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NASA TO LAUNCH  
FIRST ORBITING  
GEOPHYSICAL OBSERVATORY

The first in a new United States series of large scientific observatory satellites, the 1,073-pound Orbiting Geophysical Observatory, is scheduled for launch from Cape Kennedy, Fla., no earlier than Sept. 3.

The National Aeronautics and Space Administration will use an Atlas-Agena B rocket to lift the observatory, designated OGO-A, into an elongated Earth orbit.

NASA launched the first observatory-class satellite, the highly successful Orbiting Solar Observatory I, March 7, 1962.

The first Orbiting Geophysical Observatory, if successful, will mark another milestone in NASA's program of scientific space exploration. It also will inaugurate a series of standardized observatories capable of conducting many related space experiments simultaneously. The OGO program calls for six satellites to be launched into various orbits.

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OGO has been called the bus or streetcar satellite. The first, for example, will carry 20 scientific experiments contributed by scientists from seven government laboratories and nine universities. This is more scientific experiments than carried by any other satellite to date.

OGO-A's orbit will range from 170 miles above the Earth to 92,000 miles at an angle of inclination of 31 degrees to the equator. It will make scientific measurements and observations in the Earth's atmosphere, the magnetosphere and in interplanetary space beyond the influence of the Earth's magnetic field. It will take approximately 63 hours for OGO-A to complete one orbit.

The overall scientific objective of the OGO series is to better understand the physical processes relating to the many influences that the Sun has on the near-Earth environment and to aid in the evaluation of the hazards involved in manned exploration of space. OGO satellites have been designed to have a high probability of a one-year operational life-time. The OGO-A mission will be a success, however, its life-time is less than a year.

OGO is one of the most advanced unmanned satellites developed to date. It represents a new concept in satellite engineering since it has been designed to use the same basic structure, power supply, attitude control, thermal control, telemetry and command systems and provide space to carry up to 50 different experiments in the main body or on booms.

OGO looks like an insect. Attached to its rectangular box-shaped body are booms, antennas, attitude control jets and solar panels.

It contains more than 100,000 parts. With its booms, including experiment antennas, and solar panels fully extended in orbit, OGO measures 59 feet long and 50 feet wide. These appendages are folded inside the rocket fairing during launch and deployed after orbit is achieved.

Other OGO engineering features include:

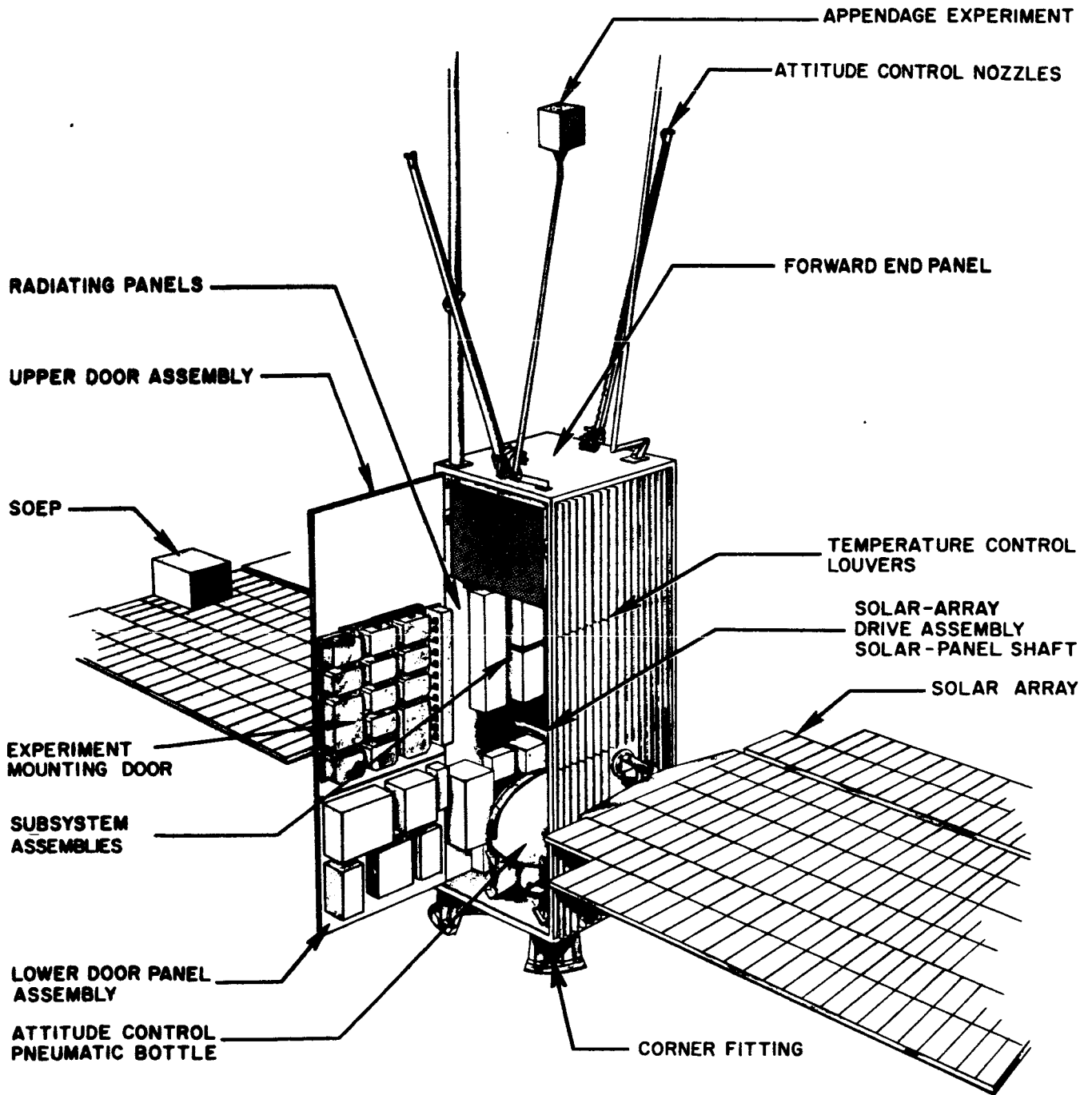
An active three-axis, five-degree-of-freedom attitude-control system which will point the bottom portion of the main body always toward the Earth, the solar panels automatically toward the Sun, and rotating experiment packages in the direction of motion.

