NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
AC 202 755-8370

For Release:
SUNDAY,
June 8, 1975

PRESS KIT

PROJECT: NIMBUS-F

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Howard Allaway
Headquarters, Washington, D.C.
(Phone: 202/755-8617)

Don Witten
Goddard Space Flight Center, Greenbelt, Md.
(Phone: 301/982-4955)

RELEASE NO: 75-145

NIMBUS-F TO CARRY ADVANCED WEATHER INSTRUMENTS

The most sophisticated package of meteorological research instruments ever developed will be launched aboard NASA's Nimbus-F spacecraft from the Western Test Range near Lompoc, Calif., about June 11.

Data collected by the nine instruments will help in the development of numerical models of the atmosphere for the international Global Atmospheric Research Program (GARP).

"Numerical models of the atmosphere eventually will help us to increase the accuracy of weather forecasts from one day to several weeks," said John Theon, Nimbus-F project scientist at NASA's Goddard Space Flight Center, Greenbelt, Md.

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May 15, 1975

From the launch of the first Nimbus in 1964, the capability of this series of spacecraft has evolved from observations in the visible and infrared areas to virtually the entire electromagnetic spectrum.

The synoptic sensor data provided by the Numbus-F and other meteorological satellites offer many potential benefits to man. Long-range weather predictions, according to a conservative estimate by the National Academy of Sciences, could save more than $2 billion annually.

The 827-kilogram (1,823-pound) Nimbus-F will be launched aboard a two-stage Delta launch vehicle into a near-polar, circular orbit at 1,110 kilometers (690 miles) altitude. Measurements with the spacecraft's nine experiments will be made twice a day over every point on Earth -- once at about noon and again at about midnight, local times.

A mid-June launch of Nimbus-F will be in time for participation in the checkout and evaluation of the data systems to be used in the GARP's first worldwide experiment scheduled for 1978-79.

The Nimbus-F instruments will provide high-altitude temperature sounding data. These are the Limb Radiance Inversion Radiometer (LRIR) and the Pressure Modulated Radiometer (PMR). The LRIR will provide extended temperature profiles up to 70 km (42 mi.) with a 2-km (6,500-ft.) resolution. Previous Nimbus experiments of this type were limited to a 10-km (6-mi.) resolution with a 45-km (35-mi.) altitude limit.

Other meteorological instruments carried by Nimbus-F include:

- Earth Radiation Budget (ERB) which will provide data for establishing Earth's atmospheric radiation balance to a precision never before achieved
- Electrically Scanning Microwave Radiometer (ESMR), designed to map the liquid water content of clouds, ocean rainfall and the distribution and variation of sea ice cover as well as other surface features
- Temperature, Humidity Infrared Radiometer (THIR) which provides data on cloud cover, ground temperatures and water vapor distribution

The Nimbus satellite program was initiated by NASA in 1960 to develop an observatory system capable of meeting the research and development needs of the nation's atmospheric and Earth sciences program.

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The first spacecraft was launched in 1964. In the intervening years the project has matured to become the nation's principal satellite program for remote-sensing research. Each observatory has grown significantly in sophistication, complexity, weight, capability and performance.

Nimbus-F is the seventh spacecraft in a series of eight approved in the program. All the satellites have met or exceeded their mission objectives except Nimbus-B, which never achieved orbit because of a launch vehicle failure.

The Nimbus program is managed by NASA's Office of Applications, Washington, D.C. NASA's Goddard Space Flight Center, Greenbelt, Md., is responsible for the spacecraft, the launch vehicle and the global network for tracking the satellite and two-way communications with it.

Launch site operations are managed by the NASA Kennedy Space Center's Unmanned Launch Operations Division.

General Electric Co., Space Systems Organization, Valley Forge, Pa., is the Nimbus prime contractor. McDonnell Douglas Astronautics Company, Huntington Beach, Calif., is prime contractor for the Delta launch vehicle.

More than 50 major subsystem contractors are responsible for various components in the spacecraft, launch vehicle, or ground receiving equipment. In addition, there are more than 1,000 subcontractors and vendors working on the program.

The Nimbus-F spacecraft and instruments cost about $60 million; the Delta launch vehicle about $4.6 million.

(END OF GENERAL RELEASE; BACKGROUND INFORMATION FOLLOWS.)

