40 kg? Objective: Communications Description: Spheroid?	1475	1461	115.3	74.0	
	and						
	Cosmo 1293 USSR 1981-74G C-1 Plesetsk	Total weight: 40 kg? Objective: Communications Description: Spheroid?	1462	1408	114.6	74.0	
	and						
	Cosmo 1294 USSR 1981-74H C-1 Plesetsk	Total weight: 40 kg? Objective: Communications Description: Spheroid?	1462	1391	114.4	74.0	
Aug. 7	*Intercosmos Bulgaria* USSR 1981-75A A-1 Plesetsk	Total weight: Unavailable Objective: Study physical processes in ionosphere and magnetosphere using UV and proton spectrometer and laser reflector Description: Unavailable	889	792	101.7	81.2	Second launch under Bulgaria 1300 program (see 1981-65A, *Meteor Priroda*)
Aug. 10	*Himawari 2* Japan 1981-76A N-2 Tanegashima	Total weight: 340 kg Objective: Develop metesat technology and improve domestic weather service Description: Spin-stabilized cylinder 4.4m long, 2.1 dia carrying despin antennas and meteorological sensors	35 791	35 788	1436.3	1.0	Japanese metesat on station at 140°E

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
Aug. 12	*Cosmos 1295* USSR 1981-77A C-1 Plesetsk	Total weight: 700 kg? Objective: "Continuation of outer space investigations" Description: Cylinder about 2m in dia and length, enclosed in drumlike solar array	1011	944	104.7	82.9	Probable navsat to replace 1980-39A (*Cosmos 1181*)
Aug. 13	*Cosmos 1296* USSR 1981-78A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	353	171	89.8	67.1	Probable military photo reconnaissance satellite; reentered Sept. 13
Aug. 18	*Cosmos 1297* USSR 1981-79A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	247	223	89.3	72.8	Probable military photo reconnaissance satellite; reentered Aug. 30
Aug. 21	*Cosmos 1298* USSR 1981-80A A-2 Baykonur-Tyuratam	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	330	172	89.6	65.0	Probable military photo reconnaissance satellite; reentered Oct. 2
Aug. 24	*Cosmos 1299* USSR 1981-81A F-1 Baykonur-Tyuratam	Total weight: Unavailable Objective: "Continuation of outer space Description: Unavailable	971	919	104.0	65.1	Probable radar ocean surveillance satellite powered by nuclear reactor; mission terminated Sept. 5 after boosting reactor to higher orbit

	Cosmo 1300 USSR 1981-82A F-1 Plesetsk	Total weight: Unavailable Objective: Undisclosed Description: Unavailable	651	625	97.5	82.5	Possible electronic ferret; orbit resembled those of 1979-11A (*Cosmos 1076*) and 1980-5A (*Cosmos 1151*), both ocean survey satellites
Aug. 27	*Cosmo 1301* USSR 1981-83A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	271	213	89.4	82.3	Probable military photo reconnaissance satellite; reentered Sept. 10
Aug. 28	*Cosmo 1302* USSR 1981-84A C-1 Plesetsk	Total weight: Unavailable Objective: Undisclosed Description: Unavailable	804	777	100.7	74.0	Possible military comsat to replace or backup 1981-41A (*Cosmos 1269*)
Sept. 3	DOD satellite U.S. 1981-85A Titan 3D WSMC	Total weight: 13 000 kg Objective: Military photo reconnaissance, including real-time transmission of TV images Description: Cylinder 15m long, 3m dia, with antennas and solar panels	525	242	92.3	97.0	Replaced 1978-60A which reentered Aug. 23, 1981
Sept. 4	*Cosmos 1303* USSR 1981-86A A-2 Baykonur-Tyuratam	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	415	360	92.3	70.4	Probable military photo reconnaissance satellite; reentered Sept. 18
	Cosmos 1304 USSR 1981-87A C-1 Plesetsk	Total weight: Unavailable Objective: Undisclosed Description: Unavailable	975	905	103.9	82.9	Possible navsat; orbit lower than normal for this application (see 1981-77A, *Cosmos 1295*)
Sept. 11	*Cosmos 1305* USSR 1981-88A A-2-e Plesetsk	Total weight: 2000 kg? Objective: Replacement or backup for 1978-48A (*Molniya 3-12*). Failed Description: Unavailable	13 670	815	263.7	63.0	Premature shutdown of "e" stage resulted in orbit too low for spacecraft to do the intended comsat job. See 1981-105A

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
Sept. 14	*Cosmos 1306* USSR 1981-89A F Baykonur-Tyuratam	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	442	430	93.3	65.0	Probable ocean survey satellite working with 1981-72A (*Cosmos 1286*) and replacing *Cosmos 1260* (1981-28A); orbit initially incorrect, probably because of launch vehicle malfunction, but maneuvers corrected it within 8 days; reentered July 16, 1982
Sept. 15	*Cosmos 1307* USSR 1981-90A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	417	354	92.3	72.9	Probable military photo reconnaissance satellite; reentered Sept. 28
Sept. 18	*Cosmos 1308* USSR 1981-91A C-1 Plesetsk	Total weight: 700 kg? Objective: Navigation? Description: Cylinder 2m long, 2m dia enclosed in drumlike solar array	1001	962	104.7	82.9	Navsat replacing or backing up 1981-53A (*Cosmos 1275*) launched June 4
	Cosmos 1309 USSR 1981-92A A-2 Plesetsk	Total weight: 5500 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	256	211	89.2	82.3	Probable military photo reconnaissance satellite; reentered Oct. 1
Sept. 19	*China 9, 10, 11* PRC 1981-93A, B, C (No data on vehicle) Shuang-Cheng-Tse	Total weight: Unavailable (3 payloads) Objective: Space physics experiments Description: Octahedral prism (b) 1m high, 1.2m dia with 4 rectangular solar panels at one end; second satellite (C), a cone; third, a balloon (A) linked by a wire to a metal ball (reentered Sept. 26). Cone reentered Nov. 22, 1981. Prism reentered Oct. 6, 1982	1600	390	103.3	59.4	Research areas included magnetic fields, IR and UV radiation, charged-particle measurements, X-ray detection, and atmospheric density (the function of the balloon)

Sept. 21	*Aureole (Oreol) 3* USSR 1981-94A F Plesetsk	Total weight: 1000 kg (170 kg of experiments) Objective: Ionospheric and magnetospheric research using Soviet- and French-built instruments Description: "Standard Soviet automatic unified orbital station (AUOS)"—cylinder 2.5m long, 1m dia, with 8 solar panels	1912	401	108.5	82.5	Onboard sensors included photometers, a magnetometer, spectrometers, an interferometer, and an electric-field instrument. French Arcad-3 would collect magnetospheric data at high latitudes over 6 mo lifetime
Sept. 23	*Cosmos 1310* USSR 1981-95A C-1 Plesetsk	Total weight: 1000 kg? Objective: Undisclosed Description: Unavailable	449	413	93.2	65.8	Probable military test vehicle
Sept. 24	*SBS 2* U.S. 1981-96A Delta ESMC	Total weight: 550 kg (in orbit) Objective: Provide commercial communications through Satellite Business Systems network Description: Cylinder 2.8m long, 2.2 dia, covered in solar cells with extendable solar panel deployed after launch; spin-stabilized; despun aerial array	35 791	35 785	1436.2	0.0	*SBS 2*, first to use commercially the 12 to 14 GHz band, carried 10 transponders capable of relaying 480 million data bits/sec. Built by Hughes Aircraft; carried telephone, computer, electronic-mail, video links for business and industrial clients; stationed at 97°W
Sept. 28	*Cosmos 1311* USSR 1981-97A C-1 Plesetsk	Total weight: Unavailable Objective: Undisclosed (probably military) Description: Unavailable	557	465	94.5	83.0	Reentered Aug. 28, 1983
Sept. 30	*Cosmos 1312* USSR 1981-98A F (?) Plesetsk	Total weight: Unavailable Objective: Undisclosed Description: Unavailable	1501	1488	115.9	82.6	Probable geodetic satellite
Oct. 1	*Cosmos 1313* USSR 1981-99A A-2 Baykonur-Tyuratam	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	279	231	89.6	70.4	Probable military photo reconnaissance satellite; reentered Oct. 15

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
Oct. 6	*Solar Mesophere Explorer* U.S. 1981-100A Delta WSMC	Total weight: 437 kg Objective: Study earth atmosphere at altitudes between 20–80 km, esp. ozone formation and density Description: Cylinder 1.7m long, 1.25 dia, carrying 2.2m dia solar array disk on one face; spin-stabilized to allow onboard instruments to scan atmosphere 5 times/sec	510 Sun-synchronous orbit	506	94.8	97.6	Carried piggyback satellite, UOSAT
	and						
	UOSAT U.K. 1981-100B Delta WSMC	Total weight: 50 kg Objective: Stimulate interest in space science among students; serve as tool for radio amateurs to study ionosphere Description: Rectangular box 1m long, 0.5m square, carrying solar cells on larger faces	484	479	94.3	97.6	Built by Univ. of Surrey; onboard instruments included slow-scan TV camera with 500 km² view of earth; amateur-radio band transmitted telemetry on 145.8 MHz, either as coded data or using a voice synthesizer
Oct. 9	*Cosmos 1314* USSR 1981-101A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	235	212	89.0	82.3	Probable military photo reconnaissance satellite; reentered Oct. 22
	Raduga 10 USSR 1981-102A D-1-E Baykonur-Tyuratam	Total weight: 2000 kg? Objective: Provide 24 hr radio and telegraph links in UHF band; relay TV to stations in Orbita network Description: Cylinder carrying 2 solar panels; aerial array at one end	35 795	35 779	1436.1	2.4	Comsat on station at Statsionar 3 location, 84°E
Oct. 13	*Cosmos 1315* USSR 1981-103A A-1 Plesetsk	Total weight: 2000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	650	614	97.4	81.2	Probable electronic reconnaissance satellite; backup or replacement for 1980-8A (*Cosmos 1154*)

Oct. 15	*Cosmos 1316* USSR 1981-104A A-2 Baykonur-Tyuratam	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	278	232	89.7	70.3	Probable military photo reconnaissance satellite; reentered Oct. 29
Oct. 17	*Molniya 3-17* USSR 1981-105A A-2-e Plesetsk	Total weight: 2000 kg? Objective: Provide telegraph and long-distance telephone service; transmit Central TV programs to Orbita stations both inside and outside USSR Description: Cylinder 4m long, 1.6m dia housing instruments and topped with a conical motor section; powered by "windmill" of 6 solar panels	38 753	1600	717.8	64.4	Comsat, to replace or backup 1979-48A (*Molniya 3-12*); previous attempt on this mission failed (see 1981-88A, *Cosmos 1305*)
Oct. 30	*Venera 13* USSR 1981-106A D-1-E Baykonur-Tyuratam	Total weight: 5000 kg? Objective: Continue Venus exploration program, probably with a surface lander Description: Cylinder 2.7m long, 2.3 dia carrying 2 solar panels; experiments pkg at one end	Heliocentric orbit				*Venera 13* scheduled to arrive near Venus about March 1, 1982
Oct. 31	DOD satellite U.S. 1981-107A Titan 3C ESMC	Total weight: Unavailable Objective: Early warning satellite for missile launches Description: Unavailable	Elements not available				
	Cosmos 1317 USSR 1981-108A A-2-e Plesetsk	Total weight: Unavailable Objective: Undisclosed Description: Unavailable	38 581	1849	719.3	62.9	Probable part of early warning satellite system
Nov. 3	*Cosmos 1318* USSR 1981-109A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	352	171	89.8	67.1	Probable military photo reconnaissance satellite; reentered Dec. 4

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
Nov. 4	*Venera 14* USSR 1981-110A D-1-E Baykonur-Tyuratam	Total weight: 5000 kg? Objective: Continue Venus exploration program (see 1981-106A, *Venera 13*) Description: See *Venera 13*)	Heliocentric orbit				*Venera 14* scheduled to arrive near Venus about March 5, 1982. Both Venera spacecraft carried French- and Austrian-design apparatus as well as Soviet
Nov. 12	*STS 2* U.S. 1981-111A Columbia KSC	Total weight: Undisclosed (2452 kg of expts) Objective: Second flight in STS orbital-test program; test remote manipulator; evaluate craft as earth-observation platform Description: Reusable Shuttle craft with fixed experiment packages in payload bay	265	255	89.6	38.0	Crew (USAF Col. Joe H. Engle as commander, Navy Cdr. Richard H. Truly as pilot) performed 5 experiments from OSTA-1 (Spacelab type pallet built by ESA), plus 2 in crew compartment. Problem with one of 3 onboard fuel cells shortened 5-day mission to 2 da, 6 hr, 13 min. Recovered Nov. 14
Nov. 13	*Cosmos 1319* USSR 1981-112A A-2 Baykonur-Tyuratam	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	415	349	92.2	70.4	Probable military photo reconnaissance satellite; reentered Nov. 27
Nov. 17	*Molniya 1-51* USSR 1981-113A A-2-e Plesetsk	Total weight: 1800 kg? Objective: Provide telegraph and long-distance links and broadcast Central TV programs through Orbita system to remote areas of USSR Description: Cylinder 3.4m long, 1.6 dia, housing instruments and payload, carrying windmill of 6 solar panels	39 892	459	717.1	63.4	Comsat to replace *Molniya 1-39* (launched 1978)
Nov. 20	*RCA Satcom 3R* U.S. 1981-114A Delta ESMC	Total weight: 550 kg Objective: Distribute programs to cable TV systems in U.S. Description: Box 1.6×1.3×1.3m carying relay pkg and two 8.4m² solar	35 794	35 779	1436.1	0.1	Commercial comsat on station 132°W

	Bhaskara 2 India 1981-115A C-1 Kapustin Yar	Total weight: 436 kg Objective: Earth observation, using 2 TV cameras, 3 microwave radiometers; solar-cell experiments plus study of thermal coating Description: Polyhedron, 26 faces, 1.6m high, 1.7 dia	521	499	94.8	50.6	Designed and built by India Space Research Org.; launched by USSR
Nov. 28	*Cosmos 1320* USSR 1981-116A C-1 Plesetsk	Total weight: 40 kg? Objective: Communications Descriptions: Spheroid?	1632	1479	117.2	74.0	Multiple launch (8 satellites) to provide tactical comlinks between field units; last previous launch, 1981-74A-H
	and						
	Cosmos 1321 USSR 1981-116B C-1 Plesetsk	Total weight: 40 kg? Objective: Communications Description: Spheroid?	1629	1480	117.2	74.0	
	and						
	Cosmos 1322 USSR 1981-116C C-1 Plesetsk	Total weight: 40 kg? Objective: Communications Description: Spheroid?	1627	1479	117.2	74.0	
	and						
	Cosmos 1323 USSR 1981-116D C-1 Plesetsk	Total weight: 40 kg? Objective: Communications Description: Spheroid?	1622	1480	117.1	74.0	
	and						
	Cosmos 1324 USSR 1981-116E C-1 Plesetsk	Total weight: 40 kg? Objective: Communications Description: Spheroid?	1617	1480	117.1	74.0	

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
	and						
	Cosmos 1325 USSR 1981-116F C-1 Plesetsk	Total weight: 40 kg? Objective: Communications Description: Spheroid?	1614	1480 •	117.0	74.0	
	and						
	Cosmos 1326 USSR 1981-116G C-1 Plesetsk	Total weight: 40 kg? Objective: Communications Description: Spheroid?	1609	1479	117.0	74.0	
	and						
	Cosmos 1327 USSR 1981-116H C-1 Plesetsk	Total weight: 40 kg? Objective: Communications Description: Spheroid?	1601	1480	116.9	74.0	
Dec. 3	*Cosmos 1328* USSR 1981-117A F Plesetsk	Total weight: Unavailable Objective: "Continuation of outer space investigations" Description: Unavailable	653	626	97.5	82.5	Probable military photo reconnaissance satellite
Dec. 4	*Cosmos 1329* USSR 1981-118A A-2 Baykonur-Tyuratam	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	288	231	89.7	65.0	Probable military photo reconnaissance satellite; reentered Dec. 18

Dec. 15	*Intelsat 5 F-3* U.S. 1981-119A Atlas Centaur ESMC	Total weight: 1870 kg (incl. fuel) Objective: Provide 12 000 two-way telephone channels and 2 color TV channels using 4 to 6 GHz for wide-area coverage and 11 to 12 GHz for narrow-base coverage Description: Box carrying earth-pointed antenna array, 3-axis-stabilized in geostationary orbit	35 801	35 772	1436.1	0.0	INTELSAT-owned commercial comsat launched by NASA, on station at 15°E; designed for Shuttle, Ariane, or Atlas Centaur (this launch the last scheduled for the latter). INTELSAT's 200 ground stations worldwide would carry 60% of trans-Atlantic and -Pacific communications
Dec. 17	*Radio 3* USSR 1981-120A C-1 Plesetsk	Total weight: 40 kg? Objective: Communications Descriptions: Unavailable	1655	1563	118.4	83.0	Multiple launch (6 satellites) to provide radio amateurs with space-borne links, rebroadcasting in the 29 MHz amateur band a signal transmitted 145 MHz; *Radio 5* and *7* could transmit telemetry data on demand
	and						
	Radio 4 USSR 1981-120D C-1 Plesetsk	Total weight: 40 kg? Objective: Communications Description: Unavailable	1663	1633	119.3	83.0	
	and						
	Radio 5 USSR 1981-120C C-1 Plesetsk	Total weight: 40 kg? Objective: Communications Description: Unavailable	1664	1646	119.4	83.0	
	and						
	Radio 6 USSR 1981-120F C-1 Plesetsk	Total weight: 40 kg? Objective: Communications Description: Unavailable	1657	1578	118.6	83.0	
	and						
	Radio 7 USSR 1981-120E C-1 Plesetsk	Total weight: 40 kg? Objective: Communications Description: Unavailable	1657	1621	119.1	83.0	

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
	and						
	Radio 8 USSR 1981-120B C-1 Plesetsk	Total weight: 40 kg? Objective: Communications Description: Unavailable	1681	1648	119.6	83.0	
Dec. 19	*Cosmos 1330* USSR 1981-121A A-2 Baykonur-Tyuratam	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	379	167	90.0	70.4	Probable military photo reconnaissance satellite; reentered Jan. 19, 1982. First long-life recoverable satellite launched at Tyuratam to fly at other than 65.0° inclination
Dec. 20	*Marecs 1* ESA 1981-122A Ariane Kourou	Total weight: 1006 kg (at launch) Objective: Provide high-quality voice and data transmission between ships and shore stations; last Ariane-booster test Description: Hexagonal prism 2.5m high, 2m across, with 2 solar panels	38 805	35 771	1436.1	0.9	Stabilized in position at 26°W on Jan. 2, 1982; serving as Atlantic comlink in global network operated by Intl. Maritime Satellite Org., successor to MARISAT as of Feb. 82. Ariane carried 3 other payloads: a 4th Ariane technology capsule (CAT), a vibration isolator device (VID), and a Paris youth club experiment (Thesee) to measure ionosphere plasma density.
Dec. 23	*Molniya 1-52* USSR 1981-123A A-2-e Baykonur-Tyuratam	Total weight: 1800 kg? Objective: Provide telegraph and long-distance telephone lines, and broadcast Central TV programs to remote areas of USSR Description: Cylinder 3.4m long, 1.6m dia. topped by conical motor and carrying a windmill of 6 solar panels	38 430	1923	717.8	63.2	First Molniya launched from Tyuratam since *Molniya 1-37* (June 1977)

SATELLITES, SPACE PROBES, AND MANNED SPACE FLIGHTS, ***1982***

SATELLITES, SPACE PROBES, AND MANNED SPACE FLIGHTS, 1982

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle, Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
Jan. 7	*Cosmos 1331* USSR 1982-1A C-1 Plesetsk	Total weight: 700 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	810	773	100.7	74.1	Probable military comsat
Jan. 12	*Cosmos 1332* USSR 1982-2A A-2 Plesetsk	Total weight: 5500 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	248	210	89.1	82.3	Probable military photo reconnaissance satellite; reentered Jan. 25
Jan. 14	*Cosmos 1333* USSR 1982-3A C-1 Plesetsk	Total weight: 700 kg? Objective: "Continuation of outer space investigations" Description: Cylinder 2m in length and dia enclosed in cylindrical solar array	1013	965	104.9	82.9	Probable navsat to replace or back up *Cosmos 1150* (1980-3A)
Jan. 16	*RCA Satcom 4* U.S. 1982-4A Delta ESMC	Total weight: 1082 (incl. apogee motor) Objective: Provide U.S. with commercial services; support cable TV on 24 channels Description: Box 1.6×1.3×1.3m containing communications-relay package; 3-axis-stabilized	35 795	35 781	1436.2	0.0	Commercial comsat launched by NASA for RCA; on station at 83°W by Jan. 28
Jan. 20	*Cosmos 1334* USSR 1982-5A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	289	226	89.4	72.9	Probable military photo reconnaissance satellite; reentered Feb. 3
Jan. 21	*Ops 2849* U.S. 1982-6A Titan 3B Vandenberg AFB	Total weight: Unavailable Objective: Undisclosed Description: Unavailable	641	630	97.4	97.2	Military reconnaissance satellite; reentered May 23

Jan. 29	*Cosmos 1335* USSR 1981-7A C-1 Plesetsk	Total weight: Unavailable Objective: Undisclosed Description: Unavailable	402	385	92.4	74.0	Probable military radar calibration satellite
Jan. 30	*Cosmos 1336* USSR 1982-8A A-2 Baykonur-Tyuratam	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	356	169	89.8	70.3	Probable military photo reconnaissance satellite; reentered Feb. 26
Feb. 5	*Ekran 8* USSR 1982-9A D-1-E Baykonur-Tyuratam	Total weight: 2000 kg? Objective: Transmit Central TV programs to collective receivers in remote areas of USSR Description: Cylinder 5m long, 2m dia, carrying boom-mounted solar panels and transmitting-antenna array	36 783	34 796	1440.9	1.9	Comsat in geostationary orbit at Statsionar T location, 99°E
Feb. 11	*Cosmos 1337* USSR 1982-10A F-1 Baykonur-Tyuratam	Total weight: Unavailable Objective: "Continuation of outer space investigations" Description: Unavailable	446	428	93.3	65.0	Probable ocean survey satellite working with 1981-22A (*Cosmos 1286*) and 1981-89A (*Cosmos 1306*); reentered July 25
Feb. 16	*Cosmos 1338* USSR 1982-11A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	414	357	92.3	72.9	Probable military photo reconnaissance satellite; reentered March 2
Feb. 17	*Cosmos 1339* USSR 1982-12A C-1 Plesetsk	Total weight: 700 kg? Objective: "Continuation of outer space investigations" Description: Cylinder 2m in length and dia	1012	950	104.7	82.9	