An advanced thermal control subsystem featuring several types of controls. For example, three sides of the main body are insulated with multiple layers of aluminized Mylar. The other three sides, which will never face the Sun, include a series of louvers which will automatically open and close to maintain a main body interior temperature range of from 41 to 95 degrees F.

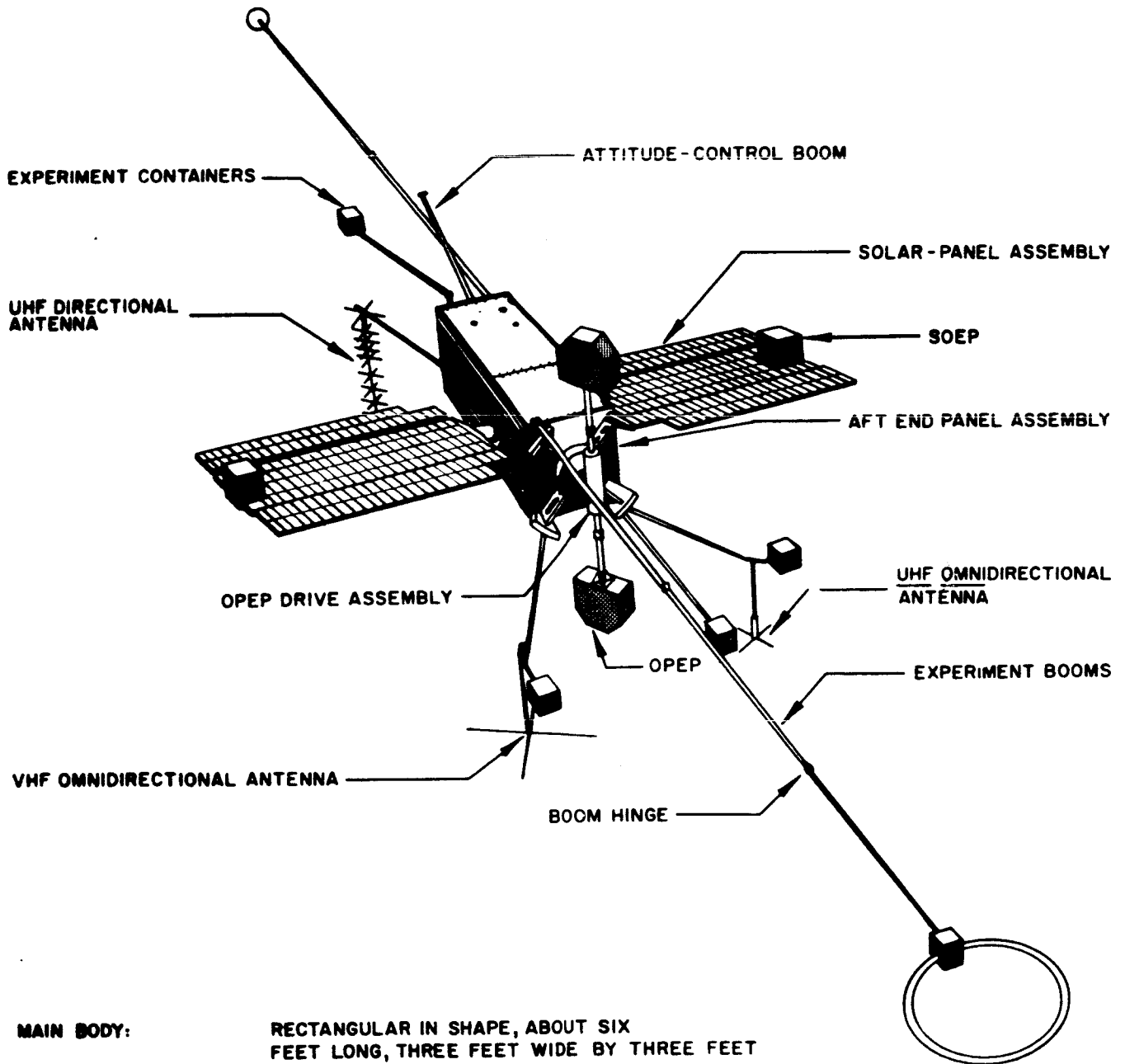
A communications system--the most advanced ever incorporated into a satellite--able to handle 254 different ground-originated commands and a data handling system which will store up to 86,000,000 bits of data on tape recorders and can transmit to ground stations in real time at a rate of 64,000 bits per second. This gives OGO the capability of sending data about the length of three novels every minute.