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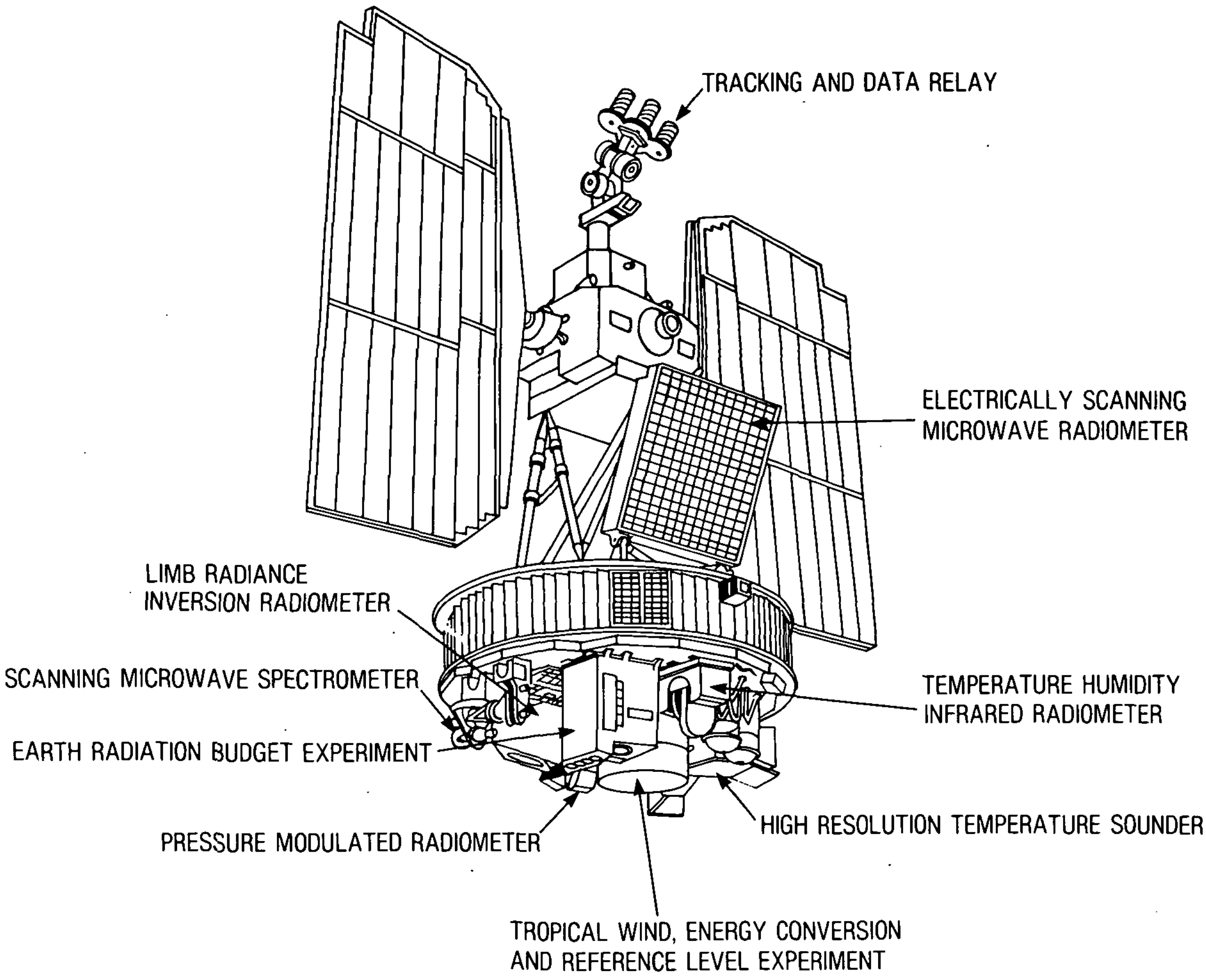

NIMBUS-F SPACECRAFT & EXPERIMENTS

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NIMBUS PROGRAM HISTORY AND RESULTS

The Nimbus satellite program was initiated by NASA early in 1960. The goal of the program is to develop an observatory system capable of meeting the research and development needs of the nation's atmospheric and earth scientists. This goal included a requirement to provide global surveillance of the atmospheric structure at low Earth-orbital altitudes for the world's weather services.