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
Feb. 19	*Cosmos 1340* USSR 1982-13A A-1 Plesetsk	Total weight: 2000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	640	620	97.3	81.2	Probable electronic ferret
Feb. 26	*Westar 4* U.S. 1982-14A Delta ESMC	Total weight: 585 kg Objective: Providing commercial communications over 24 transponder channels for Western Union Telegraph Co. Description: Cylinder 2.2 dia, 2.7 high, covered with solar cells; cylindrical solar panel deployed after launch; spin-stabilized, with despun antenna array	35 794	35 779	1436.1	0.0	Hughes Aircraft Co.-built comsat, initially on station at 79°W for systems checks; to be located at 99°W when operating; replacement for *Westar 1*
	Molniya 1-53 USSR 1982-15A A-2-e Plesetsk	Total weight: 1800 kg? Objective: Provide telegraph and long-distance telephone communications; transmit Central TV programs to Orbita network stations in remote areas of USSR Description: Cylinder 3.6m long, 1.6 dia, with conical motor section, carrying windmill of six solar panels	39 985	1364	717.7	63.8	Comsat to replace or back up 1980-53A (*Molniya 1-47*)
March 3	*Cosmos 1341* USSR 1982-16A A-2-e Plesetsk	Total weight: 2000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	38 277	2085	718.0	64.6	Probably part of early warning system, replacing or backing up 1981-16A (*Cosmos 1247*)
March 5	*Intelsat 5 F-4* U.S. 1982-17A Atlas Centaur ESMC	Total weight: 1870 kg (at launch)? Objective: Provide telephone and TV communications for INTELSAT customers Description: Box with 16m-wide solar array, spin-stabilized	35 800	35 774	1436.1	0.0	Positioned at 63°E in May 1982; to serve Indian Ocean region

	Cosmos 1342 USSR 1982-18A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	288	227	89.7	72.9	Probable military photo reconnaissance satellite; reentered March 19
March 6	DOD satellite U.S. 1982-19A Atlas Centaur ESMC	Total weight: Unavailable Objective: Undisclosed Description: Unavailable	Elements not available				Early warning satellite for missile launches
March 15	*Horizont 5* USSR 1982-20A D-1-E Baykonur-Tyuratam	Total weight: 2000 kg? Objective: Provide telephone, telegraph, and TV comlinks both inside and outside USSR Description: Cylinder 5m long, 2 dia, carrying a pair of solar panels; array of horn and reflector antennas at one end	35 790	35 778	1436.3	1.9	Relay comsat in geostationary orbit at Statsionar 5 position, 54°E
March 17	*Cosmos 1343* USSR 1982-21A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	328	222	90.0	72.8	Probable military photo reconnaissance satellite; reentered March 31
March 22	*STS 3* U.S. 1982-22A Columbia KSC	Total weight: 2,031,619 kg (incl. 9659 cargo) Objective: Third flight in STS orbital-test program; test remote manipulator, measure orbiter's thermal response to long periods of constant attitude with respect to the sun Description: Reusable Shuttle craft carrying OSS experiment package in payload bay and in crew compartment	255	244	89.4	38.0	Crew (astronauts USMC Col. Jack R. Lousma, commander, and USAF Col. Charles Gordon Fullerton, pilot) landed the Columbia at White Sands, N.M., instead of Edwards AFB because heavy rains had softened the planned lakebed landing area. Flight time, 8da 4h 49min
March 24	*Molniya 3-18* USSR 1982-23A A-2-e Plesetsk	Total weight: 2000 kg? Objective: Provide telegraphic and long-distance telephone comlinks, and broadcast Central TV programs to Orbita network stations inside and outside USSR Description: Cylinder 4m long, 1.6 dia, topped by conical motor; carrying windmill of six solar panels	39 734	614	717.7	64.7	Comsat to replace or back up 1981-30A (*Molniya 3-15*)

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
	Cosmos 1344 USSR 1982-24A C-1 Plesetsk	Total weight: 700 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	1008	965	104.8	82.9	Probable navsat to replace or back up 1981-13A (*Cosmos 1224*)
March 25	*Meteor 2-8* USSR 1982-25A F? Plesetsk	Total weight: 2200 kg? Objective: Weather and earth-resources research; return cloudcover and other meteorological data through scanning radiometers etc Description: Cylinder 5m long, 1.5 dia, carrying 2 sun-seeking solar panels	958	936	104.0	82.5	Usually an A-1 launch; this orbit slightly higher than previous Meteor 2 craft (usually about 900km)
March 31	*Cosmos 1345* USSR 1982-26A C-1 Plesetsk	Total weight: Unavailable Objective: Undisclosed Description: Unavailable	501	468	94.3	74.0	Probable military satellite for radar calibration
	Cosmos 1346 USSR 1982-27A A-1 Plesetsk	Total weight: 2000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	652	613	97.4	81.2	Probable electronic ferret; back up or replacement for 1980-93A (*Cosmos 1222*)
April 2	*Cosmos 1347* USSR 1982-28A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	340	172	89.7	70.4	Probable military photo reconnaissance satellite; reentered May 21
April 7	*Cosmos 1348* USSR 1982-29A A-2-e Plesetsk	Total weight: Unavailable Objective: "Continuation of outer space investigations" Description: Unavailable	39 082	1325	718.9	62.8	Probable part of early warning system, replacing or backing up 1980-28A (*Cosmos 1172*).

April 8	*Cosmos 1349* USSR 1982-30A C-1 Plesetsk	Total weight: 700 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	1011	962	104.8	82.9	Probable navsat to replace or back up 1980-7A (*Cosmos 1153*)
April 10	*Insat 1A* India 1982-31A Delta ESMC	Total weight: 1152 (incl. fuel) Objective: Provide channels for uplink and downlink communications and for direct TV transmission to small ground stations; for radio-program distribution; and for disaster warning Description: Box 1.6m×1.4×2.2 carrying a solar panel balanced by a solar sail	35 936	35 562	1434.2	0.1	First of two Indian National Satellites built by Ford Aerospace for govt. of India; launched by NASA into geostationary orbit; at 74°E
April 15	*Cosmos 1350* USSR 1982-32A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	357	171	89.8	67.2	Probable military photo reconnaissance satellite; reentered May 16
April 19	*Salyut 7** USSR 1982-33A D-1 Baykonur-Tyuratam	Total weight: 19T Objective: Serve as manned orbiting space laboratory Description: Cylinder 15m long, 4 dia, with 3 large solar panels; docking unit at each end	369	365	91.9	51.6	Maneuvered into 340km orbit for manned occupation (*Salyut 6*'s operating altitude)
April 21	*Cosmos 1351* USSR 1982-34A C-1 Kapustin Yar	Total weight: 550 kg? Objective: Undisclosed Description: Unavailable	547	348	93.5	50.7	Reentered March 14, 1983
	Cosmos 1352 USSR 1982-35A A-2 Baykonur-Tyuratam	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	349	415	92.2	70.4	Probable military photo reconnaissance satellite; reentered May 5
April 23	*Cosmos 1353* USSR 1982-36A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	241	211	89.1	82.4	Probable military photo reconnaissance satellite; reentered May 6

*See May 17, Nov. 18

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
April 28	*Cosmos 1354* USSR 1982-37A C-1 Plesetsk	Total weight: Unavailable Objective: Undisclosed Description: Unavailable	804	789	100.8	74.0	Probable military comsat using store-and-dump technique
April 29	*Cosmos 1355* USSR 1982-38A F-1 Baykonur-Tyuratam	Total weight: Unavailable Objective: Undisclosed Description: Unavailable	446	428	93.3	65.1	Probable ocean surveillance satellite; reentered March 7, 1984
May 5	*Cosmos 1356* USSR 1982-39A A-1 Plesetsk	Total weight: 2500 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	660	626	97.6	81.2	Probable electronic ferret
May 6	*Cosmos 1357* USSR 1982-40A C-1 Plesetsk	Total weight: 40 kg? Objective: Communications Description: Spheroid?	1476	1399	114.6	74.0	Multiple launch (8 satellites) probably for tactical military communications
	and						
	Cosmos 1358 USSR 1982-40B C-1 Plesetsk	Total weight: 40 kg? Objective: Communications Description: Spheroid?	1479	1414	114.8	74.0	

and					
Cosmos 1359 USSR 1982-40C C-1 Plesetsk	Total weight: 40 kg? Objective: Communications Description: Spheroid?	1478	1431	115.0	74.0
and					
Cosmos 1360 USSR 1982-40D C-1 Plesetsk	Total weight: 40 kg? Objective: Communications Description: Spheroid?	1480	1444	115.2	74.0
and					
Cosmos 1361 USSR 1982-40E C-1 Plesetsk	Total weight: 40 kg? Objective: Communications Description: Spheroid?	1482	1459	115.3	74.0
and					
Cosmos 1362 USSR 1982-40F C-1 Plesetsk	Total weight: 40 kg? Objective: Communications Description: Spheroid?	1494	1464	115.5	74.0
and					
Cosmos 1363 USSR 1982-40G C-1 Plesetsk	Total weight: 40 kg? Objective: Communications Description: Spheroid?	1503	1471	115.7	74.0
and					
Cosmos 1364 USSR 1982-40H C-1 Plesetsk	Total weight: 40 kg? Objective: Communications Description: Spheroid?	1522	1471	115.9	74.0

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
May 11	DOD satellite U.S. 1982-41A Titan 3D WSMC	Total weight: 13 000 kg? Objective: Military photo reconnaissance Description: Cylinder 15m long, 3 dia, carrying antennas and solar panels, and containing reentry capsules for film recovery	262	177	90.0	96.4	Reentered Dec. 5
	and						
	DOD satellite U.S. 198-41C Titan 3D WSMC	Total weight: Unavailable Objective: Undisclosed Description: Unavailable	707	701	98.9	96.0	Piggyback payload launched with 1982-41A; probable electronic ferret
May 13	*Soyuz T-5* USSR 1982-42A A-2 Baykonur-Tyuratam	Total weight: 6500 kg? Objective: Carry crew to orbiting space station *Salyut 7* (1982-33A) Description: Near-spherical module 7.5m long, 2.2 dia; conical reentry module; cylindrical instrument unit	356	343	91.4	51.6	Crew (Anatoly Berezovoi and Valentin Lebedev) docked with *Salyut 7* May 14
May 14	*Cosmos 1365* USSR 1982-43A F-1 Baykonur-Tyuratam	Total weight: Unavailable Objective: Undisclosed Description: Unavailable	984	878	103.7	65.1	Probable military photo reconnaisance satellite using radar powered by a nuclear reactor
May 17	*Iskra 2** USSR 1982-33C *Salyut 7* (in orbit)	Total weight: 28 kg? Objective: Amateur-radio delay Description: Spheroid 0.5 dia, covered with solar cells	342	336	91.3	51.6	Launched from an airlock on orbiting *Salyut 7** (see April 19, 1982-33A); reentered July 9

	Cosmos 1366 USSR 1982-44A D-1-E Baykonur-Tyuratam	Total weight: 2000 kg? Objective: Experimental comsat, forerunner of planned new series Description: Unavailable	35 818	35 754	1436.1	1.6	Comsat on station at 90°E
May 20	*Cosmos 1367* USSR 1982-45A A-2-e Plesetsk	Total weight: Unavailable Objective: Undisclosed Description: Unavailable	39 210	1195	18.8	63.4	Probably part of an early warning satellite system
May 21	*Cosmos 1368* USSR 1982-46A A-2 Baykonur-Tyuratam	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	341	211	90.0	70.4	Probable military photo reconnaissance satellite; reentered June 3
May 23	*Progress 13* USSR 1982-47A A-2 Baykonur-Tyuratam	Total weight: 7000 kg? Objective: Carry supplies to crew in orbiting *Salyut 7* and equipment for upcoming Soyuz T6 mission experiments Description: Unavailable	278 (initial orbit)	191	88.9	51.6	Docked with rear part of *Salyut 7* on May 25; undocked June 4; reentered June 6 after retrofiring
May 25	*Cosmos 1369* USSR 1982-48A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	276	269	90.0	82.3	Probable photo reconnaissance satellite, carrying earth resources package; recovered June 8
May 28	*Cosmos 1370* USSR 1982-49A A-2 Baykonur-Tyuratam	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	275	197	89.2	64.9	Probable military photo reconnaissance satellite; reentered July 11
	Molniya 1-54 USSR 1982-50A A-2-e Plesetsk	Total weight: 1800 kg? Objective: Provide telegraph and long-distance telephone communications and broadcast Central TV programs to Orbita receivers in remote areas of USSR Description: Cylinder 3.6m long, 1.6 dia topped by conical motor, carrying windmill arrangement of 6 solar panels	39 872	476	717.7	64.3	Comsat

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
June 1	*Cosmos 1371* USSR 1982-51A C-1 Plesetsk	Total weight: 700 kg? Objective: Undisclosed Description: Unavailable	808	787	100.8	74.0	Probable military comsat using data store-and-dump technique
June 2	*Cosmos 1372* USSR 1982-52A F-1 Baykonur-Tyuratam	Total weight: Unavailable Objective: Undisclosed Description: Unavailable	976	909	103.9	64.9	Probable military reconnaissance satellite using radar powered by a nuclear reactor
	Cosmos 1373 USSR 1982-53A A-2 Baykonur-Tyuratam	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	347	210	90.1	70.4	Probable military photo reconnaissance satellite; reentered June 16
June 3	*Cosmos 1374* USSR 1982-54A C-1 Kapustin Yar	Total weight: 1000 kg? Objective: Reentry test Description: Unavailable	225	225		50.7	Recovered over (or in) water at the end of one orbit
June 6	*Cosmos 1375* USSR 1982-55A C-1 Plesetsk	Total weight: Unavailable Objective: Serve as target for satellite-interceptor test Description: Unavailable	1009	979	105.0	65.8	
June 8	*Cosmos 1376* USSR 1982-56A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	274	261	89.9	82.3	Probable photo reconnaissance satellite, carrying earth resources package; reentered June 22

	Cosmos 1377 USSR 1982-57A A-2 Baykonur-Tyuratam	Total weight: 6000 kg? Objective: "Continuation of outer space investigations". Description: Unavailable	363	173	89.9	64.9	Probable military photo reconnaissance satellite; reentered July 22
June 9	*Westar 5* U.S. 1982-58A Delta ESMC	Total weight: 1100 kg? Objective: U.S. commercial domestic comsat Description: Cylinder 3m long, 2m dia	35 796	35 783	1436.3	0.0	Launched by NASA for Western Union Telegraph Co., to replace *Westar 2* at 123°W when operational
June 10	*Cosmos 1378* USSR 1982-59A F Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	656	625	97.5	82.5	Probable electronic ferret
June 18	*Cosmos 1379* USSR 1982-60A F-1 Baykonur-Tyuratam	Total weight: Unavailable Objective: Test of satellite interceptor system, using *Cosmos 1375* (1982-55A) as target Description: Unavailable	1021	540	100.4	65.8	"De-oribited same day as launch"
	Cosmos 1380 USSR 1982-61A C-1 Plesetsk	Total weight: 700 kg? Objective: "Continuation of outer space investigations" Description: Cylinder 2×2m with domed ends, enclosed in drum-shape solar array	657 (intended orbit altitude, 1000 km)	146	92.6	82.9	Probable navsat; early shutdown of final rocket stage prevented successful operation; craft reentered because of air drag after 9 days (June 27)
	Cosmos 1381 USSR 1982-62A A-2 Baykonur-Tyuratam	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	450	372	92.7	70.4	Probable military photo reconnaissance satellite; reentered July 1

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
June 24	*Soyuz T-6* USSR 1982-63A A-2 Baykonur-Tyuratam	Total weight: 6500 kg? Objective: Ferry crew to join group aboard orbiting space station Description: Standard Soyuz T design	233	189	88.7	51.6	Visiting crew (Vladimir Dzhanibekov, Aleksandr Ivanchenkov, and France's Jean-Loup Chretien) docked with *Salyut 7* June 25, 14 min ahead of schedule because of a computer problem; returned in same spacecraft July 2
June 25	*Cosmos 1382* USSR 1982-64A A-2-e Plesetsk	Total weight: Unavailable Objective: Undisclosed Description: Unavailable	38 307	2091	718.7	62.8	Probable part of early warning system
June 27	*STS 4* U.S. 1982-65A Columbia KSC	Total weight: 2,033,437 kg Objective: Fourth flight in STS orbital-test program; completion of test program Description: Reusable shuttle craft	301	296	90.3	28.5	Crew (Ken Mattingly and Henry Hartsfield) landed July 4 at Edwards AFB, Calif. First DOD payload
June 29	*Cosmos 1383* USSR 1982-66A C 1 Plesetsk	Total weight: 700 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	1024	986	105.2	82.9	Probable test of SARSAT (search-and-rescue satellite) system to pinpoint transmissions from ships or planes in distress
June 30	*Cosmos 1384* USSR 1982-67A A-2 Baykonur-Tyuratam	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	354	170	89.8	67.2	Probable military photo reconnaissance satellite; reentered July 30
July 6	*Cosmos 1385* USSR 1982-68A F(?) Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	236	186	88.8	82.3	Probable photo reconnaissance satellite carrying earth resources instruments; reentered July 20

July 7	*Cosmos 1386* USSR 1982-69A C-1 Plesetsk	Total weight: 700 kg? Objective: "Continuation of outer space investigations" Description: See *Cosmos 1380* (1982-61A)	1006	949	104.7	83.0	Probable navsat
July 10	*Progress 14* USSR 1982-70A A-2 Baykonur-Tyuratam	Total weight: Unavailable Objective: Carry consumables and experiment material to crew of orbiting space station Description: Like Soyuz T vehicle except that reentry module is replaced by conical nonrecoverable container for supplies	326	300	90.7	51.6	Docked with rear port of *Salyut 7* on July 12; undocked Aug. 10; reentered Aug. 13 over Pacific
July 13	*Cosmos 1387* USSR 1982-71A F (?) Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	234	212	89.1	82.3	Probable photo reconnaissance satellite carrying earth resources package; reentered July 26
July 16	*Landsat 4* U.S. 1982-72A Delta Vandenberg AFB	Total weight: 2000 kg Objective: Earth-resources reconnaissance using a variety of scanners for different parts of the spectrum Description: Irregularly shape container 6m long, 2 dia, with 2 solar panels	700	699	98.8	98.2	Supplement and improve remote sensing data availability to civilian users relying on aging Landsat 3 sensing system
July 21	*Cosmos 1388* USSR 1982-73A C-1 Plesetsk	Total weight: 40 kg? Objective: Communications Description: Spheroid?	1473	1390	114.5	74.0	Multiple launch (8 satellites) probably for tactical military communications
	Cosmos 1389 USSR 1982-73B C-1 Plesetsk	Total weight: 40 kg? Objective: Communications Description: Spheroid?	1474	1407	114.7	74.0	
	and						
	Cosmos 1390 USSR 1982-73C C-1 Plesetsk	Total weight: 40 kg? Objective: Communications Description: Spheroid?	1473	1424	114.9	74.0	

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
	and						
	Cosmos 1391 USSR 1982-73D C-1 Plesetsk	Total weight: 40 kg? Objective: Communications Description: Spheroid?	1474	1440	115.0	74.0	
	and						
	Cosmos 1392 USSR 1982-73E C-1 Plesetsk	Total weight: 40 kg? Objective: Communications Description: Spheroid?	1473	1458	115.2	74.0	
	and						
	Cosmos 1393 USSR 1982-73F C-1 Plesetsk	Total weight: 40 kg? Objective: Communications Description: Spheroid?	1481	1468	115.4	74.0	
	and						
	Cosmos 1394 USSR 1982-73G C-1 Plesetsk	Total weight: 40 kg? Objective: Communications Description: Spheroid?	1493	1473	115.6	74.0	
	and						
	Cosmos 1395 USSR 1982-73H C-1 Plesetsk	Total weight: 40 kg? Objective: Communications Description: Spheroid?	1513	1472	115.8	74.0	

	Molniya 1-55 USSR 1982-74A A-2-e Plesetsk	Total weight: 1800 kg? Objective: Provide telegraph and long-distance telephone service, and broadcast Central TV programs through Orbita system to remote areas of USSR Description: Cylinder 4.2m long, 1.6 dia with conical motor section, carrying windmill of 6 solar panels	39 723	624	717.7	64.7	Comsat
July 27	*Cosmos 1396* USSR 1982-75A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	298	198	89.5	72.9	Probable military photo reconnaissance satellite; reentered Aug. 10
July 29	*Cosmos 1397* USSR 1982-76A C-1 Kapustin Yar	Total weight: Unavailable Objective: Undisclosed Description: Unavailable	541	343	93.4	50.7	Probable radar calibration mission, reentered May 18, 1983
Aug. 3	*Cosmos 1398* USSR 1982-77A F ? Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	234	216	89.0	82.4	Probable photo reconnaissance satellite, carrying earth-resources package; reentered Aug. 13
Aug. 4	*Cosmos 1399* USSR 1982-78A Baykonur-Tyuratam	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	345	170	89.7	64.9	Probable military photo reconnaissance satellite; reentered Sept. 16
Aug. 5	*Cosmos 1400* USSR 1982-79A A-1 Plesetsk	Total weight: 2000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	643	621	97.4	81.2	Probable electronic ferret
Aug. 19	*Soyuz T-7* USSR 1982-80A A-2 Baykonur-Tyuratam	Total weight: 6500 kg? Objective: Replacement ferry for resident crew of orbiting space station Description: Standard Soyut T design	299	289	90.3	51.6	Crew (Leonid Popov, Aleksandr Serebrov, and #2 female cosmonaut Svetlana Savitskaya) docked with *Salyut* 7 Aug. 20; returned to earth Aug. 27 in *Soyuz T-5* (1982-42A) that brought Berezovoi and Lebedev May 14

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
Aug. 20	*Cosmos 1401* USSR 1982-81A F (?) Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	274	261	89.9	82.3	Probable photo reconnaissance satellite, carrying earth resources package; reentered Sept. 3
Aug. 26	*Anik D-1* (Telesat G) Canada 1982-82A Delta/PAM ESMC	Total weight: 1200 kg Objective: Canadian domestic comsat Description: Cylinder 6.7m long, 2m dia	35 791	35 783	1436.1	0.0	Launched into geostationary orbit by NASA for Telesat Canada; first use of Delta with payload-assist module (PAM)
Aug. 27	*Molniya 3-19* USSR 1982-83A A-2-e Plesetsk	Total weight: 2000 kg? Objective: Provide telephone and telegraph communications, broadcast Central TV programs to Orbita stations inside and outside USSR Description: Cylinder 4m long, 1.6 dia, topped by conical motor section and carrying a windmill of 6 solar panels	38 870	1486	717.8	63.1	Comsat
Sept. 1	*Cosmos 1402* USSR 1982-84A F-1 Baykonur-Tyuratam	Total weight: Unavailable Objective: "Continuation of outer space investigations" Description: Unavailable	264	251	89.7	65.0	Probable military reconnaissance satellite using radar; reentered Jan. 23, 1983
	Cosmos 1403 USSR 1982-85A A-2 Baykonur-Tyuratam	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	416	354	92.3	70.4	Probable military photo reconnaissance satellite; reentered Sept. 15

	Cosmos 1404 USSR 1982-86A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	414	358	92.3	72.9	Probable military photo reconnaissance satellite; reentered Sept. 15
Sept. 3	*Kiku 4* Japan 1982-87A N-1 Tanegashima	Total weight: 385 Objective: Technical experiments governing future satellite development: attitude and thermal control, operation of solar array, earth imagery Description: Box 0.85×0.85×2.1m with 6m solar panels, 3-axis-stabilized using reaction wheels	1229	967	107.2	44.6	Japan-built and -launched
Sept. 4	*Cosmos 1405* USSR 1982-88A F-1 Baykonur-Tyuratam	Total weight: Unavailable Objective: "Continuation of outer space investigations" Description: Unavailable	444	430	93.3	65.0	Probable ocean surveillance satellite doing electronic reconnaissance; reentered Feb. 5, 1984
Sept. 8	*Cosmos 1406* USSR 1982-89A F (?) Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	220	212	88.8	82.3	Probable photo reconnaissance satellite, carrying earth-resources package; reentered Sept. 21
Sept. 9	*China 12* PRC 1982-90A Long March 2 Shuang-Cheng-Tse	Total weight: Unavailable Objective: Satellite development techniques including recovery test Description: Unavailable	384	175	90.1	63.0	Part of satellite recovered Sept. 13
Sept. 15	*Cosmos 1407* USSR 1982-91A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	340	174	89.6	67.2	Probable military photo reconnaissance satellite; reentered Oct. 16
Sept. 16	*Cosmos 1408* USSR 1982-92A F (?) Plesetsk	Total weight: Unavailable Objective: Undisclosed Description: Unavailable	661	624	97.6	82.6	Probable electronic ferret