The OGO program is directed by the Physics and Astronomy Programs Division of NASA's Office of Space Science and Applications. Project management is assigned to the Goddard Space Flight Center, Greenbelt, Md.

# OGO MAIN BODY SHOWING EXPERIMENT MOUNTING



# OGO FULLY DEPLOYED IN ORBIT



**MAIN BODY:**

RECTANGULAR IN SHAPE, ABOUT SIX FEET LONG, THREE FEET WIDE BY THREE FEET

**LENGTH:**

OVERALL, BOOMS EXTENDED, 54 FEET

**WIDTH:**

OVERALL, SOLAR PANELS UNFOLD, 20 FEET

FACT SHEET

ORBITING GEOPHYSICAL OBSERVATORY A

OBSERVATORY

Weight: About 1,073 pounds, including

Experiments: 172 pounds

Power Supply: 200 pounds

Spacecraft Structure and Thermal Control System: 221 pounds

Communications and Data Handling Systems: 146 pounds

Spacecraft Integration Element and Wiring: 178 pounds

Stabilization and Attitude Control System: 135 pounds

Interstage and Separation Mechanism: 22 pounds

Shape: Main body, rectangular box-shaped, about six feet long, three feet wide, three feet high

Appendages: Two booms, 22 feet long

Four booms, four feet long

Two gas jet booms, 3 3/4 feet long

One directional antenna boom, five feet long

Two solar panels, six feet wide, seven and one-half feet long with 78 square feet total area covered with 32,250 P/N solar cells

Two orbital plane experiment packages (OPEP), 17 in. long, eight inches wide and eight inches deep

Overall Dimensions: Length, booms extended, 59 feet

Width, solar panels and experiment booms extended, 50 feet



Design Lifetime: One year

Power Supply: Solar supply to two 28-volt nickel-cadmium batteries using unregulated direct current with maximum capability of about 560 watts

COMMUNICATIONS AND DATA HANDLING SYSTEM

Wideband telemetry (PCM/PM): Two four-watt 400 mc RF transmitters  
Two data-handling units  
Two high-capacity tape recorders  
(12-hour capability at 1,000 data bits per second)

Special Purpose Telemetry: One 500-mw, 400-mc RF transmitter  
(FM/PM): One signal combiner and AGC unit

Tracking: One 10-watt 136 mc beacon (apogee tracking)

Two 100-mw, 136 mc beacons

One Range and Range Rate Transponder

Command: Two receivers

PCM/FM/AM

Approximately 120 mc

LAUNCH PHASE

Launch Site: Complex 12, Cape Kennedy, Air Force Eastern Test Range

Launch Vehicle: Atlas-Agena B (Atlas series D, first stage, Agena B second stage)

Orbit: Apogee 92,000 statute miles; Perigee, 170 statute miles

Angle of Inclination: 31 degrees

Orbital Period: About 63 hours

TRACKING AND DATA ACQUISITION STATIONS\*

Primary Stations: Rosman, N.C.  
Fairbanks, Alaska

Secondary Stations: Quito, Ecuador  
Johannesburg, Republic of South Africa

Tracking Stations: World-wide Space Tracking and Data-Acquisition  
Network (STADAN)

Range and Range Rate Stations

\*All tracking and telemetry stations are operated by the Goddard  
Space Flight Center

TECHNICAL INFORMATION

Orbiting Geophysical Observatory satellites are part of the scientific space exploration program conducted by NASA's Office of Space Science and Applications. OGO project technical management is under direction of the Goddard Space Flight Center, Greenbelt, Md. Experiments were provided by scientific investigators at universities and Government laboratories located throughout the country.