In the intervening years, the project has become the nation's principal satellite program for remote-sensing research. Each observatory has grown significantly in complexity, weight, capability and performance. The basic spacecraft system has worked so well, in fact, that NASA patterned its LANDSAT Earth resources survey spacecraft after the Nimbus.

All Nimbus spacecraft are launched from the Western Test Range near Lompoc, Calif., because of the requirement for a Sun-synchronous orbit which permits the spacecraft to view the same areas of the globe under similar lighting conditions. Altitude for the Nimbus circular orbit is 1,110 km (690 mi.).

Nimbus-1

Carrying three instruments, Nimbus-1 was launched into orbit on Aug. 28, 1964. A short second burn of stage two of the launch vehicle placed the spacecraft into an eccentric orbit ranging in altitude from 932 to 422 km (579 to 262 mi.). Despite this orbit, the spacecraft became fully operational shortly after orbit insertion.

Nimbus-1 worked for about one month before it stopped operating due to a failure of the solar array drive system, which is a major part of the satellite's power system. During its lifetime, it proved that a weather satellite could maintain three-axis stability and Earth orientation. It provided man with the first high-resolution television and infrared weather photos from a satellite.

The spacecraft photographed Hurricane Cleo during its first day in orbit and later took exceptionally clear photos of Hurricane Dora and Typhoon Ruby. On the basis of photos taken by Nimbus-1, Mount Siple (a 10,000 ft.-high mountain in the Antarctic used by pilots as a navigational aid) was repositioned on relief maps 45 miles farther west.

Nimbus-1 photos also indicated that a mountain group thought to be in the Kohler Range did not really exist. In addition, its pictures provided experimenters with a much better definition of the formation of the Antarctic ice front in the Filchner Ice Shelf, Weddell Sea and Princess Martha Coast area.

Nimbus-2

Nimbus-2, carrying four instruments, was launched into a near-perfect orbit on May 15, 1966. While the design lifetime of the spacecraft was six months (about 2,500 orbits), the mission was finally terminated during orbit 13,029 on Jan. 17, 1969, after almost 33 months of operation.

During the first day in orbit, Nimbus-2 photographed Typhoon Irma in the Philippine Islands. It also located and tracked Hurricanes Alma, Dora, and Faith and numerous other storms throughout the world. Nimbus-2 was the first satellite to measure Earth's heat balance. Physicists hope the study of this data will unlock some of the mystery of weather and storm development and dissipation. Cameras on board Nimbus-2 tracked Hurricane Alma from its birth to death and Hurricane Faith as it first boiled up as a tropical storm off the west coast of Africa. Nimbus-2 transmitted data that will serve to form the mathematical models for future weather forecasting.

(Another Nimbus was launched on May 18, 1968, but because of a guidance failure on the launch rocket, the mission was aborted.)

Nimbus-3

Nimbus-3 was successfully launched April 14, 1969. The spacecraft carried seven meteorological instruments plus a two-unit nuclear isotopic system for generating electrical power, the Systems for Nuclear Auxiliary Power (SNAP-19), developed by the Atomic Energy Commission.

At the end of its design lifetime of six months, Nimbus-3 was transmitting data from all its experiments. The spacecraft remained in orbit two years and nine months.

Of particular interest to meteorologists was the success of the infrared experiments in measuring emitted infrared energy, thus permitting global determination of the atmosphere's vertical temperature, water vapor, and ozone distribution. The U.S. National Weather Service used this data in connection with short-term and long-term weather forecasting.

Nimbus-4

Nimbus-4 was launched April 8, 1970, and continues to operate after 24,000 orbits. It achieved the best orbit of the series to date with only an 11 km (7 mi.) difference between apogee and perigee. The spacecraft's nine experiments were designed primarily to provide reliable, long-range computerized weather forecasting.

Nimbus-4 has extended satellite sounding of the atmosphere from 30 to 50 km (19 to 31 mi.) altitude, tracked a migratory animal and constant-level balloons, differentiated between ice and water clouds, found indications of very high altitude storm clouds and determined wind fields by tracking balloon platforms.

Nimbus-5

Nimbus-5 was launched into a near perfect orbit on Dec. 11, 1972, carrying six highly advanced instruments. Several of these are directed at the global forecast problem. The spacecraft is still operating after more than 17,000 orbits.