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
	Ekran 9 USSR 1982-93A D-I-E Baykonur-Tyuratam	Total weight: 2000 kg? Objective: Transmit Central TV programs to collective receivers in remote areas of USSR Description: Cylinder 5m long, 2m dia, carrying boom-mounted solar panels and transmitting antenna array	36 695	34 873	1436.0	1.5	Soviet domestic comsat on station at Statsionar T location (99°E)
Sept. 18	*Progress 15* USSR 1982-94A A-2 Baykonur-Tyuratam	Total weight: 1000 kg Objective: "Continuation of outer space investigations" Description: Unavailable	326	302	90.8	51.6	Unmanned cargo vehicle docked with rear port of *Salyut* 7 Sept. 20; undocked Oct. 14; reentered over Pacific after retrofire Oct. 16
Sept. 22	*Cosmos 1409* USSR 1982-95A A-2-e Plesetsk	Total weight: Unavailable Objective: Undisclosed Description: Unavailable	39 158	1199	717.8	64.4	Probably part of early warning system
Sept. 24	*Cosmos 1410* USSR 1982-96A F (?) Plesetsk	Total weight: Unavailable Objective: Undisclosed Description: Unavailable	1498	1491	115.9	82.6	Possible geodetic-measurements satellite
Sept. 28	*Intelsat 5 F-5* U.S. 1982-97A Atlas Centaur ESMC	Total weight: 1000 kg Objective: International communications plus maritime subsystem for lease to Intl. Maritime Satellite Org. (INMARSAT) Description: Box with antenna array and 16m — span solar panels	35 801	35 773	1436.1	0.0	INMARSAT had lost Marecs-B satellite in failure of Ariane 5 launch vehicle delayed from May to Sept. 10, when third stage malfunctioned
Sept. 30	*Cosmos 1411* USSR 1982-98A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	357	198	90.1	72.9	Probable military photo reconnaissance satellite; reentered Oct. 14

Oct. 2	*Cosmos 1412* USSR 1982-99A F-1 Baykonur-Tyuratam	Total weight: Unavailable Objective: "Continuation of outer space investigations" Description: Unavailable	985	901	103.9	64.8	Probable ocean-survey satellite using nuclear-powered radar
Oct. 12	*Cosmos 1413* USSR 1982-100A D-1-E Baykonur-Tyuratam	Total weight: 700 kg? Objective: Establish global navigation system for USSR Description: Cylinder 2m in length and dia	19 072	19 065	673.3	64.7	First launch in USSR's global navigation satellite system (GLONASS)
	and						
	Cosmos 1414 USSR 1982-100D D-1-E Baykonur-Tyuratam	Total weight: 700 kg? Objective: Establish global navigation system for USSR Description: Cylinder 2m in length and dia	19 153	19 105	675.7	64.6	
	and						
	Cosmos 1415 USSR 1982-100F D-1-E Baykonur-Tyuratam	Total weight: 700 kg? Objective: Establish global navigation system for USSR Description: Cylinder 2m in length and dia	19 076	19 069	673.5	64.7	
Oct. 14	*Cosmos 1416* USSR 1982-101A A-2 Baykonur-Tyuratam	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	278	231	89.6	70.4	Probable military photo reconnaissance satellite; reentered Oct. 28
Oct. 19	*Cosmos 1417* USSR 1982-102A C-1 Plesetsk	Total weight: 700 kg? Objective: Continuation of outer space investigations" Description: Cylinder 2m in length and dia, enclosed in drum-shape solar array	1006	957	104.7	83.0	Probable navsat

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
Oct. 20	*Horizont 6* USSR 1982-103A D-I-E Baykonur-Tyuratam	Total weight: 2000 kg? Objective: Provide telephone, telegraph, and TV relay through "Moscow" system inside and outside USSR Description: Cylinder 5m long, 2m dia, 3-axis-stabilized, carrying array of horn and reflector antennas at earth-pointing end	35 795	35 778	1436.1	1.1	Comsat on location at Statsionar 6 position, 90°E
Oct. 21	*Cosmos 1418* USSR 1982-104A C-1 Kapustin Yar	Total weight: Unavailable Objective: Undisclosed Description: Unavailable	414	370	50.7	92.3	Probable radar calibration mission; reentered Sep. 30, 1983
Oct. 27	*RCA Satcom 5* U.S. 1982-105A Delta ESMC	Total weight: 600 kg Objective: Provide U.S. domestic and international commercial communications Description: Box 1.4×1.6×1.8m carrying solar panels	35 792	35 783	1436.2	0.0	Commercial comsat on location at 143°W to provide services to Alaska
Oct. 30	*Dscs 15* U.S. 1982-106A Titan 3D ESMC	Total weight: Unavailable Objective: Put DOD comsats into geosynchronous orbit Description: Unavailable	35 789	35 783	1436.1	0.6	Two defense comsats, first in series of uprated satellites; first use of Titan 3D with inertial upper stage to launch spacecraft

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	and						
	Dscs 16 U.S. 1982-106B Titan 3D ESMC	Total weight: Unavailable Objective: Put DOD comsats into geosynchronous orbit Description: Unavailable	35 797	35 775	1436.1	0.0	
Oct. 31	*Progress 16* USSR 1982-107A A-2 Baykonur-Tyuratam	Total weight: Unavailable Objective: Carry consumables and experiment materials to orbiting space station Description: See 1982-70A	362	353	91.6	51.6	Docked at rear port of *Salyut 7* Nov. 2; undocked Dec. 13; reentered earth atmosphere on command Dec. 14
Nov. 2	*Cosmos 1419* USSR 1982-108A A-2 Baykonur-Tyuratam	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	285	228	89.6	70.3	Probable military photo reconnaissance satellite; reentered Nov. 16
Nov. 11	*Cosmos 1420* USSR 1982-109A C-1 Plesetsk	Total weight: 700 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	807	775	100.7	74.0	Probable military comsat using data store-and-dump technique
	STS 5 U.S. 1982-110A Columbia KSC	Total weight: 2 306 010 kg Objective: First operational flight of Space Transportation Systems; deploy 2 commercial comsats Description: Unavailable	317	294	90.5	28.5	First launch of 4-man crew (Vance Brand, Robert Overmyer, Joseph Allen, William Lenoir) landed at Edwards AFB, Calif., Nov. 16. Satellite payloads (*SBS 3*, *Anik C3*) released from cargo bay to seek geostationary orbit. Spacewalks canceled because of problems with 2 space suits.
	and						
	SBS 3 U.S. 1982-110B Columbia (in orbit)	Total weight: 580 kg Objective: Business communications Description: Cylinder 6m long, 2m dia	35 790	35 782	1436.1	0.0	Geostationary orbit

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
	and						
	Telesat 6 (Anik C-3) Canada 1982-110C Columbia (in orbit)	Total weight: 2100 kg (including fuel) Objective: Canadian government comsat Description: Cylinder 2m long, 1.5 dia	35 793	35 789	1436.1	0.0	Geostationary orbit at 117.5°W
Nov. 17	DOD satellite USSR 1982-111A Titan 3D WSMC	Total weight: 13 000 kg Objective: U.S. military reconnaissance using TV transmission system Description: Cylinder 15m long, 3 dia	518	281	92.6	97.0	
Nov. 18	*Cosmos 1421* USSR 1982-112A A-2 Baykonur-Tyuratam	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	280	230	89.6	70.3	Probable military photo reconnaissance satellite; reentered Dec. 2
	*Iskra 3** USSR 1982-33D *Salyut 7* (in orbit)	Total weight: Unavailable Objective: Experimental amateur-radio relay Description: Unavailable	365	350	91.5	51.6	Launched from *Salyut 7** (see May 17, 1982-33C); reentered Dec. 16
Nov. 26	*Raduga 11* USSR 1982-113A D-1-E Baykonur-Tyuratam	Total weight: 2000 kg? Objective: Provide 24hr radio and telegraph communications in UHF band, relay Central TV programs to Orbita network stations Description: Cylinder 5m long, 2 dia, carrying a pair of solar panels; aerial array at one end	35 794	35 789	1436.4	0.6	Comsat on station at 35°E
Dec. 3	*Cosmos 1422* USSR 1982-114A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	288	228	89.7	72.9	Probable military photo reconnaissance satellite; reentered Dec. 17

Dec. 8	*Cosmos 1423* USSR 1982-115A A-2-e Plesetsk	Total weight: Unavailable Objective: "Continuation of outer space investigations" Description: Unavailable	429	330	92.2	62.8	Probable comsat; final rocket stage seemed to explode on ignition; orbit figures given for largest fragment
Dec. 14	*Meteor 2-9* USSR 1982-116A A-1 Plesetsk	Total weight: 2200 kg? Objective: Scan cloudcover and return images and data on earth surface and weather Description: Cylinder 5m long, 1.5 dia, with 2 sun-seeking solar panels	886	806	101.9	81.2	Metesat
Dec. 16	*Cosmos 1424* USSR 1982-117A A-2 Baykonur-Tyuratam	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	349	171	89.7	64.9	Probable military photo reconnaissance satellite; reentered Jan. 28, 1983
Dec. 21	DOD satellite U.S. 1982-118A Thor Burner 2 WSMC	Total weight: Unavailable Objective: Undisclosed Description: Unavailable	822	810	101.2	98.7	Probable military weather satellite
Dec. 23	*Cosmos 1425* USSR 1982-119A A-2 Baykonur-Tyuratam	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	415	348	92.2	70.0	Probable military photo reconnaissance satellite; reentered Jan. 6, 1983
Dec. 28	*Cosmos 1426* USSR 1982-120A A-2 Baykonur-Tyuratam	Total weight: 6000 kg? Objective: Undisclosed Description: Unavailable	351	205	90.0	50.5	Probable photo reconnaissance satellite, possibly doing parallel studies with the currently unmanned *Salyut 7*; reentered March 5, 1983
Dec. 29	*Cosmos 1427* USSR 1982-121A C-1 Plesetsk	Total weight: Unavailable Objective: Undisclosed Description: Unavailable	476	422	93.6	65.8	Probable military radar calibration satellite

SATELLITES, SPACE PROBES, AND MANNED SPACE FLIGHTS, 1983

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Launch Date	Spacecraft, Country, Int'l Designation, Vehicle Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
Jan. 12	*Cosmos 1428* USSR 1983-1A C-1 Plesetsk	Total weight: 700 kg? Objective: "Continuation of outer space investigations" Description: Cylinder 2m in length and dia enclosed in cylindrical solar array	1003	949	104.6	82.9	Probable navsat
Jan. 19	*Cosmos 1429* USSR 1983-2A C-1 Plesetsk	Total weight: 40 kg? Objective: Communications Description: Spheroid?	1517	1464	115.8	74.0	Multiple launch (8 satellites) probably for tactical military communications
	and *Cosmos 1430* USSR 1983-2B C-1 Plesetsk	Total weight: 40 kg? Objective: Communications Description: Spheroid?	1497	1464	115.6	74.0	
	and *Cosmos 1431* USSR 1983-2C C-1 Plesetsk	Total weight: 40 kg? Objective: Communications Description: Spheroid?	1482	1463	115.4	74.0	
	and *Cosmos 1432* USSR 1983-2D C-1 Plesetsk	Total weight: 40 kg? Objective: Communications Description: Spheroid?	1466	1461	115.2	74.0	
	and *Cosmos 1433* USSR 1983-2E C-1 Plesetsk	Total weight: 40 kg? Objective: Communications Description: Spheroid?	1465	1444	115.0	74.0	

	and						
	Cosmos 1434 USSR 1983-2F C-1 Plesetsk	Total weight: 40 kg? Objective: Communications Description: Spheroid?	1465	1429	114.8	74.0	
	and						
	Cosmos 1435 USSR 1983-2G C-1 Plesetsk	Total weight: 40 kg? Objective: Communications Description: Spheroid?	1465	1413	114.7	74.0	
	and						
	Cosmos 1436 USSR 1983-2H C-1 Plesetsk	Total weight: 40 kg? Objective: Communications Description: Spheroid?	1464	1397	114.5	74.0	
	Cosmos 1437 USSR 1983-3A A-1 Plesetsk	Total weight: 2000 kg? Objective: Undisclosed Description: Unavailable	650	622	97.5	81.2	Probable electronic ferret
Jan. 26	*IRAS* U.S. 1983-4A Delta WSMC	Total weight: 1000 kg Objective: Joint mission of U.S., U.K. and Netherlands to study infrared sources in space Description: Cylinder 3.6m long, 2 dia	910	889	103.0	99.1	Satellite ceased operation Nov. 21
Jan. 27	*Cosmos 1438* USSR 1983-5A A-2 Baykonur-Tyuratam	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	293	175	89.2	70.4	Probable military photo reconnaissance satellite; reentered Feb. 7

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
Feb. 4	*Sakura 2A* Japan 1983-6A N-11 Tanegashima	Total weight: 670 (including fuel) Objective: Japanese domestic comsat to provide telephone, TV, and data links on K-band and C-band Description: Cylinder 3.3m long including despun antenna, 2.2 dia, enclosed in drum-shape solar panel; spin-stabilized	35 792	35 789	1436.2	0.1	Geostationary orbit at 130°E
Feb. 6	*Cosmos 1439* USSR 1983-7A A-2 Baykonur-Tyuratam	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	295	160	89.1	70.4	Probable military photo reconnaissance satellite; reentered Feb. 22
Feb. 9	DOD satellites U.S.	Total weight: Unavailable Objective: Undisclosed					Multiple launch; probable ocean surveillance system using radar; orbital records not maintained
	1983-8A		1156	1059	107.4	63.4	
	8B	Description: Unavailable	1171	1054	107.5	63.4	
	8C		1152	1064	107.4	63.4	
	8D		1150	1067	107.5	63.4	
	8E		1156	1060	107.4	63.4	
	8F		1156	1060	107.4	63.4	
	8G		1159	1044	107.3	63.4	
	8H		1155	1061	107.4	63.4	
	Atlas WSMC						
Feb. 10	*Cosmos 1440* USSR 1983-9A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	275	260	89.9	82.3	Probable photo reconnaissance satellite carrying earth resources package; reentered Feb. 24
Feb. 16	*Cosmos 1441* USSR 1983-10A A-1 Plesetsk	Total weight: 2000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	635	623	97.3	81.1	Probable electronic ferret

Feb. 20	*Tenma* Japan 1983-11A Mu3S Kagoshima	Total weight: Unavailable Objective: X-ray observation of stars and galaxies using monitors, detectors, a collimator, and a proportional counter Description: Unavailable	473	462	94.0	31.5	Eighth of Japanese scisats (Astro-B series) carried 5 sets of instruments
Feb. 25	*Cosmos 1442* USSR 1983-12A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	360	169	89.8	67.2	Probable military photo reconnaissance satellite; reentered April 11
March 2	*Cosmos 1443* USSR 1983-13A D-1 Baykonur-Tyuratam	Total weight: 20 T? Objective: To enlarge orbiting space station, and to carry consumables and experiment equipment for use by following crews Description: See *Salyut 7* (1982-33A)	235	195	88.7	51.6	Maneuvered to meet *Salyut* and docked with it March 4; module would allow expanded manned operations; undocked Aug. 14; reentry module returned Aug. 23
	Cosmos 1444 USSR 1983-14A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	416	358	92.3	72.8	Probable military photo reconnaissance satellite; reentered March 16; orbit maintained by low-thrust motor
March 11	*Molniya 3-20* USSR 1983-15A A-2-e Plesetsk	Total weight: 2000 kg? Objective: Transmit telephone, telegraph and TV through Orbita system to the USSR and abroad Description: Cylinder 4m long, 1.6 dia, with conical motor and windmill of 6 solar panels	39 114	1241	717.8	63.2	Orbit adjusted to ensure daily repeat of ground tracks
March 12	*Ekran 10* USSR 1983-16A D-1-E Baykonur-Tyuratam	Total weight: 2000 kg? Objective: Transmit Central TV programs to collective receivers in remote areas of USSR Description: Cylinder 5m long, 2 dia, with boom-mounted solar panels and transmitting array	35 800	35 775	1436.2	0.6	Geostationary orbit at 99°E
March 15	*Cosmos 1445* USSR 1983-17A C-1 Kapustin Yar	Total weight: 1000 kg? Objective: Reentry and recovery test Description: D-wing vehicle 3m long, 2m across wings	225	200	88.0	50.7	Reentered in less than 2 hr
March 16	*Cosmos 1446* USSR 1983-18A A-2 Baykonur-Tyuratam	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	241	222	89.1	69.9	Probable military photo reconnaissance satellite; reentered March 30

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
	Molniya 1-56 USSR 1983-19A A-2-e Plesetsk	Total weight: 1800 kg? Objective: Internal Soviet communications Description: Similar to *Molniya 3-20* (1983-15A)	39 485	864	717.7	63.4	Orbit adjusted to ensure daily repeat of ground tracks
March 23	*Astron* USSR 1983-20A D-1-E Baykonur-Tyuratam	Total weight: 3900 kg? Objective: Astronomical research on faint objects, using X-ray and UV telescopes Description: Vehicle resembling interplanetary Venera, 3m long, 2.5 dia, with a pair of solar panels	181 927	22 156	5921.4	58.4	Spacecraft equipped with X-ray spectrometers and 5m-long UV telescope; main mirrors, 800mm diameter
March 24	*Cosmos 1447* USSR 1983-21A C-1 Plesetsk	Total weight: 700 kg? Objective: Navigation satellite combining mission with COSPAS search-and-rescue mission Description: Cylinder 2m in length and dia. with domed ends enclosed in cylindrical solar array	1010	956	104.8	82.9	(COSPAS: Cosmos payload for signal-receiving, position-fixing, data-relay mission/search and rescue: designed for compatibility with SARSAT system developed jointly by France, Canada, and U.S.)
March 28	*NOAA 8* U.S. 1983-22A Atlas WSMC	Total weight: 2000 kg Objective: Meteorological satellite, carrying SARSAT search-and-rescue package like that on *Cosmos 1447* (1983-21A) Description: Box 4m long, 2 dia	825	802	101.2	98.7	(SARSAT: search-and-rescue satellite: outgrowth of France's Arogs program for satellite acq. of meteorology/oceanography data from drifting buoys); orbit unstable after separation from launcher, stabilized by April 21
March 30	*Cosmos 1448* USSR 1983-23A C-1 Plesetsk	Total weight: 700 kg? Objective: "Continuation of outer space investigations" Description: Cylinder 2m in length and dia, enclosed in cylindrical solar array	1001	958	104.7	83.0	Probable navsat
March 31	*Cosmos 1149* USSR 1983-24A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	417	356	92.3	72.9	Probable military photo reconnaissance satellite; reentered April 15; maintained orbit by use of low-thrust motor

April 2	*Molniya 1-57* USSR 1983-25A A-2-e Plesetsk	Total weight: 1800 kg? Objective: Internal Soviet communcations Description: Similar to *Molniya 3-20* (1983-15A)	39 249	1102	717.7	63.1	Orbit adjusted to ensure daily repeat of ground track
April 4	*STS 6* U.S. 1983-26A Challenger KSC	Total weight: 69T Objective: To orbit Challenger for first time; launch TDRS; do various experiments Description: Standard Shuttle craft (see 1981-34A)	290	280	90.0	28.5	Crew (Paul Weitz, Karol Bobko, Donald Peterson, Story Musgrave) launched *TDRS 1*; landed Edwards AFB April 9
April 5	*TDRS-1* U.S. 1983-26B Challenger (in orbit)	Total weight: 1500 (in orbit) Objective: Provide improved space-to-ground communications for U.S.-launched satellites (link Spacelab mision with ground control) Description: Irregular box 6m long, 2 dia. carrying aerial and solar array	35 788	35 782	1436.0	0.8	Second-stage malfunction put tracking and data relay satellite into orbit lower than intended; small onboard thrusters raised it to operating altitude; arrived at station 41 °W on Oct. 17
April 6	*Cosmos 1450* USSR 1983-27A C-1 Plesetsk	Total weight: Unavailable Objective: Undisclosed Description: Unavailable	500	455	94.2	65.8	Probable military mission
April 8	*Raduga 12* USSR 1983-28A D-1-E Baykonur-Tyuratam	Total weight: 2000 kg? Objective: Provide 24 hr radio, telegraph, and TV communications within the USSR Description: Cylinder 5m long, 2 dia, with boom-mounted solar panels and antenna array	35 902	35 685	1436.5	0.3	Domestic comsat in geostationary orbit
	Cosmos 1451 USSR 1983-29A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	323	227	90.0	82.4	Probable photo reconnaisance satellite; reentered April 22
April 11	*RCA Satcom 6* U.S. 1983-30A Delta ESMC	Total weight: 1000 kg Objective: Commercial communications Description: Unavailable	35 794	35 779	1436.1	0.0	Launched by NASA for RCA; in geostationary orbit at 128 °W

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
April 12	*Cosmos 1452* USSR 1983-31A C-1 Plesetsk	Total weight: 700 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	806	780	100.7	74.1	Probable military comsat using data store-and-dump technique
April 15	DOD satellite U.S. 1983-32A Titan 3B-Agena D WSMC	Total weight: 3T Objective: Undisclosed Description: Cylinder 8m long, 1.5 dia	298	135	88.9	96.5	Probable military photo reconnaissance satellite; maneuverable; reentered Aug. 21
April 17	*Rohini 3* India 1983-33A SLV-3 Sriharikota	Total weight: Unavailable Objective: Undisclosed Description: Unavailable	808	385	96.6	46.6	India-built and -launched spacecraft
April 19	*Cosmos 1453* USSR 1983-34A C-1 Plesetsk	Total weight: Unavailable Objective: Undisclosed Description: Unavailable	488	449	94.0	74.0	Probable military mission
April 20	*Soyuz T-8* USSR 1983-35A A-2 Baykonur-Tyuratam	Total weight: 7000 kg? Objective: Carry 3-man crew to orbiting *Salyut 7/Cosmos 1443* complex Description: Near-spherical orbital craft 7.5m long, 2.2 dia; conical reentry module, cylindrical instrument section with solar panels	228	180	88.5	51.6	Mission failed before docking because of malfunction in rendezvous system; crew (Vladimir Titov, Gennady Strekalov, Aleksandr Serebrov) recovered April 22; later reported that Soyuz antenna failed to deploy
April 22	*Cosmos 1454* USSR 1983-36A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	343	170	89.6	67.1	Probable military photo reconnaissance satellite; reentered May 22