The satellite was developed by TRW Space Technology Laboratories, Redondo Beach, Calif., under the technical direction of the Goddard Space Flight Center. Contractors from throughout the country provided various subsystems and instrumentation for the satellite.

Actual work on the OGO design began in January 1961. Selection of the 20 experiments for the first payload was made by NASA Headquarters in December 1961. As the experiments were built, they were sent to Goddard for tests and an evaluation of the compatibility of the individual experiments with the satellite and with each other.

The individually-tested experiments were then sent to Space Technology Laboratories where they were installed in the satellite and, beginning in December 1963, subjected to further environmental

testing. This program was completed early in June 1964, and the OGO-A was flown to Cape Kennedy June 18 for final assembly, checkout and mating with the Atlas-Agena.

The original OGO launch schedule established in 1961, called for the first launch early in 1963. This was delayed, however, by technical difficulties encountered in developing advanced, complex systems of sufficient flexibility to be the standard for many missions and yet able to function for a long period in space.

Through Fiscal Year 1964, \$120 million had been spent on the first three OGO satellites, the launch vehicles, equipment for data acquisition and reduction and analysis. Later OGO missions will cost about \$30 million each.

The second OGO -- OGO-B -- scheduled for launching next year, will be placed into a near-polar orbit from the Air Force Western Test Range, by a Thrust Augmented Thor-Agena. The satellite, also carrying 20 experiments, will serve primarily as an atmosphere observatory, with an apogee of about 160 miles and a perigee of 575 miles. Its orbital period will be about 96 minutes.

Future OGOs will be launched into orbits determined primarily by the scientific objectives of the experiments on board.

Depending on the availability of higher-thrust rockets, such as the Atlas-Centaur, OGO has been designed to permit a 400-pound weight increase bringing its overall weight to 1,500 pounds. This will allow the satellite to carry more experiments.

The OGO series of satellites is one phase of the NASA advanced observatory-class of spacecraft under development. Other programs include the Orbiting Astronomical Observatory (OAO) and the Orbiting Solar Observatory (OSO) satellites developed under the technical direction of the Goddard Space Flight Center.

#### The OGO Satellite and How It Works

Early satellites were small, highly specialized engineering marvels which could carry only a limited number of experiments. Their size was determined by the boosting capability of existing rockets such as the Vanguard and the Jupiter C. For this reason, satellites had to be redesigned for each new mission. This was a costly and time consuming process.

As larger booster rockets became available, engineers had greater freedom in the design of new satellites. More space for experiments was available and the standardization of spacecraft, basically a space bus concept, became a reality and the evolution of observatory-class satellites such as the OGO was possible.

Coupled with the savings made possible by standardization and the ability to carry more and more experiments -- more science for the dollar, as it were -- was a basic scientific consideration. This was that early space exploration using sounding rockets, satellites and other observational methods revealed a keen and extremely sensitive relationship between our Sun and the physical characteristics of the near-Earth environment. These studies have been interpreted as indicating that phenomena such as the solar wind, solar flare activity, terrestrial magnetic field disturbances, sudden ionospheric disturbances, radiation belt particle populations, aurora events, polar cap events, ionospheric ionization, and variations in atmospheric density are part of a complex Earth-Sun-interplanetary space relationship. Furthermore, they have clearly stressed the importance of obtaining simultaneous measurements and observations which could be correlated among the various phenomena.

For this reason, an observatory such as OGO, capable of making such measurements and observations came into existence as an advanced tool for research.

#### The OGO Structure

The satellite consists of a main body approximately six feet long by three feet square. Attached to this rectangular

box-shaped section are the booms and antennas which give OGO its insect-like appearance. There are two approximately 22-foot-long booms carrying sensitive magnetometers which must be mounted away from the main body because of possible magnetic and electric interference, and four, four-foot-long booms for somewhat less sensitive experiments. The OGO antennas are mounted away from the main body to take advantage of improved antenna patterns made possible by this technique.

Other external characteristics of the satellite include two additional box-like experiment-carrying packages. These packages, known to OGO project people as the OPEPs (Orbital Plane Experiment Packages) are 17 inches long, and eight by eight inches square. On OGO-A they will carry experiments which will take readings in the orbital plane of the satellite. The OPEPs are rotated about an axis normal to the long axis of the satellite to always look in the plane of the orbit.