Nimbus-5 data contributed significantly to the early observational efforts of the GARP, an international effort to enhance weather forecasting. Temperature profiles obtained from this spacecraft during tests conducted in May 1974 contributed to the production of the first full global analysis of weather in near real-time. Such analyses permit the study of northern and southern inter-hemisphere interactions, a necessary step toward meeting the GARP goal of weather forecast improvement.

Earth and atmospheric radiation measurements made by the Nimbus-5 Electrically Scanning Microwave Radiometer (ESMR), verified for use in determining ice boundaries, are now being used by the U.S. Navy in polar navigation. Other radiation measurements by the Nimbus-5 ESMR have helped establish rainfall rates over oceanic areas. Such delineation of global areas of precipitation and the rainfall rates will enhance forecasting by providing indications of the amount and distribution of the heat of condensation, the upward mass flow and the distribution of convection.

Nimbus-5 ESMR data also have demonstrated the possibilities of developing new techniques for the forecasting of tropical storm movement. This is based on rainfall areas detected through the heavy cloud cover of Tropical Storm Nora on Oct. 3, 1973, in the Pacific Ocean.

THE NIMBUS-F SPACECRAFT

Nimbus-F is similar in design to the previous six spacecraft of this type. In its orbit configuration, it is a butterfly-shaped device measuring about 3 meters (10 feet) tall by about 2 m (5 ft.) wide.

The major service subsystems and experiments are housed in a circular structure on the bottom of the spacecraft. A three-axis attitude control subsystem included in these subsystems keeps the sensors pointed toward Earth with an accuracy of better than one degree about all axes.

Two solar paddles, which automatically unfold after the spacecraft is separated from the launch vehicle, track the sun during daylight operation and convert its energy into spacecraft power. The spacecraft will require about 550 watts of peak power for operation.

Spacecraft and experiment data are handled by a versatile information processor and either transmitted to Earth immediately or stored on a high-speed tape recorder for subsequent playback when the spacecraft is in full view of a data acquisition station.

THE INSTRUMENTS

The Nimbus-F carries nine instruments. These are designed to advance man's scientific knowledge of his environment in the areas of meteorology, oceanography and Earth-surface phenomena.

Earth Radiation Budget (ERB) (Dr. W. Smith, National Oceanic and Atmospheric Administration, Rockville, Md., and Dr. J.R. Hickey, Eppley Laboratory, Newport, R.I., experimenters.)

Measures the solar radiation impinging upon Earth as well as the angular distribution of outgoing planetary radiation to determine regional and global heat balance. This will provide data for new research areas in numerical weather analysis and eventually help improve long-range forecast accuracies. These data also will be used for defining climatological models.

Electrically Scanning Microwave Radiometer (ESMR) (Dr. T.T. Wilheit, NASA Goddard Space Flight Center, Greenbelt, Md.)

Improved version of Nimbus-E instrument using dual polarization for mapping liquid-water content of clouds, distribution and variation of sea ice cover and gross characteristics of land surfaces, such as vegetation, soil moisture and snow cover.

High Resolution Infrared Radiation Sounder (HRIRS), (A.W. McCulloch, NASA Goddard Space Flight Center, Greenbelt, Md., Dr. W. Smith, National Oceanic and Atmospheric Administration, Rockville, Md.).

Uses 17 channels to measure Earth's emitted radiances, as well as reflected solar radiation, with high spatial resolution and provide global vertical temperature and water-vapor profiles in the presence of clouds up to 40 km (25 mi.).

Limb Radiance Inversion Radiometer (LRIR) (J.C. Gille, National Center for Atmospheric Research, Boulder, Colo.).

Uses multichannel infrared radiometer to scan the limb of Earth with an attitude reference unit to measure stratospheric temperature structure and to determine water vapor and ozone density distributions. Geostropic winds will be calculated from temperature measurements.

Pressure Modulated Radiometer (PMR) (Dr. J.T. Houghton, Oxford University, England).

Utilizes a pressure modulation technique to obtain radiometric temperature measurements in the upper stratosphere and mesosphere.

Scanning Microwave Spectrometer (SCAMS) (Dr. D. Staelin, Massachusetts Institute of Technology, Cambridge, Mass., F. Barath, Jet Propulsion Laboratory, Pasadena, Calif.).