April 23	*Cosmos 1455* USSR 1983-37A F Plesetsk	Total weight: Unavailable Objective: Undisclosed Description: Unavailable	661	629	97.6	82.5	Probable electronic ferret
April 25	*Cosmos 1456* USSR 1983-38A A-2-e Plesetsk	Total weight: Unavailable Objective: "Continuation of outer space investigations" Description: Unavailable	39 179	1141	717.1	65.5	Probably part of early warning system; orbit adjusted to ensure daily repeat of ground track
April 26	*Cosmos 1457* USSR 1983-39A A-2 Baykonur-Tyuratam	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	350	171	89.7	70.4	Probable military photo reconnaissance satellite; reentered June 8
April 28	*Cosmos 1458* USSR 1983-40A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	245	212	89.1	82.3	Probable photo reconnaissance satellite carrying earth resources package; reentered May 11
	GOES 6 U.S. 1983-41A Delta ESMC	Total weight: 800 (incl. fuel) Objective: Return meteorological data from geostationary orbit Description: Spin-stabilized drum 3m long, 2 dia	35 850	35 728	1436.2	0.1	*G*eostationary *O*peratonal *E*nvironmental *S*atellite aimed at location 135°W
May 6	*Cosmos 1459* USSR 1983-42A C-1 Plesetsk	Total weight: 700 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	1016	940	104.6	83.0	Probable navsat
	Cosmos 1460 USSR 1983-43A A-2 Baykonur-Tyuratam	Total weight: 6000 kg Objective: "Continuation of outer space investigations" Description: Unavailable.	416	350	92.2	70.3	Probable military photo reconnaisance satellite; reentered May 20

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
May 7	*Cosmos 1461* USSR 1983-44A F-1 Baykonur-Tyuratam	Total weight: Unavailable Objective: "Continuation of outer space investigations" Description: Unavailable	886	566	99.3	65.0	Probable electronic reconnaissance, directed at ship movements
May 17	*Cosmos 1462* USSR 1983-45A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	277	259	89.9	82.3	Probable photo reconnaissance satellite carrying earth resources package; reentered May 31
May 19	*Cosmos 1463* USSR 1983-46A C-1 Plesetsk	Total weight: 700 kg? Objective: Undisclosed Description: Unavailable	1461	297	102.5	82.9	Probable geodetic satellite
	Intelsat 5 F-6 U.S. 1983-47A Atlas Centaur ESMC	Total weight: 1000 kg Objective: Communications Description: Box-shaped vehicle with 16m-span solar array	35 802	35 773	1436.1	0.0	
May 24	*Cosmos 1464* USSR 1983-48A C-1 Plesetsk	Total weight: 700 kg? Objective: "Continuation of outer space investigations Description: Cylinder 2m in length and dia, domed ends; enclosed in drum-shaped solar array	1011	968	104.9	82.9	Probable navsat
May 26	*Cosmos 1465* USSR 1983-49A C-1 Kapustin Yar	Total weight: Unavailable Objective: Undisclosed Description: Unavailable	283	249	89.8	50.6	Spacecraft used either as radar test target, or for electronic reconniassance

	Cosmos 1466 USSR 1983-50A A-2 Baykonur-Tyuratam	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable.	345	174	89.7	64.9	Probable military photo reconnaissance satellite; reentered July 6
	Exosat ESA 1983-51A Delta WSMC	Total weight: 510 kg (incl 120 kg scientific instruments) Objective: X-ray spectroscopy; locating new sources; use of telescopes to observe occultations of sources by the moon; mapping low-energy extended sources Description: Box 1.4 high, 2.1 across containing instruments, control equipment, and payload, with single 1.9 solar panel	187 645	4498	5438.9	71.3	*E*uropean *X*-ray *O*bservatory *Sat*ellite launched by NASA for ESA
May 31	*Cosmos 1467* USSR 1983-52A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	417	357	92.3	72.9	Probable military photo reconnaissance satellite; reentered June 12
June 2	*Venera 15* USSR 1983-53A D-1-E Baykonur-Tyuratam	Total weight: 4000 kg? Objective: Study Venus from orbit, mapping planet surface by radar Description: Cylinder 3m long; 2.5 dia, with pair of solar panels; instrument package at one end	Launched toward circumvenerean orbit				Venus encounter predicted for October; carrying radar mapping instruments; entered Venus orbit Oct. 10; *Venera 16* arrived there Oct. 14
June 7	*Venera 16* USSR 1983-54A D-1-E Baykonur-Tyuratam	Total weight: See *Venera 15* Objective: See *Venera 15* Description: See *Venera 15*	Launched toward circumvenerean orbit				
	Cosmos 1468 USSR 1983-55A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	277	252	89.9	82.3	Probable photo reconnaissance satellite carrying earth resources package; reentered June 21

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
June 10	DOD satellite (OPS 6432) 1983-56A 56C 56D Atlas WSMC	Total weight: Unavailable Objective: Ocean surveillance Description: Unavailable .	1165	1065	107.4	63.4	Three payloads
June 14	*Cosmos 1469* USSR 1983-47A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	342	231	90.3	72.8	Probable military photo reconnaissance satellite; reentered June 24
June 16	*ECS 1* ESA 1983-58A Ariane L-6 Kourou	Total weight: 1043 kg (incl. fuel) Objective: Provide international telephone circuits covering Europe, the Middle East, and North Africa; distribute TV programs in the same area Description: Box 2.4m high, 2.2 dia, carrying a 13.8 span solar array	35 799	35 777	1436.1	0.0	Geosynchronous orbit at 10°E
	and						
	Oscar 10 (Amsat P3B) ESA 1983-58B Ariane L-6 Kourou	Total weight: 130 kg (90 after maneuvers) Objective: Provide communications over large areas of So. America using inexpensive equipment; demonstrate use of microprocessor for monitoring operations Description: Three pointed star, 1.3m wide 0.4 high	35 431	4203	699.6	25.9	Third-generation German-built amateur radio comsat
June 18	*STS 7* U.S. 1983-59A Challenger KSC	Total weight: 69T Objective: Orbit the Challenger; launch various objects; test retrieval system Description: Standard Shuttle (see 1981-84A)	320	295	90.5	28.5	Second flight of Challenger; crew (Crippen, Hauck, Fabian, Ride, Thagard) launch *Palapa 3* and *Telesat 7*; tested remote manipulator for spacecraft release/retrieval using *Spas 01* pallet carrying payload. Landed June 24 at Edwards AFB in Calif. because of bad weather at KSC

	and						
	Telesat 7 (Anik C-2) Canada 1983-59B Challenger (in orbit)	Total weight: 1238 (including fuel) Objective: Provide domestic telephone and TV channels to Canada Description: Spin-stabilized cylinder 2.8m long, extended to 6.7m with solar array deployed	35 796	35 779	1436.1	0.0	Released June 18 in Challenger orbit; payload assist module maneuvered it to location
	and						
	Palapa 3 (B-1) Indonesia 1983-59C Challenger (in orbit)	Total weight: 550 kg? Objective: Part of Indonesian domestic comsat system Description: Not available	35 794	35 780	1436.1	0.0	Released June 19 in Challenger orbit; payload-assist module maneuvered it to location
	and						
	Spas 01 U.S. 1983-59F Challenger (remote manipulator arm)	Total weight: 1500 kg Objective: Test satellite release and retrieval using Shuttle's manipulator arm Description: Standard Spacelab pallet	(Same as Challenger's)				Initial capture performed immediately after release; pallet was released and retrieved 4 times over 10 hr, separated from orbiter as far as 300m
June 20	DOD satellite (OPS 0721) U.S. 1983-60A Titan 3D WSMC	Total weight: 13 000 kg Objective: Military reconnaissance Description: Cylinder 15m long, 3 dia	220	165	88.4	96.4	Carried film return capsules
	and						
	Subsatellite U.S. 1983-60C Titan 3D WSMC	Total weight: Unavailable Objective: Undisclosed Description: Unavailable	1290	1290	111.4	96.7	Piggyback payload on DOD satellite launch; probable military electronic reconnaissance
June 23	*Cosmos 1470* USSR 1983-61A F Plesetsk	Total weight: Unavailable Objective: Undisclosed Description: Unavailable	663	629	97.7	82.5	Probable electronic ferret

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
June 27	*Soyuz T-9* USSR 1983-62A A-2 Baykonur-Tyuratam	Total weight: 700 kg? Objective: Ferry crew to *Salyut 7-Cosmos 1443* orbiting laboratory Description: Near-sphere orbital compartment, 7.5m long, 2.2 dia; conical reentry module; cylindrical instrument unit carrying solar panels	337	325	91.1	51.6	Crew (Vladimir Lyakhov and Aleksandr Aleksandrov) docked at rear port of *Salyut 7* June 28; unloaded cargo from *Cosmos 1443*, which undocked Aug. 14 and returned capsule to earth with 500 kg of cargo from station. Crew undocked *Soyuz T-9* Aug. 16 and redocked at forward port
	Hilat U.S. 1983-63A Scout WSMC	Total weight: 113 kg Objective: USAF ionospheric research at high latitudes Description: Octagonal cylinder 1m long, 0.5 dia	835	765	100.9	82.0	Spacecraft similar to Transit navsat
June 28	*Cosmos 1471* USSR 1983-64A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	344	185	89.8	67.2	Probable military photo reconnaissance satellite; reentered July 27
	Galaxy 1 U.S. 1983-65A Delta EMSC	Total weight: 698 kg Objective: Commercial comsat with 12 channels available for sale or lease Description: Spin-stabilized cylinder 2.8m long, extended to 6.7m with solar aray deployed	35 793	35 787	1436.2	0.0	Geostationary orbit at 134°W; built and launched by divisions of the Hughes organization
July 1	*Horizont 7* USSR 1983-66A D-1-E Baykonur-Tyuratam	Total weight: 200 kg (in orbit) Objective: Provide telephone, telegraph, and TV-relay links through "Moscow" system inside and outside USSR Description: Cylinder 5m long, 2m dia, with array of aerials and pair of solar panels at one end	35 827	35 748	1436.2	0.1	

	Prognoz 9 USSR 1983-67A A-2-e Baykonur-Tyuratam	Total weight: 1000 kg? Objective: Ionosphere and magnetosphere studies, esp. research and residual radio emissions from "Big Bang" Description: Cylinder 2m in length and dia, carrying 4 solar panels	720 000	380	38 448.0	65.5	Scisat carrying apparatus from Czechoslovakia and France as well as USSR
July 5	*Cosmos 1472* USSR 1983-68A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	362	338	91.6	82.4	Probable photo reconnaissance satellite carrying earth resources package; reentered July 19
July 6	*Cosmos 1473* USSR 1983-69A C-1 Plesetsk	Total weight: 40 kg? Objective: "Continuation of outer space investigations" Description: Spheroid?	1461	1392	114.4	74.0	Multiple launch (8 satellites) probably for military communications
	and						
	Cosmos 1474 USSR 1983-69B C-1 Plesetsk	Total weight: 40 kg? Objective: "Continuation of outer space investigations" Description: Spheroid?	1461	1410	114.6	74.0	
	and						
	Cosmos 1475 USSR 1983-69C C-1 Plesetsk	Total weight: 40 kg? Objective: "Continuation of outer space investigations" Description: Spheroid?	1460	1427	114.8	74.0	
	and						
	Cosmos 1476 USSR 1983-69D C-1 Plesetsk	Total weight: 40 kg? Objective: "Continuation of outer space investigations" Description: Spheroid?	1461	1444	114.9	74.0	

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
	and						
	Cosmos 1477 USSR 1983-69E C-1 Plesetsk	Total weight: 40 kg? Objective: "Continuation of outer space investigations" Description: Spheroid?	1463	1459	115.1	74.0	
	and						
	Cosmos 1478 USSR 1983-69F C-1 Plesetsk	Total weight: 40 kg? Objective: "Continuation of outer space investigations" Description: Spheroid?	1480	1461	115.3	74.0	
	and						
	Cosmos 1479 USSR 1983-69G C-1 Plesetsk	Total weight: 40 kg? Objective: "Continuation of outer space investigations" Description: Spheroid?	1498	1460	115.5	74.0	
	and						
	Cosmos 1480 USSR 1983-69H C-1 Plesetsk	Total weight: 40 kg? Objective: "Continuation of outer space investigations" Description: Spheroid?	1518	1460	115.8	74.0	
July 8	*Cosmos 1481* USSR 1983-70A A-2-e Plesetsk	Total weight: 2000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	38 465	1370	707.3	63.9	Probable part of early warning system

July 13	*Cosmos 1482* USSR 1983-71A A-2 Baykonur-Tyuratam	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	413	352	92.2	70.0	Probable military photo reconnaissance satellite; reentered July 27
July 14	*Navstar 8* U.S. 1983-72A Atlas F ESMC	Total weight: 800 kg Objective: Operational Block 1 satellite in U.S. global positioning system Description: Box 2m on a side carrying 2 solar panels	20 461	19 903	718.0	62.8	Previous navsat launch Dec. 18, 1982, failed when launcher malfunctioned at liftoff. *Navstar 8* would be 7th in system to reach orbit
July 19	*Molniya 1-58* USSR 1983-73A A-2-e Plesetsk	Total weight: 1800 kg? Objective: Provide telegraph and long-distance telephone links; relay Central TV programs to Orbita receivers in remote areas of USSR Description: Cylinder 3.4m long, 1.6 dia, carrying windmill of 6 solar panels	39 933	414	717.7	63.1	Comsat
July 20*	*Cosmos 1484* USSR 1983-74A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	275	260	89.9	82.3	Probable earth resources photo reconnaissance satellite; reentered Aug. 3
July 25	*Cosmos 1483* USSR 1983-75A A-1 Baykonur-Tyuratam	Total weight: 2200 kg? Objective: Earth resources sensing; testing new remote equipment Description: Cylinder 5m long, 1.5 dia, carrying 2 sun-seeking solar panels; sensing equipment at one end	656	587	97.1	97.9	Sensors resemble those on *Meteor 2* spacecraft
July 26	*Cosmos 1485* USSR 1983-76A A-2 Plesetsk	Total weight: 2200 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	415	358	92.3	72.9	Probable military photo reconnaissance satellite; reentered Aug. 9

* This and following launch were numbered/reported out of sequence

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
July 28	*Telstar 3A* U.S. 1983-77A Delta ESMC	Total weight: 1225 kg (incl. fuel) Objective: Provide commercial communications channels for AT&T Description: Cylinder 2.8m long, 2.2 dia, extending to 6.8 after deployment of drum-shaped solar array	35 794	35 782	1436.2	0.05	First of a series of three comsats to replace the Comstars leased by AT&T from ComSatCorp; stationed at 66°W for testing, later at 96°W for operations
July 31	DOD satellite U.S. 1983-78A Titan 3B-Agena D (launch site not given)	Total weight: Unavailable Objective: Military communications esp. in polar regions Description: Unavailable	Information not available				DOD comsat
Aug. 3	*Cosmos 1486* USSR 1983-79A C-1 Plesetsk	Total weight: 700 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	801	781	100.7	74.1	Probable military comsat using data store-and-dump technique
Aug. 5	*Cosmos 1487* USSR 1983-80A A-2 Plesetsk	Total weight: 2200 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	275	261	89.9	82.3	Probable photo reconnaissance satellite carrying earth resources package; reentered Aug. 19
	Sakura 2B Japan 1983-81A N11 Tanegashima	Total weight: 670 kg (including fuel) Objective: Provide telephone, TV, and data links for Japanese mainland and remote islands Description: Spin-stabilized cylinder 2.1m long, 2.2 dia (3.3m long incl. antenna) enclosed in drum-shaped solar panel, with despun antenna and deflector	35 789	35 785	1436.1	0.0	Geosynchronous orbit at 135°E; carried uplinks in 27.5–29.3 GHz range and downlinks in 17.7 and 19.5 GHz range, plus C-band channels

Aug. 9	*Cosmos 1488* USSR 1983-82A A-2 Plesetsk	Total weight: 2200 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	415	356	92.3	72.9	Probable military photo reconnaissance satellite; reentered Aug. 23
Aug. 10	*Cosmos 1489* USSR 1983-83A A-2 Baykonur-Tyuratam	Total weight: 700 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	365	171	89.9	64.7	Probable military photo reconnaissance satellite; reentered Sept. 23
	Cosmos 1490 USSR 1983-84A D-1-E Baykonur-Tyuratam	Total weight: Unavailable Objective: "Continuation of outer space investigations" Description: Unavailable	19 172	19 086	675.7	64.8	Multiple launch (3 satellites) probably to form part of USSR navigation system (GLONASS); second launch of three
	and						
	Cosmos 1491 USSR 1983-84B		19 509	18 938	679.5	64.8	
	and						
	Cosmos 1492 USSR 1983-84C		19 161	19 152	676.8	64.8	
Aug. 17	*Progress 17* USSR 1983-85A A-2 Baykonur-Tyuratam	Total weight: Unavailable Objective: Carry consumables and experiment materials to crew aboard orbiting *Salyut 7* Description: Unavailable	339	319	91.1	51.6	Docked at rear port of *Salyut 7* Aug. 19; undocked and reentered earth's atmosphere Sept. 18
Aug. 19	*China 13* PRC 1983-86A Long March 2 Shuan-Cheng-Tse	Total weight: Unavailable Objective: Satellite development, including recovery techniques Description: Unavailable	382	173	90.1	63.3	Reentered Sept. 3

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
Aug. 23	*Cosmos 1493* USSR 1983-87A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	414	360	92.3	72.9	Probable military photo reconnaissance satellite; reentered Sept. 6
Aug. 25	*Raduga 13* USSR 1983-88A D-1-E Baykonur-Tyuratam	Total weight: 2000 kg (in orbit) Objective: Provide 24 hr radio, TV, and telegraph communications with the USSR Description: Cylinder 5m long, 2 dia, carrying a pair of solar panels and an aerial array at one end	35 789	35 783	1436.1	0.2	
Aug. 30	*STS 8* U.S. 1983-89A Challenger KSC	Total weight: 69 T (not incl. cargo & exp.) Objective: Carry 5-man crew with scientific and technical payload into orbit; launch satellite for India Description: Delta-wing recoverable spacecraft 37m long, 24m wingspan	301	294	90.3	28.5	Crew (Truly, Brandenstein, Thornton, Bluford, Gardner) launched Indian comsat into geosynchronous orbit; landed Sept. 5 at Edwards AFB, Calif. First nighttime launch and landing
	and						
	Insat 1B India 1983-89B Challenger (in orbit)	Total weight: 1152 kg (incl. fuel) Objective: Provide communications and meteorological service to India Description: Box 1.6×1.4×2.2m carrying single solar panel and balancing "sail"	35 939	35 636	1436.2	0.2	Launched from Challenger cargo bay Aug. 31 as replacement for Insat A, which ceased to operate soon after launch in April 1982; on station at 74°E over equator south of India; film from *STS 8* showed hit by unidentified object
	Molniya 3-21 USSR 1983-90A A-2-e Plesetsk	Total weight: 2000 kg? Objective: Transmit telephone and TV signals via Orbita system inside and outside the USSR Description: Cylinder 4m long, 1.6 dia, with conical motor, carrying a 6-solar-panel windmill	39 209	1144	717.8	63.0	

Aug. 31	*Cosmos 1494* USSR 1983-91A C-1 Kapustin Yar	Total weight: Unavailable Objective: Undisclosed Description: Unavailable	413	309	91.8	50.7	Described in press as "minor military support mission"
Sept. 3	*Cosmos 1495* USSR 1983-92A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	236	215	89.0	82.3	Probable photo reconnaissance satellite carrying earth resources package; reentered Sept. 16
Sept. 7	*Cosmos 1496* USSR 1983-93A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	341	170	89.6	67.2	Probable military photo reconnaissance satellite; reentered Oct. 19
Sept. 8	*RCA Satcom 7* U.S. 1983-94A Delta ESMC	Total weight: 600 kg (not incl. fuel) Objective: Commercial communications Description: Box measuring 1.5m per side, 2 solar panels on booms	35 797	35 779	1436.2	0.0	Third of series of comsats launched by NASA for RCA, replacing Satcom 2 launched in 1976; on station at 72°W
Sept. 9	*Cosmos 1497* USSR 1983-95A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	416	357	90.3	72.8	Probable military photo reconnaissance satellite; reentered Sept. 23
Sept. 14	*Cosmos 1498* USSR 1983-96A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	275	261	89.9	82.3	Probable photo reconnaissance satellite carrying earth-resources package; reentered Sept. 29
Sept. 17	*Cosmos 1499* USSR 1983-97A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	416	357	90.2	72.9	Probable military photo reconnaissance satellite; reentered Oct. 1

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
Sept. 22	*Galaxy 2* U.S. 1983-98A Delta ESMC	Total weight: 1218 kg (incl. fuel) Objective: Commercial comsat carrying 12 channels for sale or lease Description: Cylinder 2.2m dia; 2.8 long extending to 6.7 with solar array deployed	35 792	35 789	1436.2	0.0	Hughes-built and -managed spacecraft; geostationary orbit at 74°W
Sept. 28	*Cosmos 1500* USSR 1983-99A F Plesetsk	Total weight: Unavailable Objective: Undisclosed Description: Unavailable	661	629	97.6	82.5	Probable earth resources mission; described in press as ocean scanner/iceberg detector/test of new optical radar system
Sept. 29	*Ekran 11* USSR 1983-100A D-1-E Baykonur-Tyuratam	Total weight: 2000 kg (in orbit) Objective: Transmit programs of USSR Central TV to collective receiving stations in remote areas Description: Cylinder 5m long, 2 dia, with pair of boom-mounted solar panels, carrying flat aerial array at one end	35 795	35 778	1436.1	0.2	Geosynchronous orbit at 99°E
Sept. 30	*Cosmos 1501* USSR 1983-101A C-1 Plesetsk	Total weight: 700 kg? Objective: Undisclosed Description: Unavailable	494	450	94.1	82.9	Described in press as "military monitor"
Oct. 5	*Cosmos 1502* USSR 1983-102A C-1 Plesetsk	Total weight: Unavailable Objective: Undisclosed Description: Unavailable	327	314	90.0	65.8	Described in press as an "anti-satellite space interceptor target"; inclination "seldom used by Soviet satellites"
Oct. 12	*Cosmos 1503* USSR 1983-103A C-1 Plesetsk	Total weight: 700 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	806	786	74.0	100.8	Probable military comsat using data store-and-dump technique

Oct. 14	*Cosmos 1504* USSR 1983-104A A-2 Baykonur-Tyuratam	Total weight; 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	306	171	64.9	88.7	Probable military photo reconnaissance satellite; reentered Nov. 6
Oct. 19	*Intelsat 5 F-7* ITSO 1983-105A Ariane Kourou	Total weight: 1012 kg (in orbit) Objective: Commercial communications Description: Box 1.7×2.0×1.8m; span across solar panels 16m, 4m aerial mast	35 800	35 778	1436.2	0.0	First of Intelsat series to carry maritime communications package
Oct. 20	*Progress 18* USSR 1983-106A A-2 Baykonur-Tyuratam	Total weight: 7000 kg? Objective: Deliver supplies to crew on orbiting *Salyut 7* Description: Near spherical; conical fuel module; cylindrical instrument unit; overall length 7.5m, 2.2 dia	357	318	91.2	51.6	Docked at rear port of *Salyut 7* Oct. 22; separated Nov. 13; burned up on reentry Nov. 16
Oct. 21	*Cosmos 1505* USSR 1983-107A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	414	356	92.3	72.9	Probable military photo reconnaissance satellite; reentered Nov. 4
Oct. 26	*Cosmos 1506* USSR 1983-108A C-1 Plesetsk	Total weight: 700 kg? Objective: Navigation Description: Cylinder 2m in length and dia, enclosed in drum-shaped solar array	1011	947	104.7	82.9	
Oct. 28	*Meteor 2-10* USSR 1983-109A A-1 Plesetsk	Total weight: 2200 kg? Objective: Obtain scanning-radiometer images of earth surface and cloudover Description: Cylinder 5m long, 1.5 dia, carrying 2 sun-seeking solar panels	886	747	101.2	81.2	Metesat
Oct. 29	*Cosmos 1507* USSR 1983-110A F-1 Baykonur-Tyuratam	Total weight: Unavailable Objective: Undisclosed Description: Unavailable	452	415	93.3	65.1	Probable military intelligence, electronic monitoring, ocean surveillance satellite; normally used to check on communications among naval task force ships