Also mounted externally are the attitude control jet nozzles. These are placed on booms at the "forward" end of OGO in order to increase the "lever arm" action needed to help stabilize the satellite and thus reduce gas system weight. Finally, the most predominant physical features of the OGO, aside from its main body, are two large solar-cell panels which convert energy from the Sun into electricity to power the satellite. The panels are

mounted on a shaft running through the main body. They rotate automatically, and the orientation of the satellite changes to permit them to face the direction of the Sun at all times. Mounted on the solar panels are two Solar-Oriented Experiment Packages called SOEPs designed to contain experiments which need to look constantly toward or away from the Sun.

The unusual engineering design of the main body of the OGO is a satellite first. For example, experiments not sensitive to the satellite's local environment are mounted inside two large hinged doors, similar in manner to the tray-doors on refrigerators. These doors can be opened to allow installation of equipment or experiments. All connectors and fasteners are attached from the inside to permit installation or removal of items from the doors without disturbing any of the others. Furthermore, electrical cables to experiments from the data-handling system and power-supply junction boxes also are readily accessible.

The upper section of each door is removable and may be replaced by doors having special cutouts or other features, as needed.

OGO, indeed, is a standardized satellite -- a space bus for wide-ranging of space.



### Attitude Control System

The OGO attitude control system, capable of five degrees of freedom, consists of sensors, servos, and torquing components to keep the experiments properly oriented. Control of the main body to insure that the bottom section points toward the Earth is accomplished by infra-red horizon scanners to provide error signals and inertia wheels and gas jets to provide the necessary torques about the roll and pitch axes. Error signals to control motion about the third body axis and rotation of the solar panels about their long axis are controlled by Sun sensors located on the ends of the panels.

The body yaw torque, produced by still another inertia wheel and a set of gas jets, keeps the axis of the solar panels normal and the plan of the main body thermal radiation louvers parallel to the spacecraft-Sun line.

A third part of the attitude control subsystem controls the Orbital Plane Experiment Packages to permit the study of particles whose velocities are not great compared with that of the observatory. These experiments are directed forward in the plane of the orbit and normal to the observatory-Earth line. A special mechanical scanner oscillates one OPEP over a large angle relative to the orbital plane allowing its experiments to view a large segment of space. The OPEP gyroscope controls a drive which rotates the OPEPs with respect to the body.

### Thermal Control System

A combination of active and passive thermal control techniques regulate the temperatures of the electronics system compartments of the observatory. The temperatures of all assemblies within the main body will be kept within the range from about 41 to 95 degrees F. by sets of radiating panels and 112 temperature-actuated aluminum louvers located on three sides of the main body. These panels, owing to the characteristics of the attitude control system, are never exposed to the Sun and therefore permit the transfer of heat from the satellite to space.

Louvers, controlled by temperature-sensitive bimetallic coils, regulate the exposure of the radiating panels to space. The loss of thermal energy from the other surfaces of the main body is kept as low as possible by the use of radiation barriers. Thus, the louvers will maintain a balance between the thermal energy input from the Sun and Earth -- including that converted to electrical power and dissipated within the observatory -- and the thermal energy lost by radiation from the observatory. Adequate thermal paths are provided between the radiating panels and assemblies within the body, in order to keep the thermal gradients low.

The temperatures of the appendage packages containing experimental instrumentation are controlled by a somewhat similar thermal balance technique, except that louvers are not used. Radiation barriers cover the packages except for radiating panels whose areas are chosen to radiate the maximum anticipated thermal power input from the Sun and Earth and from electrical power dissipation within the packages. Heaters are employed to maintain temperature limits when experiments are turned off. This system will normally keep the temperatures within the appendage containers within the range of about 32 to 104 degrees F.

#### Communications and Data Handling

The OGO communications and data handling systems is designed to provide for tracking and command functions both for satellite "housekeeping" and experiment data, plus telemetry for up to 50 separate experiments. The main telemetry is a wideband PCM (pulse code modulation) system using a nine-bit word and capable of operating at three data rates which are selected by ground command. The data rate capability of the system ranges from 1,000 to 64,000 bits per second. Tape recorders carried by OGO can store up to 86,000,000 bits of data.

The wideband telemetry system is the major data handling system of the OGO. It is composed of two redundant data handling units that operate with outputs transmitted to Earth in real time

or are connected to one of the two pressurized tape recorders provided for storing data. The recorders can play back within 11.5 minutes data that required 12 hours for acquisition.

There are two transmitters for the wideband telemetry system, each capable of operating at an output of four watts at 400 mc. The transmitters can be commanded to transmit data over either a directional antenna or an omnidirectional antenna. The former, providing an additional gain of 12 decibels, is intended to be used for eccentric orbits.