A microwave vertical-profile radiometer for mapping tropospheric temperature profiles, water vapor abundance and cloud water content even in the presence of many types of clouds.

Tracking and Data Relay (T&DR) F.O. Vonbun, NASA Goddard Space Flight Center, Greenbelt, Md.).

Will be used to investigate the extent to which it is possible to establish the Nimbus-F orbit using data acquired by a geosynchronous relay satellite and to demonstrate the technology of command and telemetry data transmission between a low-altitude satellite and a ground station via a geosynchronous satellite communications relay.

Temperature-Humidity Infrared Radiometer (THIR) (A.W. McCulloch, NASA Goddard Space Flight Center, Greenbelt, Md.).

Measures the infrared radiation from Earth in two spectral bands during day and night portions of the orbit. These data will provide pictures of the cloud cover, three-dimensional maps of the cloud cover and temperature maps of the clouds, land and ocean surfaces, including cirrus cloud content, contamination, and relative humidity.

Tropical Wind, Energy Conversion and Reference Level (TWERLE) (Dr. P. Julian, National Center for Atmospheric Research, Boulder, Colo., C. Cote, NASA Goddard Space Flight Center, Greenbelt, Md., and Dr. V. Suomi, University of Wisconsin, Madison, Wis.).

Monitors location and collection of data from balloon-borne sensor packages above the ocean surface in conjunction with the Global Atmospheric Research Program. The balloon motions and sensors will provide data on large-scale atmospheric motion, upper tropospheric interactions and a southern hemispheric radiance level.

GLOBAL ATMOSPHERIC RESEARCH PROGRAM (GARP)

The Global Atmospheric Research Program (GARP) is an international effort to enhance the understanding of , and ability to predict, weather. It is jointly directed by the World Meteorological Organization and the International Council of Scientific Unions.

This well organized cooperative program has as its main thesis the concept that satellite and surface observations can be used in mathematical models of the atmosphere to achieve a major improvement in the quality and duration of weather forecasts. Accurate forecasts extending one and perhaps two weeks are believed achievable. The First GARP Global Experiment (FGGE), a major international experiment to test this thesis, is planned for 1978 and 1979.

FGGE will be the largest and most complex international cooperative space effort yet undertaken. It will involve five geosynchronous satellites launched by the European Space Research Organization, Japan, the Soviet Union and the United States. More than 20 countries have volunteered supplementary facilities for use in FGGE.

In preparing for FGGE, NASA and other government agencies and universities have undertaken a large scale test of the major elements involved. The test is called the Data System Tests (DST) and involves supplementing conventional weather data and operational satellite observing systems with research and development systems as they become available. It includes processing all available data in near real time and utilizing these data in numerical forecast models for feedback to improve the observational and data management systems. The DST will be underway for the period 1974-76.

Data from the Nimbus-F experiments and particularly from its atmospheric sounding instruments, will play a major role in the DST.

During the DST tests run in May 1974, temperature profiles obtained from Nimbus-5 and wind information derived from the Applications Technology Satellite-3 cloud images were used to augment data from operational satellites and conventional sources to produce a first full global analysis in near real time. This analysis used new techniques whose development was accelerated for this test. The full global analysis permits the study of northern and southern inter-hemisphere interactions, a necessary step toward meeting the GARP goal of weather forecast improvement.

Both theoretical studies and numerical experimentation have demonstrated a critical need for direct wind measurements with high accuracy at various altitudes in the equatorial zone. The World Weather Watch surface-based network provides only about 20 per cent of the necessary coverage. For the remaining areas, a combination of ships and carrier balloon systems, capable of deploying windfinding sondes, is planned for FGGE. A prototype system has been developed to obtain meteorological wind data from balloons on command.

The meteorological satellite data available in 1975, particularly when supplemented by that obtained from Nimbus-F, should provide the best description of atmospheric processes available to date. These data will be utilized in the GARP Data System Test. One-to-two-month periods will be selected for near real time data analysis and forecasting research studies to test out the procedures, techniques and operations required for the First GARP Global Experiment and to estimate the forecasting improvements to be realized. Extensive use of these data will be made in numerical forecasting models by NASA and other cooperating agencies.