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
Nov. 11	*Cosmos 1508* USSR 1983-111A C-1 Plesetsk	Total weight: Unavailable Objective: Undisclosed Description: Unavailable	1950	394	108.8	82.9	Possible ionospheric research satellite
Nov. 17	*Cosmos 1509* USSR 1983-112A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	290	225	89.7	72.9	Probable military photo reconnaissance satellite; reentered Dec. 1
Nov. 18	DOD satellite U.S. 1983-113A Atlas F WSMC	Total weight: 750 kg Objective: USAF meteorological satellite Description: Irregular cylinder 6m long, 2m dia with solar panel	828	810	101.3	98.7	
	Molniya 1-59 USSR 1983-114A A-2-e Plesetsk	Total weight: 1800 kg? Objective: Provide telegraph and long-distance telephone links; broadcasat Central TV programs to Orbita sations in remote USSR areas Description: Cylinder topped with conical motor, 3.4m long, 1.6 dia, carrying "windmill" of 6 solar panels	39 324	1031	717.8	62.9	
Nov. 24	*Cosmos 1510* USSR 1983-115A C-1 Plesetsk	Total weight: Unavailable Objective: Undisclosed Description: Unavailable	1521	1479	116.0	73.6	Possible geodetic satellite

Nov. 28	*STS 9* U.S. 1983-116A Columbia KSC	Total weight: Unavailable Objective: Carry ESA Spacelab on its first mission Description: Standard Shuttle	254	242	89.4	57.0	Carried 2-shift crew to permit 24 hr operation of experiments: John Young, pilot, with Dr. Robert Parker (mission specialist and West Germany's Dr. Ulf Merbold (payload specialist); Brewster Shaw, pilot, with Dr. Owen Garriott (mission specialist) and Dr. Byron Lichtenberg (payload specialist). Mission extended to 10 da while in flight; computer fault delayed actual landing by 7 hr. Landed Dec. 8 at Edwards AFB, Calif. First non-U.S. citizen on U.S. space mission
Nov. 30	*Cosmos 1511* USSR 1983-117A A-2 Plesetsk	Total weight: 6000 kg?) Objective: "Continuation of outer space investigations" Description: Unavailable	325	183	89.6	67.1	Probable military photo reconnaissance satellite; reentered Jan. 13, 1984
	Horizont 8 USSR 1983-118A D-1-E Baykonur-Tyuratam	Total weight: 2000 kg? Objective: Unspecified (comsat) Description: Cylinder 5m long, 2 dia, carrying pair of solar panels; an aerial array at one end	35 793	35 780	1436.1	0.5	Geosynchronous orbit at 90°E
Dec. 7	*Cosmos 1512* USSR 1983-119A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	416	355	92.3	72.9	Probable military photo reconnaissance satellite; reentered Dec. 21
Dec. 8	*Cosmos 1513* USSR 1983-120A C-1 Plesetsk	Total weight: 700 kg? Objective: Navigation Description: Cylinder 2m in length and dia with domed ends, enclosed in drum-shaped solar array	1013	958	104.8	82.9	
Dec. 14	*Cosmos 1514* USSR 1983-121A A-2 Plesetsk	Total weight: 6000 kg? Objective: Biosat, carrying 2 monkeys, 18 rats, other specimens Description: Unavailable	259	214	89.3	82.3	Reentered Dec. 19

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
Dec. 15	*Cosmos 1515* USSR 1983-122A F Plesetsk	Total weight: Unavailable Objective: Undisclosed Description: Unavailable	661	630	97.6	82.5	Probable electronic ferret
Dec. 21	*Molniya 3-22* USSR 1983-123A A-2-e Plesetsk	Total weight: 2000 kg? Objective: Provide telephone, telegraph and TV relays through Orbita system Description: Cylinder 4m long, 1.6 dia, with conical motor section; carrying "windmill" of 6 solar panels	39 884	464	717.7	63.5	
Dec. 27	*Cosmos 1516* USSR 1983-124A A-2 Baykonur-Tyuratam	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	276	196	89.2	64.9	Probable military photo reconnaissance satellite; reentered Feb. 9, 1984
	Cosmos 1517 USSR 1983-125A C-1 Kapustin Yar	Total weight: 1000 kg? Objective: Reentry and recovery test Description: Delta-winged reentry vehicle 3m long, 2 across	221	181	88.5	50.7	Craft landed in the Black Sea near the end of the first orbit; press described it as "Space Shuttle prototype," third of a scaled-down series; first 2 (*Cosmos 1374* and *1445*) recovered from Indian Ocean in 1982 and 1983
Dec. 28	*Cosmos 1518* USSR 1983-126A A-2-e Plesetsk	Total weight: 2000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	39 268	907	714.1	64.4	Probable early warning satellite

Dec. 29	*Cosmos 1519* USSR 1983-127A	Total weight: Unavailable Objective: Navigation; test elements of experimental system for locating USSR civil aviation plus merchant marine and fishing ships Description: Unavailable	19 156	19 102	675.7	64.9	Multiple launch (3 navsats) to complete Soviet GLONASS system of 9 with *Cosmos 1413–1415* (launched Oct. 1982) and *Cosmos 1490–1492* (launched Aug. 1983)
	and						
	Cosmos 1520 USSrR 1983-127B		19 177	19 081	675.7	64.9	
	and						
	Cosmos 1521 USSR 1983-127C D-1-E Baykonur-Tyuratam		19 141	19 000	673.4	64.9	

SATELLITES, SPACE PROBES, AND MANNED SPACE FLIGHTS, 1984

SATELLITES, SPACE PROBES, AND MANNED SPACE FLIGHTS, 1984

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
Jan. 5	*Cosmos 1522* USSR 1984-1A	Total weight: 40 kg? Objective: Communications Description: Spheroid?	1490	1460	115.4	74.0	Multiple launch (8 spacecraft) probably for military communications among field units
	and						
	Cosmos 1523 USSR 1984-1B	Total weight: 40 kg? Objective: Communications Description: Spheroid?	1460	1393	114.4	74.0	
	and						
	Cosmos 1524 USSR 1984-1C	Total weight: 40 kg? Objective: Communications Description: Spheroid?	1461	1409	114.6	74.0	
	and						
	Cosmos 1525 USSR 1984-1D	Total weight: 40 kg? Objective: Communications Description: Spheroid?	1460	1425	114.7	74.0	
	and						
	Cosmos 1526 USSR 1984-1E	Total weight: 40 kg? Objective: Communications Description: Spheroid?	1461	1440	114.9	74.0	
	and						
	Cosmos 1527 USSR 1984-1F	Total weight: 40 kg? Objective: Communications Description: Spheroid?	1461	1456	115.1	74.0	

	and						
	Cosmos 1528 USSR 1984-1G	Total weight: 40 kg? Objective: Communications Description: Spheroid?	1474	1460	115.3	74.0	
	and						
	Cosmos 1529 USSR 1984-1H C-1 Plesetsk	Total weight: 40 kg? Objective: Communications Description: Spheroid?	1508	1461	115.6	74.0	
Jan. 11	*Cosmos 1530* USSR 1984-2A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	415	356	92.3	72.8	Probable military photo reconnaissance satellite; reentered Jan. 25
	Cosmos 1531 USSR 1984-3A C-1 Plesetsk	Total weight: 700 kg? Objective: Navigation Description: Cylinder 2m in length and dia, with domed ends, enclosed in drum-shaped solar array	1007	978	105.0	82.9	
Jan. 14	*Cosmos 1532* USSR 1984-4A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	355	167	89.8	67.1	Probable military photo reconnaisance satellite; reentered Feb. 26
Jan. 23	*Bs-2A* Japan 1984-5A N-11 Tanegashima	Total weight: Unavailable Objective: Provide TV links on K-band frequencies to remote areas of Japan Description: Cylinder 2m long, 1.3 dia, carrying dish aerial and 9m-span solar array	35 801	35 777	1436.3	0.0	Broadcast Satellite 2A, geostationary orbit at 100°E
Jan. 26	*Cosmos 1533* USSR 1984-6A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	414	348	92.2	70.4	Probable military photo reconnaissance satellite; reentered Feb. 9

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
	Cosmos 1534 USSR 1984-7A C-1 Plesetsk	Total weight: Unavailable Objective: Undisclosed Description: Unavailable	506	465	94.3	65.8	Probable eletronic ferret
Jan. 29	*China 14* PRC 1984-8A Long March 3 (New site)	Total weight: Unavailable Objective: Undisclosed Description: Unavailable	6586	460	163.4	36.2	Possible instrumented rocket stage for testing new launch facility or booster design; multiple orbit adjustments indicated test of apogee motor system
Jan. 31	DOD satellite U.S. 1984-9A Titan 34D ESMC	Total weight: Unavailable Objective: Undisclosed Description: Unavailable	Elements not available				Military launch for either early warning or communications use
Feb. 1	*Cosmos 1535* USSR 1984-10A C-1 Plesetsk	Total weight: 700 kg? Objective: Navigation Description: Cylinder 2m in length and dia with domed ends, enclosed in drum-shaped solar array	1015	951	104.8	83.0	
Feb. 3	*STS 41B* U.S. 1984-11A Challenger KSC	Total weight: 70T Objective: Launch 2 commercial satellites; carry out tests before Solar Maximum repair mission in April Description: Delta wing orbiter 37m long, 24m wingspan	322	306	90.6	28.5	Manned maneuvering unit tests successful. Crew (Vance Brand, commander; Bruce McCandless, Robert Stewart, Robert Gibson, Ron McNair) landed Feb. 11 at KSC, first orbiter to do so; 2 launches unsuccessful; robot arm failed in retrieval test

	and						
	Westar 6 U.S. 1984-11B Challenger (in orbit)	Total weight: 1200 kg (incl. fuel) Objective: Provide commlinks for use by Western Union Description: module; reentered Nov. 16	1216	303	99.8	27.7	Hughes-built satellite failed to reach intended geostationary orbit probably because of failure in payload-assist module; reentered Nov. 16
	and						
	IRT U.S. 1984-11C Challenger (in orbit)	Total weight: 234 kg Objective: Orbital testing of Shuttle's rendezvous techniques and capabilities Description: Spherical ballon	Similar to Challenger				*I*ntegrated *R*endezvous *T*arget ballon exploded while inflating after deployment
	and						
	Palapa B2 Indonesia 1984-11D Challenger (in orbit)	Total weight: 1200 kg (incl. fuel) Objective: Provide domestic communications for Indonesian govt. Description: Cylinder 2.8m long, 2.5m dia	1186	277	99.2	28.5	Hughes-built satellite failed to reach intended geostationary orbit probably because of failure in payload-assist module; reentered Nov. 16
Feb. 5	DOD satellite U.S. 1984-12A (No information on vehicle) WSMC	Total weight: Unavailable Objective: Undisclosed Description: Unavailable	Elements not available				Possible triple payload to perform radar surveillance
Feb. 8	*Cosmos 1536* USSR 1984-13A F Plcsetsk	Total weight: Unavailable Objective: Undisclosed Description: Unavailable	661	630	97.6	82.5	Probable electronic ferret
	Soyuz T-10 USSR 1984-14A A-2 Baykonur-Tyuratam	Total weight: 7000 kg? Objective: Carry long-stay crew to orbiting space station *Salyut 7* Description: Near-spherical with conical reentry module and cylindrical instrument unit carrying solar panels: 7.5m long, 22m dia	297 (orbit after docking)	289	90.3	51.6	Crew (Leonid Kizim, Vladimir Solovyev, Oleg Atkov) docked at *Salyut 7* forward port Feb. 9; vehicle returned Apr. 11 with crew of *Soyuz T-11* (1984-32A)

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
Feb. 14	*Ohzora* Japan 1984-15A M-35 Tanegashima	Total weight: 180 kg Objective: Study atmosphere between 10–130 km, also ionosphere in relation to South Atlantic magnetic anomaly Description: Cuboid 1m to a side, carrying 4 solar panels	776	346	95.9	74.6	Aeronomy satellite, part of Middle Atmosphere Program, carried optical sensors
Feb. 15	*Raduga 14* USSR 1984-16A D-1-E Baykonur-Tyuratam	Total weight: 2000 kg? Objective: Provide 24 hr radio, TV and telegraph links throughout USSR through Orbita system Description: Cylinder 5m long, 2m dia, carrying solar panels, with aerial array at one end	35 786	35 784	1436.0	0.5	Circular orbit at 85°E
Feb. 16	*Cosmos 1537* USSR 1984-17A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations Description: Unavailable	273	259	89.9	82.4	Probable photo reconnaissance satellite carrying earth resources package; reentered March 1
Feb. 21	*Progress 19* USSR 1984-18A A-2 Baykonur-Tyuratam	Total weight: 7000 kg? Objective: Carrying supplies and equipment to crew on orbiting *Salyut 7* Description: Like standard Soyuz T (see 1984-14A) except for nonrecoverable cargo module instead of reentry module	311	306	90.6	51.6	Docked at rear port of *Salyut 7* Feb. 23; undocked March 31; fired retrorocket Apr. 1 for destructive reentry over Pacific Ocean
	Cosmos 1538 USSR 1984-19A C-1 Plesetsk	Total weight: 700 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	807	775	100.7	74.0	Probable military comsat using data store-and-dump technique

Feb. 28	*Cosmos 1539* USSR 1984-20A Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	241	169	89.6	67.2	Probable military photo reconnaissance satellite; reentered Apr. 9
March 1	*Landsat* U.S. 1984-21A Delta WSMC	Total weight: 2000 kg Objective: Remote sensing of earth resources Description: Cylindrical, 4m long, 2 dia, carrying solar panel; dish aerial at one end	700	699	98.8	98.2	In circular, near-polar, sun-synchronous orbit, replacing disfunctioning *Landsat 4* (1982-72A)
	and						
	Uosat 2 U.K. 1984-21B Delta WSMC	Total weight: 50 kg Objective: Continue *Uosat 1's* space science education and space engineering; provide amateur radio users access to random memory for messages Description: Cuboid measuring 0.8×0.3×0.3	694	673	98.4	98.2	Piggyback payload was an educational spacecraft for scientific research, built and operated by Surrey Univ., launched by NASA for U.K.
March 2	*Cosmos 1540* USSR 1984-22A D-1-E Baykonur-Tyuratam	Total weight: 2000 kg? Objective: Experimental communications relay Description: Unavailable	35 816	35 750	1435.9	1.1	Circular orbit at 80°E; probably related to development of "Luch" satellite series
March 5	*Intelsat 5 F-8* ITSO 1984-23A Ariane V8 Kourou	Total weight: 1072 kg (in orbit) Objective: INTELSAT communications Description: Box 1.7×2.0×1.8m with 4m mast, 15.9m solar panel width	35 795	35 777	1436.1	0.0	Launched by ESA for ITSO
March 6	*Cosmos 1541* USSR 1984-24A A-2-e Plesetsk	Total weight: Unavailable Objective: Undisclosed Description: Unavailable	39 570	784	717.8	63.4	Probable early warning satellite
March 7	*Cosmos 1542* USSR 1984-25A A-2 Baykonur-Tyuratam	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	414	348	92.2	70.4	Probable military photo reconnaissance satellite; reentered March 21

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
March 10	*Cosmos 1543* USSR 1984-26A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	394	216	90.6	62.8	Probable military photo reconnaissance satellite; reentered Apr. 5
March 15	*Cosmos 1544* USSR 1984-27A F Plesetsk	Total weight: Unavailable Objective: Undisclosed Description: Unavailable	662	628	97.6	82.5	Probable electronic ferret
March 16	*Ekran 12* USSR 1984-28A D-1-E Baykonur-Tyuratam	Total weight: 2000 kg? (in orbit) Objective: Transmit programs of Central TV to collective stations in remote areas of USSR Description: Cylinder 5m long, 2m dia, with boom-mounted solar panels, carrying aerial array at one end	35 818	35 776	1436.6	0.7	Circular orbit at 99°
	Molniya 1-60 USSR 1984-29A A-2-e Plesetsk	Total weight: 1800 kg? Objective: Provide telephone, telegraph, and TV signals through Orbita system Description: Cylinder 3.4m long, 1.6m dia, housing payload and instruments, topped by conical motor, carrying windmill of 6 solar panels	39 855	491	717.6	63.4	
March 21	*Cosmos 1545* USSR 1984-30A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	415	356	92.3	72.8	Probable military photo reconnaissance satellite; reentered Apr. 5

March 29	*Cosmos 1546* USSR 1984-31A D-1-E Baykonur-Tyuratam	Total weight: 2000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	35 793	35 783	1436.2	0.6	Geostationary of 23°W; possibly part of development of Luch comsat series
April 3	*Soyuz T-11* USSR 1984-32A A-2 Baykonur-Tyuratam	Total weight: 7000 kg? Objective: Carrying visiting crew to orbiting *Salyut 7* Description: Near-spherical, 7.5m long, 2.2 dia, conical reentry module, cylindrical instrument unit with solar panels	296	284	90.3	51.6	Crew (Yuri Malyshev, Gennady Strekalov, India cosmonaut Rakesh Sharma) docked Apr. 4 at rear port of *Salyut 7*; returned to earth Apr. 11 in *Soyuz T-10* vehicle. Resident crew undocked *T-11* Apr. 13, redocked at forward port to permit Progress docking
April 4	*Cosmos 1547* USSR 1984-33A A-2-e Plesetsk	Total weight: 1800 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	39 323	1034	717.9	63.0	Probable early warning satellite
April 6	*STS 41-C* U.S. 1984-34A Challenger KSC	Total weight: Unavailable Objective: Capture and repair Solar Maximum Mission satellite (1980-14A); launch long-duration exposure facility Description: Standard Shuttle orbiter.	498	493	94.3	28.5	11th Shuttle flight (crew, Robert Crippen, Francis Scobee, Terry Hart, George Nelson, James van Hoften) launched *LDEF* Apr. 7. Captured *SMM* Apr. 10, using remote manipulator, brought it to bay for Nelson and van Hoften to repair during EVA Apr. 12 and return it to orbit that day. Challenger landed at Edwards AFB, Calif., because of weather at KSC
	and						
April 7	*LDEF* U.S. 1984-34B Challenger Cargo bay	Total weight: 9707 kg Objective: Long Duration Exposure Facility, designed to exposure samples of materials, electronic systems, scientific packages to prolonged period of space conditions Description: Twelve-sided prism 9.1m long 4.3 dia	480	477	94.2	28.5	Launched Apr. 7 from Challenger in orbit; due for retrieval by STS mission early in 1985

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
April 8	*China 15* PRC 1984-35A Long March 3 (new site)	Total weight: Unavailable Objective: Test of comsat Description: Unavailable	35 793	35 784	1436.2	1.1	Geostationary at 125°E
April 10	*Cosmos 1548* USSR 1984-36A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	334	167	89.5	67.2	Probable military photo reconnaissance satellite; reentered May 25
April 14	DOD satellite U.S. 1984-37A Titan 34D ESMC	Total weight: Unavailable Objective: Undisclosed Description: Unavailable	Elements not available				Probable military early warning satellite
April 15	*Progress 20* USSR 1984-38A A-2 Baykonur-Tyuratam	Total weight: Unavailable Objective: Deliver consumables and other material to crew aboard orbiting *Salyut 7* Description: Unavailable	326	284	90.6	51.6	Docked at rear port of *Salyut 7* Apr. 17, undocked May 6 after unloading; reentered atmosphere on command May 7
April 17	DOD satellite U.S. 1984-39A Titan 3B-Agena D (?) WSMC	Total weight: Unavailable Objective: Undisclosed Description: Unavailable	311	127	88.9	96.4	Probable military photo reconnaissance satellite; reentered Aug. 13
April 19	*Cosmos 1549* USSR 1984-40A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	415	356	92.3	72.9	Probable military photo reconnaissance satellite; reentered May 3

April 22	*Horizont 9* USSR 1984-41A D-1-E Baykonur-Tyuratam	Total weight: 2000 kg? Objective: Provide telephone, telegraph, and TV communications inside and outside USSR Description: Unavailable	35 910	35 668	1436.3	0.8	Geosynchronous at 53°E
May 7	*Progress 21* USSR 1984-42A A-2 Baykonur-Tyuratam	Total weight: Unavailable Objective: Deliver consumables including propellants and equipment to crew aboard orbiting *Salyut 7* Description: Unavailable	316	276	90.4	51.6	Docked at rear port of *Salyut 7* May 10, undocked May 26 after unloading; reentered atmosphere on command same day
May 11	*Cosmos 1550* USSR 1984-43A C-1 Plesetsk	Total weight: 700 kg? Objective: Navigation Description: Cylinder with domed ends, 2m in length and dia, enclosed in drum-shaped solar array	1010	971	104.9	83.0	
	Cosmos 1551 USSR 1984-44A A-2-e Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	279	196	89.3	72.9	Probable military photo reconnaissance satellite; reentered May 23
May 14	*Cosmos 1552* USSR 1984-45A A-2 Baykonur-Tyuratam	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	322	182	89.5	64.9	Probable military photo reconnaissance satellite; reentered Nov. 3
May 17	*Cosmos 1553* USSR 1984-46A C-1 Plesetsk	Total weight: 700 kg? Objective: Navigation Description: Cylinder with domed ends, 2m in length and dia, enclosed in drum-shaped solar array	1007	958	104.7	82.9	
May 19	*Cosmos 1554* USSR 1984-47A D-1-E Baykonur-Tyuratam	Total weight: 6000 kg? Objective: Navigation Description: Unavailable	19 173	19 085	675.7	64.9	Multiple launch (3 spacecraft) as part of GLONASS navsat program

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
	and						
	Cosmos 1555 USSR 1984-47B	Total weight: 6000 kg? Objective: Navigation Description: Unavailable	19 149	19 109	675.7	64.9	
	and						
	Cosmos 1556 USSR 1984-47C	Total weight: 6000 kg? Objective: Navigation Description: Unavailable	19 157	19 131	676.3	64.9	
May 22	*Cosmos 1557* USSR 1984-48A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	247	211	89.2	82.3	Probable photo reconnaissance satellite carrying earth resources package; recovered June 4
May 23	*Spacenet 1* ESA 1984-49A Ariane 1 Kourou	Total weight: 705 kg (in orbit) Objective: Comsat, owned by GTE (U.S.) Description: Box with 2 solar panels	35 790	35 784	1436.1	0.0	Geosynchronous at 120°W
May 25	*Cosmos 1558* USSR 1984-50A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	294	168	89.1	67.2	Probable military photo reconnaissance satellite; reentered July 8
May 28	*Progress 22* USSR 1984-51A A-2 Baykonur-Tyuratam	Total weight: 7000 kg? Objective: Deliver fuel, scientific equipment, maintenance materials to crew on orbiting *Salyut 7* Description: Near-spherical supply compartment, conical fuel tank, cylindrical instrument unit; 7.5m long, 2.2m dia	358	334	91.4	51.6	Docked at rear port of *Salyut 7* May 30; reentered July 15