A special purpose telemetry system is provided which is capable of operating from an experiment whose output is an FM signal varying from 300 to 100,000 cps to enable transmission of data from up to five standard subcarrier oscillators. A second mode provides additional redundancy for transmission of the output of the wideband telemetry system. The special purpose transmitter is rated at 0.5 watt at 400 mc.

The tracking and command system used for OGO is designed to be compatible with the Goddard Space Flight Center's Satellite Tracking and Data Acquisition Network.

#### Data Processing

As the largest scientific satellite ever launched by the U.S., OGO will have the capability of producing a vast amount of scientific data. If OGO-A operates for a full year, for

example, it could provide (at the maximum data rate) up to 20 billion nine-bit or word measurements. This is equivalent to about 10 thousand  $10\frac{1}{2}$  inch, magnetic tape rolls of data.

This information is of little value unless it is properly presented for analysis by the experimenters. Thus, the processing and distribution of OGO data is as important to success of the program as is proper operation of the satellite.

Data received on magnetic tape by the world-wide network of acquisition and tracking stations will be forwarded to the OGO Control Center located at the Goddard Space Flight Center, Greenbelt, Md. Tracking data will also be sent to Goddard for use by OGO-A project people to operate the satellite and to provide an accurate orbit for use by experimenters.

The taped data will be processed by an OGO production processing line, using high-speed computers. When the processing is completed, digital computer tapes will be produced for each experimenter. These tapes will contain the data from his individual experiment, necessary timing information, as well as data on spacecraft temperatures, voltages, and orbital data -- the standard housekeeping information.

The production data processing conducted at Goddard will be basically a computer sorting operation, providing experimenters with raw data from their experiments. Once analyzed, the primary means of disseminating the new scientific data will be to the scientific community by publication in scientific journals. Individual OGO investigators will have exclusive use of experiment data for a period of one year at which time it will be stored in a data center to be available to other scientists.

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OGO SCIENTIFIC OBJECTIVES AND EXPERIMENTS

OGO-A will carry more experiments than any U.S. satellite to date. These experiments are highly advanced, sophisticated scientific instruments. In all, there are 20 separate experiments which will perform, for the first time from a single spacecraft and on an inter-disciplinary basis, simultaneous, correlated investigations which cover the broad spectrum of the major space science areas of study. The data they obtain will, when analyzed, hopefully provide an overall insight into geophysical and solar phenomena as well as a better understanding of the time-dependent relationship that appears to exist in galactic, interplanetary and planetary events.

OGO's investigations of the galactic, interplanetary, and planetary regions of space are possible because of its eccentric orbit. The following are some of OGO-A's specific areas of investigation:

Galactic Space

- Cosmic Rays
- Radio Astronomy
- Gegenschein, a faint glowing area in space emanating from a direction opposite the Sun.

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### Interplanetary Space

- Energetic Solar Protons
- Solar Wind
- Magnetic Fields
- Solar X-Rays
- Ultraviolet Radiation
- Micrometeorites

### Planetary Space

- Composition of the Neutral Atmosphere
- Density and Temperature of the Ionosphere
- Micrometeorites
- Magnetic Fields
- Geomagnetically Trapped Radiation
- Very Low Frequency Emissions

From the data gathered, it is hoped that OGO-A will give scientists a better insight into a number of major areas of scientific interest. Among these are:

- A better understanding of cosmic rays which reach the Earth from the Sun and from galactic sources
- More knowledge of the origins of radio noise in space
- Data on how the solar wind interacts with interplanetary magnetic fields



- What the actions are which create the Earth's magnetosphere and cause geomagnetic storms
- The relationship between solar X-ray and ultraviolet emissions and their effect on the Earth's atmosphere, ionosphere and airglow
- More detailed knowledge concerning the velocity, size and distribution of micrometeorites in planetary and interplanetary space
- Detailed information concerning energetic particles trapped in the Earth's magnetic field, the intensity of the magnetic field, and the overall relationship of these phenomena with very low frequency radio noise, ionospheric absorption and solar phenomena.

The experiments are as follows:

Experiment 1 - Solar Cosmic Rays - University of California

This two-section, nine and one-quarter pound experiment mounted on Solar-Oriented Experiment Package 1 and on the Earth-facing panel of the main body will measure the form and time variation of solar cosmic rays ranging from a few million electron volts up to 90 million electron volts. The device will also measure changes in movement of solar protons as they arrive near the Earth and look for changes in proton motion which may result from solar flares occurring on the side of the Sun not seen from Earth. In addition, the University of California experiment will monitor X-rays coming from the Sun and the energy of particles which spew into interplanetary space from solar flare events. An effort will be made to also measure cosmic rays emanating from galactic sources during periods when solar activity is at its low point.