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DELTA LAUNCH VEHICLE

Nimbus-F will be launched by an improved two-stage Delta Launch Vehicle, managed for NASA by its Goddard Space Flight Center, Greenbelt, Md. The launch vehicle is Delta 2910.

To date, the Delta has launched 110 payloads and has a 90 per cent success record.

The 36 m (116 ft.) tall Delta consists of a liquid-fuel McDonnell Douglas Astronautics Co. extended-long-tank Thor booster, incorporating nine Thiokol strap-on Castor II solid-fuel rocket motors and a TRW Corp. liquid-fuel second stage. Maximum girth of the 113,400 kg (250,000 lb.) Delta is 2.44 m (8 ft.) not including the strap-on motors.

An all-inertial guidance system, consisting of an inertial sensor package and digital guidance computer, controls the vehicle and sequence of operations from liftoff to spacecraft separation. A sensor package provides vehicle attitude and acceleration information to the guidance computer, which generates vehicle steering commands to each stage. The system thus corrects trajectory deviations by comparing computed position and velocity against prestored values.

In addition the guidance computer performs the functions of timing and staging as well as issuing pre-programmed attitude rates during the coast phases.

LAUNCH OPERATIONS

NASA launch operations from its West Coast facility are managed by the Kennedy Space Center's Unmanned Launch Operations Western Launch Operations Division (WLOD). This facility is located at Vandenberg Air Force Base, near Lompoc, Calif., approximately 125 miles northwest of Los Angeles and 280 miles south of San Francisco. Launch facilities are located on a promontory which juts into the Pacific Ocean near Point Arguello, making it possible to launch to the south to place payloads into polar orbit without overflying populated areas.

Nimbus-F will be launched from Space Launch Complex 2 West, which has been extensively updated over the years to accept the various Delta configurations, including the powerful new version now in use.

KSC personnel are permanently assigned at WLOD and supplemented by a management and technical group from KSC in Florida during final preparations and the launch countdown.

Preparations for the launch of Nimbus-F began with the arrival of the Delta first stage. Significant milestones since that date include first stage erection on the pad, installation of the nine solid strap-on rocket motors around the base of the first stage, inter-stage mating and second stage mating.

A "boilerplate" spacecraft was mated with Delta 2910 and the payload fairing was installed. A series of tests conducted included removal of the mobile service tower and spacecraft radio frequency line checks.

The flight spacecraft was scheduled to arrive at the Spacecraft Laboratory about May 20 to undergo prelaunch checks. The "boilerplate" spacecraft was to be removed and Nimbus-F will be moved to the pad for mating with the Delta on June 4.

LAUNCH EVENTS

	Time (sec.)
Liftoff	0
Solid booster burnout	39
Eject Solid booster motors	85
First stage main engine cutoff (MECO)	220
First stage vernier engine cutoff (VECO)	226
First stage/second stage separation	228
Second stage first ignition	233
Shroud separation	266
Second stage first cutoff	544
Second stage second ignition	3425
Second stage second cutoff	3438
Start second stage pitchup maneuver	3488
Stop second stage pitchup maneuver	3584
Nimbus separation	3637
Start second stage retro	3639
Second stage third ignition	4600
Second stage third cutoff	4605
Second stage fourth ignition	5560
Second stage fourth cutoff	5568

SEQUENCE OF ORBIT EVENTS

Once in orbit, Nimbus-F will be stabilized and oriented so the onboard sensors will best view Earth directly beneath the spacecraft. During the initial orbits, systematic turn-on and checkout of the spacecraft subsystems will be commanded from the Nimbus operation control center (OCC) at Goddard Space Flight Center. Simultaneously orbital information obtained from NASA's Space Tracking and Data Network (STDN), also managed and controlled by Goddard, will be used to determine the precise orbit.

Next, required orbital adjustments will be determined and executed by the Nimbus OCC to establish the precise orbit for the systematic ground coverage by the spacecraft's sensors. With the initial orbital correction and checkout phase complete, Nimbus-F will be commanded to begin its first year of normal operations.

Gross scheduling of the experiments will be performed in the operations control center for each 18-day cycle. More detailed operations will be planned for each forthcoming week, day and orbit. Real time sensor operations will be commanded over the prime observations areas of the North American continent within direct view of one of the primary Nimbus data acquisition stations located at Fairbanks, Alaska; Goldstone, Calif; and Goddard.