Cosmos 1559 USSR 1984-52A C-1 Plesetsk	Total weight: 40 kg? Objective: "Continuation of outer space investigations" Description: Spheroid?	1509	1467	115.7	74.0	Multiple launch (8 spacecraft), probable military comsats
and						
Cosmos 1560 USSR 1984-52B	Total weight: 40 kg? Objective: "Continuation of outer space investigations" Description: Spheroid?	1491	1468	115.5	74.0	
and						
Cosmos 1561 USSR 1984-52C	Total weight: 40 kg? Objective: "Continuation of outer space investigations" Description: Spheroid?	1484	1459	115.4	74.0	
and						
Cosmos 1562 USSR 1984-52D	Total weight: 40 kg? Objective: "Continuation of outer space investigations" Description: Spheroid?	1475	1451	115.2	74.0	
and						
Cosmos 1563 USSR 1984-52E	Total weight: 40 kg? Objective: "Continuation of outer space investigations" Description: Spheroid?	1475	1435	115.0	74.0	
and						
Cosmos 1564 USSR 1984-52F	Total weight: 40 kg? Objective: "Continuation of outer space investigations" Description: Spheroid?	1473	1422	114.8	74.0	

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
	and						
	Cosmos 1565 USSR 1984-52G	Total weight: 40 kg? Objective: "Continuation of outer space investigations" Description: Spheroid?	1475	1406	114.7	74.0	
	and						
	Cosmos 1566 USSR 1984-52H	Total weight: 40 kg? Objective: "Continuation of outer space investigations" Description: Spheroid?	1472	1392	114.5	74.0	
May 30	*Cosmos 1567* USSR 1984-53A A-2 Baykonur-Tyuratam	Total weight: Unavailable Objective: "Continuation of outer space investigations" Description: Unavailable	441	426	93.3	65.0	Probable electronic ferret, over ocean areas
June 1	*Cosmos 1568* USSR 1984-54A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	414	356	92.3	72.8	Probable military photo reconnaissance satellite; reentered June 14
June 6	*Cosmos 1569* USSR 1984-55A A-2-e Plesetsk	Total weight: Unavailable Objective: Undisclosed Description: Unavailable	39 589	759	717.7	63.7	Probable early warning satellite

June 8	*Cosmos 1570* USSR 1984-56A C-1 Plesetsk	Total weight: 700 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	807	787	100.8	74.1	Probable military comsat using data store-and-dump technique
June 9	*Intelsat 5 F-9* USSR 1984-57A Atlas Centaur ESMC	Total weight: 1091 kg Objective: Comsat Description: Box 1.7×2.0×1.8m with 4m mast as aerial, 1.5m-wide solar array (not deployed)	1215	176	98.5	29.2	Spacecraft lost when Centaur stage began tumble after premature shutdown; reentered Oct. 24
June 11	*Cosmos 1571* USSR 1984-58A A-2 Baykonur-Tyuratam	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	415	348	92.2	70.0	Probable military photo reconnaissance satellite; reentered June 26
June 13	*Navstar 9* U.S. 1984-59A Atlas WSMC	Total weight: 800 kg Objective: Navigation Description: Box 2m each side, carrying 2 solar panels	20 333	20 029	718.0	62.6	
June 15	*Cosmos 1572* USSR 1984-60A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	272	259	89.9	82.4	Probable photo reconnaissance satellite carrying earth resources package; reentered June 29
June 19	*Cosmos 1573* USSR 1984-61A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	309	231	90.0	72.9	Probable military photo reconnaissance satellite; reentered June 28
June 21	*Cosmos 1574* USSR 1984-62A C-1 Plesetsk	Total weight: 700 kg? Objective: Navigation (also carried COSPAS-SARSAT radio receiver to monitor intl. distress-signal frequencies) Description: Unavailable	1006	964	104.8	83.0	Instrumented for search-and-rescue use

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
June 22	*Raduga 15* USSR 1984-63A D-1-E Baykonur-Tyuratam	Total weight: 2000 kg? Objective: Soviet domestic comsat Description: Cylinder 5m long, 2m dia with solar panels, aerial array at one end	35 803	35 772	1436.2	0.8	Circular orbit at 128°W
	Cosmos 1575 USSR 1984-64A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	275	261	89.9	82.3	Probable photo reconnaissance satellite carrying earth resources package; reentered July 7
June 25	DOD satellite U.S. 1984-65A Titan 3D WSMC	Total weight: 13 000 kg Objective: Military photo reconnaissance using film-return capsules Description: Cylinder 15m long, 3 dia	Elements not available				Carried electronic ferret as piggyback payload; reentered Oct. 18
	and						
	DOD satellite U.S. 1984-65B	Total weight: Unavailable Objective: Undisclosed Description: Unavailable	Elements not available				
June 26	*Cosmos 1576* USSR 1984-66A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	351	170	89.8	67.1	Probable military photo reconnaissance satellite; reentered Aug. 24
June 27	*Cosmos 1577* USSR 1984-67A C-1 Plesetsk	Total weight: 700 kg? Objective: Navigation Description: Unavailable	1009	954	104.7	83.0	

June 28	*Cosmos 1578* USSR 1984-68A C-1 Kapustin Yar	Total weight: Unavailable Objective: Undisclosed Description: Unavailable	1622	296	104.3	50.7	Probable military mission
June 29	*Cosmos 1579* USSR 1984-69A F-1 Baykonur-Tyuratam	Total weight: Unavailable Objective: Ocean reconnaissance Description: Unavailable	981	905	103.9	65.1	Radar monitoring satellite powered by nuclear reactor
	Cosmos 1580 USSR 1984-70A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	347	243	90.4	62.8	Probable military photo reconnaissance satellite; reentered July 13
July 3	*Cosmos 1581* USSR 1984-71A A-2-e Plesetsk	Total weight: Unavailable Objective: "Continuation of outer space investigations" Description: Unavailable	39 419	947	718.0	62.9	Probable early warning satellite
July 5	*Meteor 2-11* USSR 1984-72A F (?) Plesetsk	Total weight: 2200 kg? Objective: Remote sensing and visible and infrared imagery of earth's surface and cloudcover Description: Cylinder 5m long, 2 dia with 2 sun-seeking solar panels	958	938	104.0	82.5	
July 17	*Soyuz T-12* USSR 1984-73A A-2 Baykonur-Tyuratam	Total weight: 7000 kg? Objective: Carry visiting crew to orbiting space station *Salyut 7* and return Description: Near-spherical, 7.5m long and 2.2 dia, conical reentry module and cylindrical instrument unit with solar panels	354	334	91.4	51.6	Crew (Vladimir Dzhanibekov, Svetlana Savitskaya, Igor Volk) docked with rear port of *Salyut 7* July 18; first EVA by female July 25; crew returned to earth July 29 in T-12
July 19	*Cosmos 1582* USSR 1984-74A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	279	213	89.5	82.4	Probable photo reconnaissance satellite carrying earth resources package; entered Aug. 2

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
July 24	*Cosmos 1583* USSR 1984-75A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	416	356	92.3	72.9	Probable photo reconnaissance satellite; reentered Aug. 8
July 27	*Cosmos 1584* USSR 1984-76A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	365	180	90.0	82.4	Probable photo reconnaissance satellite carrying earth resources package; reentered Aug. 10
July 31	*Cosmos 1585* USSR 1984-77A A-2 Baykonur-Tyuratam	Total weight: 6000 kg? Objective: "Continuation of outer space investigtions" Description: Unavailable	302	174	89.3	64.7	Probable military photo reconnaissance satellite; reentered Sept. 28
Aug. 1	*Horizont 10* USSR 1984-78A D-1-E Baykonur-Tyuratam	Total weight: 2000 kg? Objective: Provide telephone, telegraph, and TV relay links inside and outside USSR Description: Cylinder 5m long, 2m dia, with 2 solar panels, aerial array at one end	35 812	35 760	1436.1	1.1	Geosynchronous at 80°E
Aug. 2	*Cosmos 1586* USSR 1984-79A A-2-e Plesetsk	Total weight: 2000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	39 659	704	718.0	63.4	Probable early warning satellite

	GMS 3 (Himawari 3) USSR 1984-80A N-11 Tanegashima	Total weight: 303 kg (incl. fuel) Objective: Provide meteorological imagery in 4 visible and 1 infrared spectral band; procure data on proton, electron, and alpha-particle fluxes near satellite Description: Cylinder 4.4m high, 2.2 dia covered with solar cells; spin-stabilized with despun aerial array	35 796	35 783	1436.3	1.5	Geosynchronous at 140°E
Aug. 4	*ECS 2* ESA 1984-81A Ariane 3 Kourou	Total weight: 700 kg Objective: Provide telephone and TV links between member countries of European Post & Telecommunications Conference and the European Broadcasting Union Description: Box 2.4×2.2×2.2m with earth-pointing aerial array, 13.8m-span solar array, 3-axis-stabilized	36 826	34 749	1436.2	0.2	Geostationary at 7°E; 7yr design life
	and						
	Telecom 1A France 1984-81B	Total weight: 690 kg Objective: Provide natl. business communications, overseas TV and telephone, military point-to-point communications Description: Box 2×1.4×1.4m with earth-pointing aerial array, 3-axis-stabilized	35 792	35 782	1436.1	0.0	Launch of French piggyback payload of ESA's *ECS 2;* first of three; Geosynchronous at 8°W
Aug. 6	*Cosmos 1587* USSR 1984-82A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	416	356	92.3	72.9	Probable military photo reconnaissance satellite; reentered Aug. 31
Aug. 7	*Cosmos 1588* USSR 1984-83A F-1 Baykonur-Tyuratam	Total weight: Unavailable Objective: Ocean reconnaissance Description: Unavailable	441	427	93.3	65.0	Cf. *Cosmos 1579, 1567*
Aug. 8	*Cosmos 1589* USSR 1984-84A F (?) Plesetsk	Total weight: Unavailable Objective: Undisclosed Description: Unavailable	1499	1491	115.9	82.6	Cf. *Cosmos 1463* (1983-46A); possible geodetic satellite

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
Aug. 10	*Molniya 1-61* USSR 1984-85A A-2-e Plesetsk	Total weight: 1800 kg? Objective: Provide telephone, telegraph, and TV links through Orbita system Description: Cylinder 3.4m long, 1.6 dia with conical motor, windmill of 6 solar panels	38 700	651	717.7	62.9	
Aug. 14	*Progress 23* USSR 1984-86A A-2 Baykonur-Tyuratam	Total weight: Unavailable Objective: Carry food, fuel, mail, and scientific and technical equipment and materials to crew on orbiting *Salyut 7* Description: Unavailable	369	341	91.6	51.6	Docked with rear port of Salyut Aug. 16; undocked Aug. 26; destroyed upon reentry Aug. 28
Aug. 16	*Cosmos 1590* USSR 1984-87A A-2 Baykonur-Tyuratam	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	266	210	89.3	82.4	Probable photo reconnaissance satellite carrying earth resources package; reentered Aug. 30
	Ampte 1 (CCE) U.S. 1984-88A Delta EMSC	Total weight: 242 kg Objective: Active magnetospheric particle explorer to detect tracer ions released by German satellite Description: Octagonal prism 2m dia, 1m high, with solar panels on alternate sides	49 663	1130	939.5	5.1	Three-spacecraft mission (U.S. Charge Composition Explorer, FRG Ion-Release Mission, U.K. Satellite)
	and						
	Ampte 2 (IRM) FRG 1984-88B	Total weight: 605 kg Objective: Release clouds of lithium/barium ions to interact with magnetosphere, for detection by U.S. and U.K. satellites Description: Irregular cylinder 2m in length and dia	113 741	553	2655.7	28.7	Formed artificial comet in solar wind; first performance of such an experiment

	and						
	Ampte 3 (UKS) U.K. 1984-88C	Total weight: 77 kg Objective: Fly in formation with *Ampte 2*, measure disturbances during ion-cloud release Description: Multifacet prism 1.5m dia, 0.5 long	*See Ampte 2*				
Aug. 24	*Molniya 1-62* USSR 1984-89A A-2-e Plesetsk	Total weight: 1800 kg? Objective: Provide-telephone, telegraph, and TV links through Orbita system Description: Cylinder 3.4m long, 1.6 dia, with conical motor at one end windmill of 6 solar panels	39 927	421	717.7	63.0	
Aug. 25	*Ekran 13* USSR 1984-90A D-1-E Baykonur-Tyuratam	Total weight: 2000 kg Objective: Transmit programs of Central TV to collective receivers in remote areas of USSR Description: Cylinder 5m long, 2m dia with 2 boom-mounted solar panels, flat aerial array	35 804	35 767	1436.0	0.75	Geostationary at 99°E
Aug. 28	DOD satellite U.S. 1984-91A Titan 3B-Agena Vandenberg AFB	Total weight: Unavailable Objective: Undisclosed Description: Unavailable	39 315	380	703.8	63.3	Possible DOD Satellite Data Systems (SDS) spacecraft; 300th Titan launch, 126th success in 129 operational launches
Aug. 30	*Cosmos 1591* USSR 1984-92A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	263	209	89.3	82.3	Probable photo reconnaissance satellite satellite; reentered Sept. 13
	STS 41D U.S. 1984-93A Discovery KSC	Total weight: 70 T (not incl. payload) Objective: Fly Discovery orbiter for first first time; launch 3 comsats Description: Delta-wing vehicle 37m long, 24m span	314	297	90.4	28.5	Crew (Henry Hartsfield, Michael Coats, Steven Hawley, Richard Mullane, Judith Resnik, Charles Walker) launched 3 comsats; tested operation of an expandable 31m solar array; processed pharmaceuticals; landed Sept. 5 at Edwards AFB

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
	and						
	SBS 4 U.S. 1984-93B Discovery (in orbit)	Total weight: 1117 kg (including fuel) Objective: Commercial comsat (Satellite Business Systems) Description: Cylinder 2.8m long, 2.2 dia; 6.7 long with solar array extended	35 796	35 777	1436.1	0.3	Geosynchronous over 101°W
Aug. 31	*Syncom 4-2* U.S. 1984-93C Discovery (in orbit)	Total weight: Unavailable Objective: U.S. Navy communications Description: Cylinder 3m long, 4.2 dia	35 798	35 776	1436.1	3.2	Geosynchronous over 105°W
	and						
Sept. 1	*Telestar 3C* U.S. 1984-93D Discovery (in orbit)	Total weight: 653 kg Objective: Communications Description: Cylinder 2.8 long, 2.2 dia; 6.8 long with solar array extended	35 790	35 785	1436.1	0.0	Geosynchronous above 125°W
Sept. 4	*Cosmos 1592* USSR 1984-94A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	287	225	89.7	72.9	Probable military photo reconnaissance satellite; reentered Sept. 18
	Cosmos 1593 USSR 1984-95A D-1-Ee 1 Baykonur-Tyuratam	Total weight: 700 kg? Objective: Navigation Description: Cylinder?	19 165	19 093	675.7	64.8	Triple launch of satellites to form part of Soviet GLONASS Navigation system

	and						
	Cosmos 1594 USSR 1984-95B	Total weight: 700 kg? Objective: Navigation Description: Cylinder?	19 193	19 139	677.2	64.7	
	and						
	Cosmos 1595 USSR 1984-95C	Total weight: 700 kg? Objective: Navigation Description: Cylinder?	19 172	19 086	675.7	64.7	
Sept. 7	*Cosmos 1596* USSR 1984-96A A-2 Plesetsk	Total weight: 2000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	39 557	789	717.6	62.9	Probable early warning satellite
Sept. 8	*Navstar 10* U.S. 1984-97A Atlas Vandenberg AFB	Total weight: 800 Objective: Navigation Description: Box 2m per side, carrying 2 solar panels	20 410	19 954	718.0	63.3	
Sept. 12	*China 16* PRC 1984-98A FB-1 Shuang-Cheng-Tse	Total weight: Unavailable Objective: Undisclosed Description: Unavailable	400	174	90.3	67.9	Probable remote sensing or photo reconnaissance mission; capsule apparently recovered; upon Sept. 28 reentry
	Cosmos 1597 USSR 1984-99A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	244	211	89.1	82.3	Probable photo reconnaissance satellite carrying earth resources package; reentered Sept. 26
Sept. 13	*Cosmos 1598* USSR 1984-100A C-1 Plesetsk	Total weight: 700 kg? Objective: Navigation Description: Unavailable	1014	965	104.9	82.9	

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
Sept. 21	*Galaxy 3* U.S. 1984-101A Delta ESMC	Total weight: 520 kg Objective: Commercial comsat Description: Cylinder 2.8m long, 2.2 dia: 6.7m long with solar array extended	35 795	35 783	1436.2	0.0	Geosynchronous over 93.5°W
Sept. 25	*Cosmos 1599* USSR 1984-102A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	327	180	89.6	67.1	Probable military photo reconnaissance satellite: reentered Nov. 20
Sept. 27	*Cosmos 1600* USSR 1984-103A A-2 Baykonur-Tyuratam	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	416	349	92.2	69.0	Probable military photo reconnaissance satellite; reentered Oct. 11
	Cosmos 1601 USSR 1984-104A C-1 Plesetsk	Total weight: Unavailable Objective: Undisclosed Description: Unavailable	518	465	94.4	65.8	Possible military radar calibration satellite
Sept. 28	*Cosmos 1602* USSR 1984-105A F-2 Plesetsk	Total weight: 2000 kg? Objective: Remote sensing over ocean areas Description: Unavailable	664	629	97.7	82.5	
	and						
	Cosmos 1603 USSR 1984-106A D-1-E Baykonur-Tyuratam	Total weight: Unavailable Objective: Undisclosed Description: Unavailable	853	848	101.9	71.0	Probable launch vehicle engineering test

Oct. 4	*Cosmos 1604* USSR 1984-107A A-2-e Plesetsk	Total weight: 2000 kg? Objective: Undisclosed Description: Unavailable	39 677	689	718.0	62.9	Possible early warning comsat
Oct. 5	*STS 41G* U.S. 1984-108A Challenger KSC	Total weight: 70 T (not incl. payload) Objective: Fly crew of 7 to make observations of ocean and earth surface; launch ERBS; simulate refueling of a satellite; obtain high-resolution terrain imagery with SIR-B (shuttle imaging radar) Description: Delta-wing vehicle 37m long 24m wingspan	359	346	91.6	57.0	Crew: Robert Crippen, Jon McBride, David Leestma, Kathryn Sullivan, Sally Ride, Paul Scully-Power, and Canada's Marc Garneau. First EVA by American woman; Sullivan and Leestma performed refueling simulation to prepare for *Landsat 4* aid in 1987. Landed Oct. 13 at KSC
	and						
	ERBS U.S. 1984-108B Challenger (in orbit)	Total weight: Unavailable Objective: Study interaction of earth as radiator and as receiver of solar radiation Description: Designed to fit Shuttle payload bay; triangular, 4.6m base, 3.8 height, 1.5 deep, carrying pair of solar panels	608	598	96.8	57.0	*E*arth *R*adiation *B*udget *S*atellite, released by remote manipulator arm of Challenger
Oct. 11	*Cosmos 1605* USSR 1984-109A C-1 Plesetsk	Total weight: 700 kg? Objective: Navigation Description: Cylinder 2m in length and dia with domed ends; enclosed in drum-shaped solar array	1018	946	104.7	82.9	
Oct. 12	*Nova 3* U.S. 1984-110A Scout WSMC	Total weight: Unavailable Objective: U.S. Navy navigation Description: Unavailable	1198	1152	108.9	90.1	
Oct. 18	*Cosmos 1606* USSR 1984-111A F (?) Plesetsk	Total weight: 2000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	663	626	97.6	82.5	Probable electronic ferret

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
Oct. 31	*Cosmos 1607* USSR 1984-112A F-1 Baykonur-Tyuratam	Total weight: Unavailable Objective: "Continuation of outer space investigations" Description: Unavailable	261	249	89.6	65.0	Probable military ocean surveillance satellite using radar
Nov. 8	*STS 51A* U.S. 1984-113A Discovery KSC	Total weight: 70 T (not incl. payload) Objective: Fly crew of 5 to launch 2 satellites; retrieve 2 satellites left in unusable orbits by faulty rocket stages after *STS 41B* (1984-11A) Description: See 1984-108A	370	353	91.6	28.5	Crew: Frederick Hauck, David Walker, Anna Fisher, Joseph Allen, Dale Gardner. *Palapa B2* recovered Nov. 12; *Westar* recovered Nov. 14. Challenger landed Nov. 16 at KSC
	and						
Nov. 9	*Anik D2* Canada 1984-113B Discovery (in orbit)	Total weight: 110 kg (incl. fuel) Objective: Domestic Canadian comsat to be stored in orbit for 2 yr Description: Cylinder 2.8m long, 2.2 dia; 6.7m long with solar array deployed	35 800	35 772	1436.0	1.8	Geosynchronous at 111.5°W
	and						
Nov. 10	*Syncom IV-3* U.S. 1984-113C Discovery (in orbit)	Total weight: Unavailable Objective: U.S. Navy communications Description: Cylinder 3m long, 4.2 dia	35 847	35 727	1436.2	3.4	Geostationary above South America at 111.5°W
	Spacenet 2 ESA 1984-111A Ariane 3 Kourou	Total weight: 705 kg (in orbit, incl. fuel) Objective: Commercial comsat covering U.S., using C-band and K-Band Description: Box 1.6m×1.3×1, carying 14.3m wide 2-panel solar array	35 789	35 784	1436.1	0.0	Geosynchronous at 69°W

	and						
	Marecs B2 ESA 1984-114B	Total weight: 536 kg (in orbit, incl. fuel) Objective: Replace first Marecs B, lost Sept. 2, 1982, in malfunction of launch vehicle; maritime comsat using C-band and L-band to link satellite to ground, ships to satellite Description: Hexagonal prism 2m across, 2.5m long, carrying 13.8m span 2-panel solar array	35 802	35 779	1436.2	3.0	Geosynchronous at 177.5°E; carried maritime package leased from ESA by INMARSAT, also an emrgency search-and-rescue beacon locator
Nov. 14	*NATO 3D* NATO 1984-115A Delta ESMC	Total weight: 320 kg (in orbit) Objective: Military comsat Description: Spin-stabilized cylinder 2.2m in length and dia	35 612	35 571	1426.2	5.9	Geosynchronous at 50°W; 4th of *NATO 3* series, replacing one of earlier 3; launched by NASA for NATO
	Cosmos 1608 USSR 1984-116A A-2 Baykonur-Tyuratam	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	250	195	89.0	70.0	Probable military photo reconnaissance satellite; reentered Dec. 17
	Cosmos 1609 USSR 1984-117A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	414	356	92.3	72.9	Probable military photo reconnaissance satellite; reentered Nov. 28
Nov. 15	*Cosmos 1610* USSR 1984-118A C-1 Plesetsk	Total weight: 700 kg? Objective: Navigation Description: Cylinder 2m in length and dia with domed ends, enclosed in a drum-shaped solar array	1011	963	104.9	82.9	
Nov. 21	*Cosmos 1611* USSR 1984-119A A-2 Baykonur-Tyuratam	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	299	173	89.2	64.7	Probable military photo reconnaissance satellite

Launch Date	Spacecraft, Country, Int'l Designation, Vehicle Launch Site	Payload Data	Apogee (km)	Perigee (km)	Period (min)	Inclination (degrees)	Remarks
Nov. 27	*Cosmos 1612* USSR 1984-120A F (?) Plesetsk	Total weight: 2200 kg? Objective: Undisclosed Description: Unavailable	808	132	94.0	82.6	Probably launched to replace *Meteor 2-8* (1982-25A); failure of booster to shut down prevented achievement of designated 950km circular orbit
Nov. 29	*Cosmos 1613* USSR 1984-121A A-2 Plesetsk	Total weight: 6000 kg? Objective: "Continuation of outer space investigations" Description: Unavailable	414	356	92.3	72.8	Probable military photo reconnaissance satellite; reentered Dec. 24
Dec. 3	DOD satellite U.S. 1984-122A Titan 3D WSMC	Total weight: 13 000 kg Objective: Reconnaissance, using TV imaging Description: Cylinder 15m long, 3 dia	Elements not available				
Dec. 12	*NOAA 9* U.S. 1984-123A Atlas WSMC	Total weight: 1700 kg Objective: Meteorology Description: Box 4m long, 2 dia, single solar panel at one end	862	841	102.0	98.9	
Dec. 14	*Molniya 1-63* USSR 1984-124A A-2-e	Total weight: 1800 kg? Objective: Comsat, providing telephone, telegraph, and TV links through Orbita system Description: Cylinder 3.4m long, 1.6 dia, conical motor at one end, carrying windmill of 6 solar panels	39 888	461	717.7	62.8	

Dec. 15	*Vega 1* USSR 1984-125A D-1-E Baykonur-Tyuratam	Total weight: 4000 kg? Objective: Venus lander by June 1985; Halley's comet flyby, March 1986 Description: Cylinder 3m long, 2.5 dia; one end carried aeroshell containing Venus lander and balloon package; other end had movable scan platform for comet observations	Heliocentric orbit				At Venus encounter aeroshell would release Soviet-built lander into planet atmosphere, and French-built balloon (4m dia) to return meteorological data from attached probe
Dec. 19	*Cosmos 1614* USSR 1984-126A C-1 Kapustin Yar	Total weight: 1000 kg? Objective: Recovery test of Soviet "Shuttle" prototype Description: Delta-wing vehicle 3.5m long, 7.5 wing span	223	176	88.4	50.7	Space plane landed in Black Sea after 1 orbit (mission time, 110 min)
Dec. 20	*Cosmos 1615* USSR 1984-127A C-1 Plesetsk	Total weight: Unavailable Objective: Undisclosed Description: Unavailable	498	438	94.0	65.8	Probable military radar calibration mission
Dec. 21	*Vega 2* USSR 1984-128A D-1-E Baykonur-Tyuratam	Total weight, objective, description — Sec *Vega 1* (1984-125A)	Heliocentric orbit				
Dec. 22	DOD satellite U.S. 1984-129A Titan 34D ESMC	Total weight: Unavailable Objective: Undisclosed synchronous Description: Unavailable	Elements not available				Probable military comsat

Appendix B

MAJOR NASA LAUNCHES, 1979–1984

The following table lists payloads launched in 1979 through 1984 by NASA or under NASA direction on vehicles larger than sounding rockets.