Experiment 2 - Solar Plasma, Electrostatic Analyzer -  
NASA Ames Research Center

The purpose of this five and one-half pound, three-section experiment, mounted in Orbital Plane Experiment Package 2, SOEP 2 and on the Earth-facing panel of the main body, is to obtain a better understanding of low energy particles (up to a few thousand electron volts) and their relationship with other geophysical, solar, and cosmic phenomena. More accurate data on these low energy particles is especially essential in determining the distribution of magnetic fields in space.

Experiment 3 - Solar Plasma, Faraday Cup - Massachusetts  
Institute of Technology

This eleven and one-half pound, two-section experiment is located on SOEP 2 and on the main body Earth-facing panel. It will study solar plasma in the range from tens to thousands electron volts and their influence on the Earth's magnetosphere. Specific measurements of proton flux, proton-energy spectrum and the direction of plasma movement will be obtained. The correlation of these data with concurrent measurements of magnetic fields is another scientific objective of this MIT experiment.

Experiment 4 - Positron Search and Solar Gamma-Ray Spectrum  
- NASA Goddard Space Flight Center and the Institute of  
Defense Analysis

This seven and one-half pound experiment is concerned with determining whether or not low energy positrons -- positive

electrons -- are trapped temporarily or permanently in the Van Allen radiation belts and whether low-energy solar interplanetary positrons exist at the edge of the Earth's magnetic field. The measurement range of the flux of gamma rays is from about 30,000 electron volts to 1.2 million electron volts. The two-part experiment is located in SOEP 1 and the Earth-facing panel of the main body.

Experiment 5 - Scintillation Counter for Trapped Radiation  
- Goddard Space Flight Center

Located in OPEP 2, this four-pound device will continue earlier Goddard studies relating to variations in the intensities of energetic particles. The data obtained should help in the understanding of energetic particle sources and lifetimes, how trapped particles are lost, and what causes the acceleration of trapped particles.

Experiment 6 - Cosmic Ray Isotopic Abundance - Goddard Space  
Flight Center

This rather esoteric experiment, weighing about 13 pounds, mounted in the main body panel facing away from the Earth, consists of a cosmic ray telescope to analyze the charge and energy spectrum of primary cosmic radiation in order to obtain a better concept of the amount of interstellar material through which these rays pass. Also to be studied will be the so-called modulation mechanisms which act on cosmic rays as well as the energies of cosmic rays produced by the Sun.

Experiment 7 - Cosmic Ray Spectra and Fluxes - University of Chicago

In another approach to the search for the acceleration mechanisms which act upon cosmic rays and solar particles and to study the electrodynamic processes which originate on the Sun and lead to the cyclic modulation of galactic cosmic rays, a two-section experiment, weighing about 21.5 pounds will be used. It is mounted on OPEP 2 and on the main body panel facing away from the Earth.

Experiment 8 - Omnidirectional Counters to Study Trapped Radiation - State University of Iowa

Mounted on one of the OGO's four short booms, this experiment is a five-pound device which will study the electron populations of the outer radiation zone of the Earth in a continuing effort to further understand the dynamics of this region. What is specifically of great scientific interest is the acceleration, dumping, replenishment, redistribution in space of these electrons and their relationship to magnetic storms and the aurora.

Experiment 9 - Electron Spectrometer for Trapped Radiation - University of Minnesota

A  $14\frac{1}{2}$ -pound detector system located on the main body panel facing away from Earth uses a swept magnetic field electron spectrometer technique to make precise measurements of electron energies in the range from 50,000 electron volts to four million electron volts.

A four-pound detector system located on one of the short booms uses an ionization chamber and Geiger-Mueller counter to determine fluxes of electrons, protons, and X-rays.

The purpose of this University of Minnesota-sponsored experiment is to continue studies of the injection, trapping, and loss mechanisms which occur within the Earth's radiation belts.

Experiment 10 - Triaxial Search Coil Magnetometer - Jet Propulsion Laboratory and UCLA

This five-pound experiment, mounted in two sections on one of the OGO long booms, with electronics on the Earth-facing panel of the main body, will investigate extremely low-frequency variations in the Earth's geomagnetic field and the interplanetary field and how they blend together. The experiment is also concerned with how these regions fluctuate and what simultaneous changes occur on the Earth's surface at these times.

Experiment 11 - Rubidium Vapor Magnetometer - Goddard Space Flight Center

Located on one of the OGO long booms, with additional electronics mounted in the OGO main body, this 16½-pound experiment will provide magnetic field measurements of great accuracy. The data obtained should give measurements of the interaction of the solar and geomagnetic field phenomena, measure magnetic field sources, and provide charts and mathematical descriptions of the Earth's magnetic field for use by the International World Magnetic Field Survey.