OPERATIONS CONTROL AND TRACKING

The spacecraft management and command sequence will be generated in the Nimbus Technical Control Center (NTCC) at NASA's Goddard Space Flight Center, Greenbelt, Md. Responsibility for spacecraft evaluation and command operations will be alternated between Goddard and the Fairbanks, Alaska, station of the Spacecraft Tracking and Data Network (STDN). Both the Goddard and Alaska facilities will be on line during each spacecraft interrogation. In case of any interruption in the communication line between these two facilities, Alaska will assume responsibility for normal spacecraft operation.

Data will be collected and commands sent via the STDN stations at Alaska, Rosman, N.C.; Winkfield, England; and Orroral Valley, Australia, during normal operations. In emergency situations and during spacecraft activation shortly after launch, the Johannesburg, South Africa station will relay commands and data between the spacecraft and Goddard or Alaska. The Tananarive, Republic of Malagasy, station will serve as a back-up to Johannesburg.

The objectives of the first day after launch are to determine the fundamental operation of the spacecraft and to activate the sensors. For the second day, controllers will continue spacecraft assessment, establish management of spacecraft power and thermal control systems. The full complement of sensors will be activated over a period of several weeks after which time sensor data will be distributed routinely.

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PROGRAM OFFICIALS

NASA Headquarters, Washington, D.C.

Charles W. Mathews	Associate Administrator for Applications
William E. Stoney	Director of Earth Observations Programs
Harry Mannheimer	Nimbus Program Manager
Douglas R. Broome, Jr.	Nimbus Payload Manager
Dr. Robert A. Schiffer	Nimbus Program Scientist
Dr. Noel W. Hinners	Associate Administrator for Space Science
Joseph B. Mahon	Director of Launch Vehicle and Propulsion Programs
I.T. Gillam IV	Manager of Small Launch Vehicle and International Programs
P.T. Eaton	Delta Program Manager

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Goddard Space Flight Center, Greenbelt, Md.

Dr. John F. Clark	Director
Robert N. Lindley	Director of Projects
Harry Press	Chief of Meteorological Program Office
Don V. Fordyce	Project Manager
John S. Theon	Project Scientist
George D. Hogan	Deputy Project Manager for Engineering
J. Edward Baden	Deputy Project Manager for Resources
Robert C. Baumann	Associate Director of Projects for Delta
Ralph B. Shapiro	Flight Operations Manager
Joseph Arlauskas	Sensor Systems Manager
James Taylor	Spacecraft Manager

Kennedy Space Center, Fla.

Lee R. Scherer	Director
John J. Neilon	Director of Unmanned Launch Operations
Henry R. Van Goey	Manager, KSC Western Launch Operations Div.
Wilmer "Bud" Thacker	Chief, Delta Operations, Launch Vehicle Engineering Branch
Gene Schlimmer	Chief, Spacecraft and Support Operations Branch
Gene Langenfeld	Nimbus-F Spacecraft Coordinator

MAJOR CONTRACTORS

Spacecraft

General Electric Co. Space Systems Organization Valley Forge, Pa.	Prime Contractor Nimbus-F Integration and Test Stabilization and Control Subsystem Integration, Spacecraft Structures and Antennas

Nimbus-F Instruments

Earth Radiation Budget Experiment (ERB)	Gulton Industries Albuquerque, N.M.
Electrically Scanning Microwave Radiometer Experiment (ESMR)	Space General Division of Aerojet General El Monte, Calif.
High Resolution Infrared Radiation Sounder Experiment (HRIRS)	International Telephone & Telegraph Fort Wayne, Ind.
Limb Radiance Inversion Radiometer (LRIR)	Honeywell Radiation Center Boston, Mass.
Pressure Modulated Radiometer Experiment (PMR)	Rutherford Laboratory Berkshire, England Marconi S&DS Ltd., Surrey, England
Scanning Microwave Spectrometer Experiment (SCAMS)	Jet Propulsion Laboratory Pasadena, Calif.
Tracking and Data Relay Experiment (T&DRE)	Ball Brothers Boulder, Colo.
Temperature-Humidity Infrared Radiometer Experiment	General Electric Santa Barbara Research Center Santa Barbara, Calif.
Tropical Wind Energy Conversion and Reference Level (TWERLE)	Texas Instruments Dallas, Tex.