During 1979, NASA launched 8 spacecraft (with 8 payloads), only 3 for its own programs: the stratospheric gas and aerosol experiment (*SAGE*), the third high-energy astronomy observatory *Heao 3*, and *Magsat*. The 5 launches for others in 1979 included 2 for DOD, *SCATHA* for the U.S. Air Force and *FltSat-Com 2* for the Navy; *Ariel 6* for the United Kingdom; *Westar 3* for Western Union; and RCA Satcom for RCA; the last mentioned was the only failure.

During 1980, NASA launched 7 spacecraft, only 1 for its own programs, the solar-maximum mission (*SMM*). The other 6 were *FltSatComs 3*and *4* for DOD; 2 for NOAA, NOAA-B (which proved inoperable when its booster sent it to the wrong altitude) and *Goes 4*; *Sbs 1* for Satellite Business Systems; and *Intelsat 5* for INTELSAT.

During 1981 NASA launched 13 spacecraft with 15 payloads, including 4 for its own programs, the manned STS-1 and STS-2 launches and unmanned *Dynamics Explorer 1* and *2* (a dual payload launch) and *Solar Mesosphere Explorer* and *UOSAT* (also a dual payload launch). NASA launched *Comstar D-4* for Comsat General Corp.; *NOVA 1* for the U.S. Navy; *Goes 5* and *NOAA 7* for NOAA; *Intelsat 5B-Fl* and *Intelsat 5 f-3* for INTELSAT; *FltSatCom 5* for DOD; *SBS 2* for Satellite Business Systems; and *RCA Satcom 3R* for RCA.

During 1982 NASA launched 12 spacecraft with 13 payloads, including 4 for its own programs, the manned STS-3, STS-4, and STS-5 and unmanned *Landsat 4*. NASA launched *RCA Satcom 4* and *5 for RCA, Westar 4* and *5* for Western Union Telegraph Company, *Intelsat 5 F-4* and *Intelsat 5 F-5* for INTELSAT, *Insat 1A* for the Indian Department of Space, *Anik D-1* and *Anik C-3* (from STS-5) for Telesat Canada, and *SBS 3* (from STS-5) for Satellite Business Systems.

During 1983 NASA launched 15 spacecraft with 19 payloads, including 7 for its own programs, the manned STS-6, STS-7, and STS-8 and the *Infrared Astronomical Satellite* (IRAS, a joint program with the United Kingdom and the Netherlands), *TDRS 1*, *NOAA 8* (a search and rescue satellite), and *EXOSAT*. NASA launched *RCA Satcom 6* and *7* for RCA, *Goes 6* for NOAA, *Intelsat 5 F-6* for INTELSAT, *Anik C-2* (from STS 7) for Telesat Canada, *Palapa B-1* (from STS 7) for Indonesia, *Spas 01* (from STS 7) for MBB of Munich, West Germany, *HILAT* for the U.S. Air Force, *Galaxy 1* and *2* for the Hughes Aircraft Co., *Telestar 3A* for AT&T, *Insat 1B* (from STS 8) for India.

During 1984 NASA launched 11 spacecraft with 24 payloads (3 unsuccessful), including 10 for its own programs, the manned STS-41B, STS-41C, STS-41D, STS-41G, and STS-51A and *IRT* (from STS-41B, a balloon that exploded during inflation), *Landsat 5, Long Duration Exposure Facility* (from STS-41C), *Charge Composition Explorer* (from STS-41C as part of AMPTE), and *Earth Radiation Budget Satellite* (from STS-41G). NASA launched Westar 6 (from STS-41B for Western Union, unsuccessful), Palapa B2 (from STS-41B for Indonesia, unsuccessful), *UOSAT 2* (a piggyback on Landsat 5 for U.K. amateur radio operators), *Intelsat 5 F-9* for INTELSAT, *Ion Release Module* (built by West Germany as part of AMPTE), *AMPTE 3* (third AMPTE satellite built by U.K.), *Syncom 4-2* for U.S. Navy, *Telestar 3C* for AT&T, *Galaxy 3* for Hughes, *NOVA 3* for the U.S. Navy, *Anik D2* (from STS-51A) for Telesat Canada, *Syncom IV-1* (from STS-51A) for the U.S. Navy, *NATO 3D* for the U.S. Air Force, and *NOAA 9* for NOAA.

Further information on these launches appears in Appendix A and in the indexed entries in the text.

1979–1984

MAJOR NASA LAUNCHES, 1979–1984

Launch Date	Spacecraft Int'l Designation	General Mission	Launch Vehicle Site	Performance		Remarks
				Vehicle	Payload	
1979						
Jan. 30	*SCATHA* 1979-7A	To place the USAF satellite into elliptical orbit in order to identify and measure sources of electrical charge buildup which have disabled or affected high-altitude satellites	Delta ESMC	S	S	*S*pacecraft *C*harging *AT H*igh *A*ltitudes. 11 of the 3 NASA and 9 DOD experiments operated successfully
Feb. 18	*SAGE* (AEM B) 1979-13A	To obtain a global data base for stratospheric aerosols and ozone	Scout-D WSMC	S	S	*S*tratospheric *A*erosol and *G*as *E*xperiment
May 4	*FltSatCom 2* 1979-38A	To provide communication capability for the USAF with narrowband and wideband channels and for the USN for fleet relay and fleet broadcast channels	Atlat-Centaur ESMC	S	S	Second of 5 planned satellites. May 6 successful firing of the apogee kick motor placed spacecraft in geosynchronous orbit over the Atlantic at 23°W
June 2	*Ariel 6* (UK6) 1979-47A	To conduct high-energy astrophysics research into cosmic radiation	Scout D WSMC	S	S	Sixth satellite in cooperative US/UK program. 100th launch of Scout booster. Turned over to the United Kingdom on June 2
June 27	*NOAA 6* 1979-57A	To acquire quantitative data of the global atmosphere for use in numerical models to extend and improve long-range weather forecasting ability	Atlas F WSMC	S	S	Second of latest metesat configurations launched for NOAA into near-polar orbit; twin of TIROS-11 (1979-96A). Turned over to NOAA for operation on July 16
Aug. 10	*Westar 3* 1979-72A	To launch into synchronous orbit a general purpose telecommunications satellite designed to provide transmission throughout the continental U.S., Alaska, Hawaii and Puerto Rico	Delta ESMC	S	S	NASA launched comsat, owned by Western Union Telegraph Co. and built by Hughes Aircraft, on a reimbursable basis
Sept. 20	*HEAO 3* 1979-82A	To measure the spectrum and intensity of sources of gamma radiation and the composition of primary basic radiation	Atlas-Centaur ESMC	S	S	*H*igh *E*nergy *A*stronmical *O*bservatory. Last Spacecraft in series; first two concentrated on x-ray sources

Oct. 30	*Magsat* (AEM C) 1979-94A	To measure the near-Earth magnetic field and to map crustal anomalies	Scout G WSMC	S	S	*M*agnetic Field *Sat*ellite. Third in a series of low-cost modular design *A*pplications *E*xplorer *M*issions
Dec. 7	*RCA-Satcom* 1979-101A	To provide commercial communications services throughout the U.S.	Delta ESMC	S	U	Launched by NASA on a reimbursable basis for Radio Corporation of America. Satellite lost when apogee motor fired to inject it into geostationary orbit; subsequent attempts to locate spacecraft have failed
1980						
Jan. 18	*FltSatCom 3* 1980-4A	To provide two-way communications in the 240 to 400 MHz frequency band, serving Atlantic area users	Atlas-Centaur ESMC	S	S	Third of this series of comsats launched by NASA for DOD; in synchronous orbit at 23°W. This enabled *FltSatCom 2* to be moved to a station at 75°E to carry Indian Ocean traffic
Feb. 14	*SMM* 1980-14A	To observe the sun and solar corona during 1980–81 maximum of the sunspot cycle and to measure gamma ray, X-ray, and ultraviolet emissions and the solar constant	Delta ESMC	S	S	*S*olar *M*aximum *M*ission spacecraft designed for retrieval from orbit by a Space Shuttle mission
May 29	*NOAA B* 1980-43A	To provide systematic global meteorological observations	Atlas F WSMC	U	U	Launched by NASA for NOAA, mission failed when booster failed to inject the metesat into the intended orbit. Spacecraft inoperable; reentered May 3, 1981
Sept. 9	*GOES 4* 1980-74A	To provide near-continuous monitoring of atmospheric water vapor and temperatures in order to analyze storms and the weather phenomena they produce	Delta ESMC	S	S	*G*eostationary *O*perational *E*nvironmental *S*atellite launched by NASA for NOAA, located at 90°W
Oct. 31	*FltSatCom 4* 1980-87A	To provide 23 ultra high frequency channels and 1 super high frequency channel to enable communications between naval aircraft, ships, submarines, ground stations, and presidential command networks	Atlas-Centaur ESMC	S	S	Military comsat launched by NASA for DOD, stationed at 172°E
Nov. 15	*SBS 1* 1980-91A	To establish commercial communications system covering continental U.S.	Delta ESMC	S	S	First of 3 similar satellites launched by NASA for *S*atellite *B*usiness *S*ystems Inc.; first mission using solid fuel Payload Assist Module instead of usual Delta third stage; satellite orbiting at 106°W

Launch Date	Spacecraft Int'l Designation	General Mission	Launch Vehicle Site	Performance		Remarks
				Vehicle	Payload	
Dec. 6	*Intelsat 5 F-2* 1980-98A	To orbit the first of a new series of Intelsat comsats designed to provide communications relay for commercial television and telephone, with double the capability of Intelsat comsats	Atlas-Centaur ESMC	S	S	Inserted into synchronous orbit at 21.5°W to serve as Intelsat's primary Atlantic Ocean satellite. The new series built for Intelsat by Ford Aerospace
1981						
Feb. 21	*Comstar D-4* 1981-18A	To provide domestic commercial communications for the U.S. mainland, Hawaii, Alaska and Puerto Rico	Atlas-Centaur ESMC	S	S	Last in series of 4 domestic comsats launched for Comsat General Corp.; leased to AT&T. Became operational May 5 on station at 127°W.
April 12	*STS 1* 1981-34A	To flight test Space Transportation System	Columbia KSC	S	S	First flight of Space Shuttle in orbit and first landing from orbit of reusable spacecraft. Astronauts John Young and Robert Crippen landed April 14 at Edwards AFB, Calif.
May 15	*NOVA 1* 1981-44A	To enable Navy to provide worldwide positional data to military and commercial users	Scout WSMC	S	S	First of series of improved satellites to substitute for the Navy's earlier navigation satellites (Transits)
May 22	*GOES 5* 1981-49A	To provide near-continuous, high resolution imaging over North and South America and surrounding oceans for meteorological forecasting	Delta ESMC	S	S	Launched for NOAA. Second of 3 satellites to replace initial 3 operational satellites. Turned over to NOAA July 2; became operational Aug. 5
May 23	*Intelsat 5B-F1* 1981-50A	To orbit the second in a series of new Intelsat comsats for service between North America and Europe	Atlas-Centaur ESMC	S	S	Operational July 14 after placement at 24.5°W. Became Atlantic area primary satellite when Intelsat 5A (1980-98A) developed hardware problems
June 23	*NOAA 7* 1981-59A	To launch spacecraft into sun-synchronous orbit of sufficient accuracy to enable it to make dependable daytime and nighttime meteorological observations of the Earth	Atlas F WSMC	S	S	Third in a series of operational environment monitoring satellites; joined NOAA 6 in orbit as part of two-satellite operating system. Turned over to NOAA July 13, became operational Aug. 24

Aug. 3	*Dynamics Explorer 1* (DE 1) 1981-70A	To study interaction between Earth's magnetosphere, ionosphere and atmosphere in higher region than DE 2	Thor-Delta WSMC	S	S	Dual launch placed NASA's DE 1 and DE 2 in polar, coplanar orbits. Minimum scientific lifetime of 1 yr planned for both craft. Mission success relied on correlative sets of measurements from 2 satellites. Final orbits somewhat lower than intended, but suitable to fulfill scientific mission. Returned first color views from space of auroras at North and South Poles
	Dynamics Explorer 2 (DE 2) 1981-70B	Same as Dynamics Explorer 1	Same as DE 1	S	S	See above
Aug. 6	*FltSatCom 5* 1981-73A	To assist USAF narrow band and wide band communications and USN fleet relay and broadcast channels	Atlas-Centaur ESMC	S	S	Last of 5 comsats in series replacing DOD-leased channels on civilian Marisat system. Slight structural damage to satellite occurred during orbital insertion, limiting communications ability
Sept. 24	*SBS 2* 1981-96A	To provide integral, all-digital, interference-free transmission of telephone computer, electronic mail and video teleconferencing to SBS clients	Thor-Delta ESMC	S	S	Second of 4 domestic comsats built by Hughes Aircraft for Satellite Business Systems. Located at 97°W. Commercial operations began Dec. 15
Oct. 6	Solar Mesosphere Explorer (SME) 1981-100A	To study reactions between sunlight, ozone and other chemicals in the atmosphere and how concentrations of ozone are transported in the region from 30- to 90- km altitude	Thor-Delta WSMC	S	S	Dual launch orbited NASA's SME and UOSAT (below). Instruments returning data for first comprehensive global study of creation and destruction of ozone
	UOSAT 1981-100B	To provide radio amateurs and schools with operational satellite requiring minimal ground station support for studying ionosphere and radio propagation conditions	Same as SME	S	S	U.K. amateur scisat, launched by NASA for secondary payload with SME

Launch Date	Spacecraft Int'l Designation	General Mission	Launch Vehicle Site	Performance		Remarks
				Vehicle	Payload	
Nov. 12	*STS 2* 1981-111A	To demonstrate reusability of orbiter; launch in-orbit and entry performance under more demanding conditions than for STS 1. Test orbiter capability to support scientific and applications research with attached payload, and test remote manipulator system (RMS)	Columbia KSC	S	S	Second of 4 planned orbital flight tests of Space Transportation System, carrying astronauts Joe H. Engle and Richard H. Truly. After entering orbit, fuel cell problems reduced planned 5 day journey to minimal mission of 36 orbits. Package of OSTA scientific experiments returned good data. RMS performed well except that it would not be cradled in backup mode. Columbia landed at Edwards AFB on Nov. 14 after flight of 2 da, 6 hr, 13 min
Nov. 20	*RCA Satcom 3R* 1981-114A	To provide domestic TV, voice channel and high-speed data transmission and video programming to cable TV systems throughout the U.S.	Thor-Delta ESMC	S	S	Fourth in a series of RCA commercial comsats; situated at 132°W. Replaced RCA Satcom 3 which was lost in space (see 1979-101A)
Dec. 15	*Intelsat 5 F-3* 1981-119A	To provide 12 000 two-way voice circuits plus 2 color TV channels simultaneously	Atlas-Centaur ESMC	S	S	World's largest commercial comsat, third in series of 9, launched by NASA for Intelsat
1982						
Jan. 16	*RCA Satcom 4* 1982-4A	To transmit television, voice channels and high-speed data to the entire U.S. and to provide video programming for CATV (cable television) systems throughout the U.S.	Thor-Delta ESMC	S	S	Fifth in a series of RCA commercial domestic comsats; in geosynchronous orbit at 83°W
Feb. 26	*Westar 4* 1982-14A	To transmit television, voice, and facsimile data over 24 channels to entire U.S.	Thor-Delta ESMC	S	S	First in a series of 2nd-generation satellites built by Hughes Aircraft for Western Union Telegraph Co. Placed in synchronous orbit at 99°W as replacement for Westar 1 (1974-22A)

March 5	*Intelsat 5 F-4* 1982-17A	To provide 12 000 voice circuits and 2 color TV channels simultaneously for telephone and TV communications among Europe, Middle East and Far East	Atlas-Centaur ESMC	S	S	Fourth in a series of 9 comsats launched by NASA for Intelsat. Placed in synchronous orbit over Indian Ocean at 63°E
March 22	*STS 3* 1982-22A	To evaluate ascent, in-orbit, and entry performance under more exacting conditions than in STS 2; test remote manipulator; examine orbiter's response to long duration exposure to the sun; and conduct series of scientific and applications research with on-board Office of Space Science payload (OSS 1)	Columbia KSC	S	S	Third of 4 planned flight tests of STS. Columbia was put through extensive thermal testing at various altitudes. OSS 1 package and remote manipulator operated successfully. Crew (Jack R. Lousma and C. Gordon Fullerton) landed orbiter at White Sands, N.M., instead of Edwards AFB because of flooding produced by heavy rains at Edwards. Flight time: 8 da 4 hr 49 min
April 10	*Insat 1A* 1982-31A	To provide domestic communications, direct broadcast television and weather monitoring services for India	Delta ESMC	S	U	First of 2 comsats built by Ford Aerospace for the India Dept. of Space; positioned at 74°E. Problems occurred with release of C-band uplink antenna and solar sail. Satellite failed in September as a result of insufficient attitude control system propellant.
June 9	*Westar 5* 1982-58A	To relay voice, data, video, and facsimile communications throughout U.S.	Delta ESMC	S	S	Second in series of second-generation comsats built by Hughes Aircraft for Western Union; replaced Westar 2. On station at 123°W.
June 27	*STS 4* 1982-65A	To evaluate ascent, in-orbit, and entry performance under more exacting conditions than in STS 3; conduct long duration thermal-soak tests; and conduct scientific and applications research with varied onboard experiments	Columbia KSC	S	S	Last flight of Shuttle orbital test flight programs. Crew (Ken Mattingly and Henry Hartsfield) landed July 4 at Edwards AFB. Solid rocket boosters were not recovered from the Atlantic Ocean. Shuttle bay contained first get-away special and first DOD payload
July 16	*Landsat 4* 1982-72A	To obtain multispectral imagery using improved remote sensing and Earth resources techniques and equipment	Delta WSMC	S	S	Launched into near-polar sun-synchronous orbit. Multispectral scanner was activated July 19 and the new thematic mapper sensing system began transmitting data July 20

Launch Date	Spacecraft Int'l Designation	General Mission	Launch Vehicle Site	Performance		Remarks
				Vehicle	Payload	
Aug. 26	*Anik D-1* (Telesat G) 1982-82A	To provide expanded Canadian television, cable and long-distance telephone service	Delta ESMC	S	S	Launched for Telesat Canada into geosynchronous orbit 104°W; first use of Delta with payload assist module (PAM)
Sept. 28	*Intelsat 5 F-5* 1982-97A	To provide international telecommunications services to Europe, Africa, and Indian Ocean basin and, under lease agreement with Inmarsat, for maritime services for shipping	Atlas-Centaur ESMC	S	S	Geosynchronous orbit at 63°E
Oct. 27	*RCA Satcom 5* 1982-105A	To provide long-distance telecommunications within Alaska and between Alaska and continental U.S.	Delta ESMC	S	S	Advanced RCA Satcom using solid state power amplifiers instead of traveling wave tubes; on location at 143°W
Nov. 11	*STS 5* 1982-110A	To conduct first operational flight of Space Transportation System; to deploy 2 commercial comsats; to demonstrate extravehicular activity capability	Columbia KSC	S	S	First launch of 4-man crew (astronauts Vance Brand and Robert Overmyer; mission specialists Joseph Allen and William Lenoir. SBS 3 and Anik C-3 comsats launched from cargo bay. EVA canceled because of problems with both spacesuits. Columbia landed at Edwards AFB Nov. 16 after flight of 5 da 2 hr 14 min
	SBS 3 1982-110B	To provide business communications for Satellite Business Systems clients	Columbia (in orbit)	S	S	First satellite launch from STS cargo bay. Payload assist module (PAM-D) boosted satellite into geosynchronous orbit at 94°W
	Anik C-3 (Telesat 5) 1982-110C	To provide voice and television communications to a trans-Canada network of Earth stations	Columbia (in orbit)	S	S	Launched from STS cargo bay 7 min after SBS 3. PAM-D carried satellite into geosynchronous orbit at 117.5°W

1983

Jan. 26	*Infrared Astronomical Satellite* (IRAS) 1983-4A	To conduct atmospheric survey of objects that emit infrared radiation and prepare a catalog of infrared sources and an infrared sky map	Delta WSMC	S	S	Co-operative U.S.-Netherlands-U.K. venture
March 28	*NOAA 8* 1983-22A	To provide systematic global weather observations; to assist in search-and-rescue operations using the on-board SARSAT instrumentation package	Atlas E WSMC	S	S	*S*earch-*R*escue *Sat*ellite. First of Advanced Tiros-N spacecraft. Initial attitude control problems were rectified April 18; became operational June 20
April 4	*STS 6* 1983-26A	To deploy *T*racking and *D*ata *R*elay *S*atellite 1 (TDRS 1) comsat; engage in EVA; conduct a variety of scientific experiments; test vehicle performance	Challenger KSC	S	S	Second operational flight of Space Transportation System; first flight of Challenger. Crew (Paul Weitz, Karol Bobko, Donald Peterson, Story Musgrave) launched TDRS 1 with IUS booster. Musgrave and Peterson engaged in spacewalk in and around open cargo by April 7; first American EVA since 1974. Orbiter landed at Edwards AFB April 9 after flight of 5 day 24 min
April 5	*TDRS 1* 1983-26B	To provide improved tracking and data acquisition services to U.S. satellites	Challenger (in orbit)	U	S	Launched on first Shuttle-borne inertial upper stage (IUS-1). Second stage malfunction put satellite into lower than intended orbit. Subsequent firings of on-board thrusters maneuvered TDRS 1 to operational location at 41°W by Oct. 17
April 11	*RCA SatCom 6* 1983-30A	To provide TV, telephone and data transmission services throughout the U.S.	Delta ESMC	S	S	Second in series of advanced RCA comsats; to replace RCA-Satcom 1. Geostationary orbit at 128°W.
April 28	*GOES 6* 1983-41A	To provide near-continuous, high resolution visual and infrared imaging over North and South America and surrounding oceans	Delta ESMC	S	S	NOAA spacecraft joined GOES 5 (1981-49A) as part of dual operational system. Positioned May 12 at 135°W; became operational June 1
May 19	*Intelsat 5 F-6* 1983-47A	To provide 12 000 voice circuits and 2 color TV channels simultaneously	Atlas-Centaur ESMC	S	S	Placed in geosynchronous orbit over Atlantic Ocean

Launch Date	Spacecraft Int'l Designation	General Mission	Launch Vehicle Site	Performance		Remarks
				Vehicle	Payload	
May 26	*Exosat* 1983-51A	To conduct detailed studies of the precise position and structure, spectral and temporal characteristics of known x-ray sources and to search for new ones	Delta WSMC	S	S	Highly elliptical orbit above the North Pole designed for maximum observation
June 18	*STS 7* 1983-59A	To launch Anik C-2 and Palapa B-1 comsats; to test remote manipulator retrieval system in deployment and retrieval of the West German-made Shuttle pallet satellite (SPAS 01); to conduct several scientific experiments	Challenger KSC	S	S	Crew of Robert Crippen, Frederick Hauck, John Fabian, Sally Ride (first U.S. woman astronaut) and Dr. Norman Thagard deployed both comsats and SPAS 01. Landed at Edwards AFB after flight of 6 da 2 hr 24 min
	Anik C-2 (Telesat 7) 1983-59B	To provide for domestic Canadian TV and telephone communications	Challenger (in orbit)	S	S	Telesat Canada comsat launched from orbiter's cargo bay into geosynchronous orbit at 11.5°W
	Palapa B-1 1983-59C	To provide for domestic Indonesian telecommunications	Challenger (in orbit)	S	S	Indonesian comsat launched from orbiter's cargo bay into geosynchronous orbit over that country
	SPAS 01 1983-59F	To test the operation of a reusable satellite	Challenger (in orbit)	S	S	First shuttle cargo financed by a foreign commercial group (MBB of Munich); first time the remote manipulator arm had released and retrieved a payload
June 27	*HILAT* 1983-63A	To conduct atmospheric research	Scout WSMC	S	S	NASA launched USAF modified TRANSIT satellite
June 28	*Galaxy 1* 1983-65A	To relay TV programming to capable systems throughout the U.S. with 24 transponders available for sale or lease	Delta ESMC	S	S	Owned by Hughes Aircraft Co.; positioned at 134°E
July 28	*Telstar 3A* 1983-77A	To provide commercial communications channels for AT&T	Delta ESMC	S	S	Geostationary orbit at 87°W
Aug. 30	*STS 8* 1983-89A	To deploy Insat 1B and conduct various scientific experiments	Challenger KSC	S	S	First night launch of Shuttle. Crew (Richard Truly, Daniel Brandenstein, Dale Gardner, Guion Bluford and Dr. William Thornton) flew for 6 da 1 hr 9 min, landing Sept. 5 at Edwards AFB

	Insat 1B 1983-89B	To provide meteorological and communications service to India	Challenger (in orbit)	S	S	Launched from orbiter bay Aug. 31 to station above equator at 74°E
Sept. 8	*RCA Satcom 7* 1983-94A	To provide commercial communications services throughout the U.S.	Delta ESMC	S	S	Third in series of advanced comsats; to replace RCA-Satcom 2 (1976-29A). On station at 72°W.
Sept. 22	*Galaxy 2* 1983-98A	To relay business communications	Delta ESMC	S	S	Second in series; stationed in 74°W
Nov. 28	*STS 9* 1983-116A	To carry the ESA Spacelab on its first mission, with over 70 experiments in 5 areas of scientific research	Columbia KSC	S	S	Crew included the first foreign astronaut on a U.S. flight (payload specialist Ulf Merbold of West Germany) and the first payload specialists (Merbold and Dr. Byron Lichtenberg); other crewmembers were John Young, Brewster Shaw, Owen Garriott and Robert Parker. Mission was extended to 10 days while in flight; computer fault delayed landing by 7 hours and 47 minutes
1984						
Feb. 3	*STS 41B* 1984-11A	To deploy two comsats, test Shuttle rendezvous capabilities using the IRT, test the Manned Maneuvering Unit (MMU) and conduct several scientific experiments	Challenger KSC	S	S	First Shuttle flight under new numbering system. Crew (Vance Brand, Robert Gibson, Bruce McCandless, Ronald McNair and Robert Stewart) deployed Westar 6 and Palapa B2 comsats; both unsuccessful due to PAM-D failure. First use of MMU in space. Challenger became the first Shuttle to land at KSC, on Feb. 11 after flight of 7 da 23 hr 16 min
	Westar 6 1984-11B	To provide telecommunications services to domestic users	Challenger (in orbit)	U	U	PAM-D booster failure placed comsat in unusable low orbit. Satellite retrieved from space for refurbishment by Shuttle Discovery Nov. 14
Feb. 5	*IRT* 1984-11C	To act as target vehicle in test of Shuttle's rendezvous techniques and capabilities	Challenger (in orbit)	U	U	Balloon exploded while inflating after deployment
Feb. 6	*Palapa B2* 1984-11D	To provide for domestic Indonesian communications	Challenger (in orbit)	U	U	PAM-D booster failure placed comsat in unusuable low orbit. Satellite retrieved from space for refurbishment by Shuttle Discovery Nov. 14

Launch Date	Spacecraft Int'l Designation	General Mission	Launch Vehicle Site	Performance Vehicle	Performance Payload	Remarks
March 1	*Landsat 5* 1984-21A	To continue remote sensing program	Delta WSMC	S	S	In circular, near-polar, sun-synchronous orbit, replacing disfunctioning Landsat 4 (1982-72A)
	UOSAT 2 1984-21B	To provide communications relay for U.K. amateur radio operators	Delta WSMC	S	S	Piggyback payload on Landsat 5
April 6	*STS 41C* 1984-34A	To deploy the Long Duration Exposure Facility (LDEF-1) and retrieve, repair, and redeploy the Solar Maximum Mission (SMM) satellite	Challenger KSC	S	S	Crew (Robert Crippen, Francis Scobee, Terry Hart, George Nelson, and James van Hoften) launched LDEF Apr. 7. SMM retrieved from orbit Apr. 10, repaired, and redeployed Apr. 12. Challenger landed Apr. 13 at Edwards AFB after flight of 6 da 23 hr 41 min
April 7	*Long Duration Exposure Facility* (LDEF) 1984-34B	To expose scientific, applications and technology experiments to space conditions for an extended period	Challenger (in orbit)	S	S	Due for retrieval by STS mission in 1985
June 9	*Intersat 5 F-9* 1984-57A	To provide 12 000 voice circuits and 2 color TV channels simultaneously	Atlas-Centaur ESMC	U	U	Launch vehicle failed to boost comsat to desired orbit; reentered Oct. 24
Aug. 16	*Charge Composition Explorer* (CCE) (AMPTE 1) 1984-88A	To detect tracer ions in Earth's magnetosphere released by AMPTE 2	Delta ESMC	S	S	One of 3 satellites comprising *A*ctive *M*agnetospheric *P*article *T*racer *E*xplorers mission; all three launched together
	Ion Release Module (IRM) (AMPTE 2) 1984-88B	To release clouds of lithium/barium ions to interact with magnetosphere	see above	S	S	Second of 3 AMPTE satellites; built by West Germany
	United Kingdom Satellite (AMPTE 3) 1984-88C	To fly in formation with IRM, measuring disturbances during ion cloud release	see above	S	S	Third of 3 AMPTE satellites; built by U.K.
Aug. 30	*STS 41D* 1984-93A	To launch 3 comsats and conduct several scientific experiments	Discovery KSC	S	S	First flight of orbiter Discovery. Crew (Henry Hartsfield, Michael Coats, Steven Hawley, Richard Mullane, Judith Resnik and Charles Walker) returned Sept 5 to Edwards AFB after flight of 6 da 56 min

	SBS 4 1984-93B	To provide commercial telecommunications for Satellite Business Systems	Discovery (in orbit)	S	S	Comsat placed in geosynchronous orbit at 101°W
Aug. 31	*Syncom 4-2* (Leasat 2) 1984-93C	To provide for U.S. Navy communications under lease from Hughes Communication Service, Inc.	Discovery (in orbit)	S	S	Comsat placed in geosynchronous orbit at 105°W
Sept. 1	*Telestar 3C* 1984-93D	To provide domestic communications for AT&T	Discovery (in orbit)	S	S	Comsat placed in geosynchronous orbit at 125°W
Sept. 21	*Galaxy 3* 1984-101A	To relay business communications	Delta ESMC	S	S	On station over equator at 93.5°W
Oct. 5	*STS 41G* 1984-108A	To launch ERBS satellite and conduct several scientific experiments	Challenger KSC	S	S	First 7-person crew included Robert Crippen, Jon McBride, David Leestma, Kathryn Sullivan, Sally Ride, Paul Scully-Power and Marc Garneau. Scully-Power and Garneau were first Canadian astronauts. First EVA by an American woman. Challenger landed Oct. 13 at KSC after flight of 8 da 5 hr 24 min
	Earth Radiation Budget Satellite (ERBS) 1984-108B	To make global measurements of the Sun's radiation reflected and absorbed by Earth	Challenger (in orbit)	S	S	Released by Shuttle's remote manipulator arm. Partner with NOAA9 (1984-123A) and NOAA G (to be launched in 1985) in Earth Radiation Budget Experiment Research Program
Oct. 12	*NOVA 3* 1984-110A	To enable U.S. Navy to provide worldwide positional data to military and commercial users	Scout WSMC	S	S	Second in series of improved satellites to substitute for the Navy's earlier navsats (Transits)
Nov. 8	*STS 51A* 1984-113A	To launch 2 comsats and retrieve the inoperable Palapa B2 and Westar 6 comsats from space for return to Earth for repair; to conduct several scientific experiments	Discovery KSC	S	S	Crew of Frederick Hauck, David Walker, Joseph Allen, Anna Fisher and Dale Gardner landed at KSC Nov. 16 after flight of 7 da 23 hr 45 min

Launch Date	Spacecraft Int'l Designation	General Mission	Launch Vehicle Site	Performance Vehicle	Performance Payload	Remarks
Nov. 9	*Anik D2* 1984-113B	To provide domestic Canadian communications	Discovery (in orbit)	S	S	Delivered into synchronous orbit at 111.5°W
Nov. 10	*Syncom IV-1* 1984-113C	To provide for U.S. Navy communications under lease from Hughes Communication Services, Inc.	Discovery (in orbit)	S	S	Second of 4 satellites leased by Navy to replace FltSatCom spacecraft for worldwide UHF communications; placed at 111.5°W
Nov. 14	*NATO 3D* 1984-115A	To provide for NATO military communications	Delta ESMC	S	S	Fourth and last NATO 3 comsat launched by NASA on a fee basis for the USAF as agents for NATO; positioned at 50°W
Dec. 12	*NOAA 9* 1984-123A	To replace NOAA 7 as afternoon metesat on NOAA's two polar satellite systems; to perform radiation measurements as part of ERBE program	Atlas E WSMC	S	S	Fifth in Tiros-N series; in sun-synchronous orbit

Appendix C

ABBREVIATIONS OF REFERENCES

Listed here are the abbreviations used for citing sources in the text. Not all the sources are listed, only those that are abbreviated.

AAAS	American Association for the Advancement of Science's *AAAS Bulletin*
A&A	American Institute of Aeronautics and Astronautics' magazine, *Astronautics & Aeronautics*
ABC	American Broadcasting Company
AEC Release	Atomic Energy Commission
A/D	*Aerospace Daily* newsletter
Aero Mag	Air Force Association's *Air Force Magazine*
AFHF Newsletter	*Air Force Historical Foundation Newsletter*
AFJ	*Armed Forces Journal* magazine
AFSC *Newsreview*	Air Force Systems Command's *Newsreview*
AFSC Release	Air Force Systems Command news release
AIA Release	Aerospace Industries Association of America news release
AIA/PG&E/ARC	American Institute and Architects, Pacific Gas & Electric, and NASA's Ames Research Center Announcement
AIAA *Facts*	American Institute of Aeronautics and Astronautics' *Facts*
AIAA Release	American Institute of Aeronautics and Astronautics news release
AIP *Newsletter*	American Institute of Physics' *Newsletter*
AP	Associated Press news service
ARC anno	NASA Ames Research Center announcement
ARC *Astrogram*	NASA Ames Research Center's *Astrogram*
ARC Release	NASA Ames Research Center news release
Astro journ	American Astronomical Society's *Astrophysical Journal*
Atlanta JC	*Atlanta Journal Constitution* newspaper
AvWk	*Aviation Week & Space Technology* magazine
B News	*Birmingham News* newspaper
B Sun	Baltimore *Sun* newspaper
Bull Atom Sci	Education Foundation for Nuclear Science's *Bulletin of the Atomic Scientists*
Bus Wk	*Business Week* magazine

C Daily News	*Chicago Daily News* newspaper
C Trib	*Chicago Tribune* newspaper
Can Press	Canadian Press news release
CBS	Columbia Broadcasting System
C&E News	*Chemical & Engineering News* Magazine
Cl *PD*	Cleveland *Plain Dealer* newspaper
Cl Press	*Cleveland Press* newspaper
Columbia J Rev	*Columbia Journalism Review* magazine
ComSatCorp Release	Communications Satellite Corporation news release
ComSat Gnl Release	ComSat General news release
CQ	*Congressional Quarterly*
CR	*Congressional Record*
CSM	*Christian Science Monitor* newspaper
CTNS	Chicago Tribune News Service
D/SBD	*Defense/Space Business Daily* newspaper
D/SD	*Defense Space Daily newsletter*
D News	*Detroit News* newspaper
D Post	*Denver Post* newspaper
DASA Release	Defense Atomic Support Agency news release
Df Dly	*Defense Daily* newsletter
DFRC Release	Dryden Flight Research Center news release. Prior to 8 January 1976, Flight Research Center
DJ	Dow Jones news service
DOC PIO	Department of Commerce Public Information Office
DOC Release	Department of Commerce news release
DOD Release	Department of Defense news release
Dscvr	*Discover* magazine
DOT Release	Department of Transportation news release
Dtln Gd	NASA Goddard Space Flight Center's *Dateline Goddard*
EOP Release	Executive Office of the President news release
ESA anno	European Space Agency announcement
ESA Info Bltn	European Space Agency Information Bulletin
ESA Release	European Space Agency news release, used dated (not numbered)
ESA/CNES Release	
ESA Info	European Space Agency Information
FAA Release	Federal Aviation Administration news release
FBIS-Sov	Foreign Broadcast Information Service, Soviet number
FRC Release	See DFRC
FRC *X-Press*	NASA Flight Research Center's *X-Press*

Goddard News	NASA Goddard Space Flight Center's *Goddard News*
GSFC Release	NASA Goddard Space Flight Center news release
GSFC *SSR*	NASA Goddard Space Flight Center's *Satellite Situation Report*
GSFC/WFF Release	NASA Goddard Space Flight Center's Wallops Flight Facility Release
GT&E Release	General Telephone & Electronics news release
House anno	U.S. House of Representatives announcement
H Comm Sci	U.S. House Committee on Science and Technology
H Rept Release	U.S. House of Representatives news release
H Chron	*Houston Chronicle* newspaper
H Post	*Houston Post* newspaper
Htsvl Tms	*Huntsville Times* newspaper
INTELSAT Release	International Telecommunications Satellite Organization news release
Intervia	*Intervia* magazine
JA	*Journal of Aircraft* magazine
JPL anno	Jet Propulsion Laboratory announcement
JPL *Lab-Oratory*	Jet Propulsion Laboratory's *Lab-Oratory*
JPL Release	Jet Propulsion Laboratory news release
JPL *Universe*	Jet Propulsion Laboratory's *Universe*
JPRS	Department of Commerce Joint Publications Research Service
JSC Release	NASA Lyndon B. Johnson Space Center news release
JSC *Roundup*	NASA Lyndon B. Johnson Space Center's *Space News Roundup*
JSR	American Institute of Aeronautics and Astronautic's *Journal of Spacecraft and Rockets* magazine
KC Star	*Kansas City Star* newspaper
KSC Release	NASA John F. Kennedy Space Center news release
LA *Her-Exam*	Los Angeles *Herald-Examiner* newspaper
LA *Star News*	Los Angeles *Star News* newspaper
LA Times	*Los Angeles Times* newspaper
Langley Researcher	NASA Langley Research Center's *Langley Researcher*
LaRC anno	NASA Langley Research Center announcement
LaRC Release	NASA Langley Research Center news release
LATNS	Los Angeles Times News Service

LC/S&T	Library of Congress Science and Technology Division's Alerts
LeRC Release	NASA Lewis Research Center news release
Lewis News	NASA Lewis Research Center's *Lewis News*
MiHrld	*Miami Herald* newspaper
M News	*Miami News* newspaper
M Trib	*Minneapolis Tribune* newspaper
Marshall Star	NASA George C. Marshall Space Flight Center's *Marshall Star*
MJ	*Milwaukee Journal* newspaper
MSR	See NASA Monthly Status Report
MSFC Release	NASA George C. Marshall Space Flight Center news release
N Hav Reg	*New Haven Register* newspaper
N News	*Newark News* newspaper
N Va Sun	*Northern Virginia Sun* newspaper
NAA nsltr	National Aeronautic Association's newsletter
NAA *News*	National Aeronautic Association's *News*
NAA Record Book	National Aeronautic Association's *World and U.S.A. National World Aviation-Space Records*
NAA Release	National Aeronautic Association news release
NAC Release	National Aviation Club news release
NAE Release	National Academy of Engineering news release
NANA	North American Newspaper Alliance
NAS Release	National Academy of Sciences news release
NAS-NRC Release	National Academy of Sciences-National Research Council news release
NAS-NRC-NAE-*News Rpt*	National Academy of Sciences-National Research Council-National Academy of Engineering's *News Report*
NASA Actv	*NASA Activities*
NASA Actv Rpt	*NASA Activities Report*
NASA anno	NASA announcement
NASA Dly Actv Rept	*NASA Daily Activities Report*
NASA GMR	NASA Headquarters "General Management Review Report"
NASA Hist Off	NASA History Office
NASA Hq Mgmt Suppt Office	NASA Headquarters Management Support Office release
NASA Hq *WB*	NASA Headquarters *Weekly Bulletin*
NASA Int Aff	NASA Office of International Affairs
NASA Leg Off	NASA Office of Legislative Affairs
NASA MSR	NASA Monthly Status Report

NASA MOR	NASA Headquarters Mission Operations Report, preliminary launch and postlaunch report series (information may be revised and refined before publication)
NASA prog off	NASA program office (for the program reported)
NASA Release	NASA Headquarters news release
NASA Rpt SRL	NASA report of sounding rocket launching
NASA spl anno	NASA special announcement
NASA wkly SSR	NASA Satellite Situation Report
Natl Obs	*National Observer* magazine
Nature	*Nature Physical Science* magazine
NBC	National Broadcasting Company
NGS Release	National Geographic Society news release
NMI	NASA Management Instruction
NN	NASA Notice
NOAA Release	National Oceanic and Atmospheric Administration news release
NRC *News Rpt*	National Research Council's *News Report*
NRL Release	Naval Research Laboratory news release
NSC Release	National Space Club news release
NSC *News*	National Space Club's *News*
NSC *Letter*	National Space Club's *Letter*
NSF Highlights	National Science Foundation's *Science Resources Studies Highlights*
NSF Release	National Science Foundation new release
NSTL Release	NASA National Space Technology Laboratories news release
Ntl Sp Clb *bllton*	National Space Club's *Bulletin*
Nswk	*Newsweek* magazine
NY News	*New York Daily News* newspaper
NY Times	*New York Times* newspaper
NYTNS	New York Times News Service
O Sen Star	*Orlando Sentinel Star* newspaper
Oakland Trib	*Oakland Tribune* newspaper
Omaha W-H	*Omaha World-Herald* newspaper
ONR *Rev*	Navy's Office of Naval Research's *Reviews*
OST Policy Release	Office of Science and Technology Policy Release
P *Bull*	Philadelphia *Evening* and *Sunday Bulletin* newspaper
P Inq	*Philadelphia Inquirer* newspaper
PAO	Public Affairs Office
PD	National Archives and Records Service's Weekly Compilation of Presidential Documents
PIO	Public Information Office

PMR Missile	USN Pacific Missile Range's *Missile*
PMR Release	USN Pacific Missile Range news release
Rockwell Release	Rockwell International news release
SAO Release	Smithsonian Astrophysical Observatory news release
Sen Cte Comm	Senate Committee on Commerce, Science, and Transportation report
Science	*Science* magazine
Sci Amer	*Scientific American* magazine
Sci & Govt Rpt	*Science & Government Report*, independent bulletin of science policy
SciServ	Science Service News service
SD	*Science Digest* magazine
SD Union	*San Diego Union* newspaper
SET Manpower Comments	Scientific Manpower Commission's *Scientific, Engineering, Technical Manpower Comments*
SF	British Interplanetary Society's *Spaceflight* magazine
SF Chron	*San Francisco Chronicle* newspaper
SF Exam	*San Francisco Examiner* newspaper
Sov Aero	*Soviet Aerospace* newsletter
Sov Rpt	Center for Foreign Technology's *Soviet Report* (translation)
SP	*Space Propulsion* newsletter
Spaceport News	NASA John F. Kennedy Space Center's *Spaceport News*
Spacewarn	IUWDS World Data Center A for Rockets and Satellite's *Spacewarn Bulletin*
SP anno	Sept. 1, 1982, and During Sept.
SR list	NASA compendium of sounding rocket launches
SSN	*Soviet Sciences in the News*, publications of Electro-Optical Systems, Inc.
SSR	See NASA wkly SSR
St. Louis G-D	*St. Louis Globe-Democrat* newspaper
St. L P/Dsp	*St. Louis Post-Dispatch*, newspaper
T-Picayune	News Orleans *Times-Picayune* newspaper
Tech Rev	Massachusetts Institute of Technology's *Technology Review*
Time	*Time* magazine
Today	*Today* newspaper
testimony	Congressional testimony, prepared statement
text	Prepared report or speech text
transcript	Official transcript of news conference or congressional hearing
UA rept	United Airlines report

UN Reg	United Nations Public Registry of Space Flight
UPI	United Press International news service
USA Today	*USA Today* newspaper
USGS Release	U.S. Geological Survey news release
USPS	U.S. Postal Service news release
W Post	*Washington Post* newspaper
W Star	*Washington Star* newspaper
W Times	*Washington Times* newspaper
WFC Release	NASA Wallops Flight Center news release
WH anno	White House announcement
WH Release	White House news release
WhHs remarks	White House remarks
WJT	*World Journal Tribune* newspaper
Worc Sndy Tlg	*Worcester* (Mass) Sunday Telegraph
WSJ	*Wall Street Journal* newspaper

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