Experiment 12 - Spherical Ion and Electron Trap - Air Force Cambridge Research Laboratory

Mounted on a short boom, this 4 3/4-pound experiment will use a spherical electrostatic analyzer to measure concentrations and energy distributions of low energy charged particles -- ions and electrons -- throughout OGO-A's eccentric orbit.

Experiment 13 - Planar Ion and Electron Trap - Goddard Space Flight Center

This experiment, which complements Experiment 12, is a 15½-pound device mounted on OPEP 1 with its electronics in the main body. It will measure the density and energies of charged particles in low-energy regions which exist in the transition region between the ionosphere and interplanetary space as well as in interplanetary space itself where particle populations are quite low.

Experiment 14 - Radio Propagation - National Bureau of Standards

A small, two-pound transmitter located in the main body and two antennas will make electron density measurements by determination of the Faraday rotations of two harmonically related, linearly polarized waves. By this technique, ground stations operated by the Bureau of Standards will be able to measure the magnitude of large-scale horizontal irregularities in the electron distribution of the ionosphere and the exosphere.

Experiment 15 - Atmospheric Mass Spectrum - Goddard Space Flight Center

Mounted on OPEP 1, this six-pound device, will obtain direct measurements of positive-ion populations on a continuous basis using a Bennett R. F. mass spectrometer.

Experiment 16 - Interplanetary Dust Particles - Goddard Space Flight Center

Located on one of the short booms, this five-pound experiment will attempt to measure velocity and mass distributions of interplanetary dust particles of micron size, and determine their directions of arrival.

Experiment 17 - Very Low Frequency Noise and Propagation - Stanford University

Covering a large frequency range in the VLF spectrum, this five-pound experiment mounted on a long boom with its electronics located in the main body, will study noise propagated in the Earth's magnetosphere. This includes noise produced in the atmosphere, that is caused by incoming solar particles and cosmic noise of galactic and solar origin.

Experiment 18 - Radio Astronomy - University of Michigan

This 4½-pound experiment, located in SOEP 1 and the main body, will measure the radio spectrum of solar radio-noise bursts. It will also, it is hoped, measure radio bursts emanating from the planet Jupiter. Other measurements will be concerned

with cosmic noise intensity, auroral noise from the Earth to the satellite and radio noise from the Earth's ionosphere and in interplanetary space.

Experiment 19 - Geocornal Lyman-Alpha Scattering - U.S. Naval Research Laboratory

A three and one-half-pound experiment located in the main body panel facing away from the Earth, this device will study the scattering of Lyman-Alpha ultraviolet light by the Earth's atmosphere. To determine the height at which this scattering occurs, it is necessary to measure this effect from many positions in the OGO orbit.

Experiment 20 - Geggenschein Photometry - Goddard Space Flight Center and the University of Illinois

Weighing about  $8\frac{1}{4}$  pounds, this device mounted on SOEP 2 and in the main body, will help to solve the problem of the location of the Geggenschein, a light source which exists in a direction opposite of that of the Sun. The Geggenschein effect has been observed from the ground for more than 200 years and has defied solution. This experiment -- the first of its type for a satellite -- will obtain low-resolution images of the sky in the direction away from the Sun in an attempt to determine the source of the Geggenschein. The experiment will also study the degree of polarization and the infra-red brightness of the Geggenschein.



ATLAS-AGENA B LAUNCH VEHICLE

The half-ton OGO-A spacecraft will be launched by an Atlas-Agena-B vehicle combination. The NASA-Lewis Research Center, Cleveland, through its Agena Project Office, has technical management of the launch vehicle. Lewis responsibility begins with defining the launch vehicle requirements and follows through the procurement, design, fabrication, test and integration, launch preparations and launch through injection of the spacecraft into the proper orbit. Launchings for Lewis are conducted by Goddard's Launch Operations at Cape Kennedy.

The prime contractor for the Atlas is Astronautics division of General Dynamics, San Diego, Calif. The Agena-B stage is produced by Lockheed Missiles and Space Co. Sunnyvale, Calif.

Kicking such a heavy payload into this orbit requires the two-burn capability of the Agena-B upper stage. The Atlas booster and the Agena first burn carry the Agena-OGO combination into a near-Earth orbit about 100 miles high. They then coast more than halfway around the world to a point near Australia before the Agena is re-started. This second burn of the Agena upper stage elongates the final orbit to the desired elliptical shape. Thus, OGO, passing close to the Earth, will whip one-third of the way to the Moon before it swings around to rush back in toward the Earth. The period of this orbit is about 63 hours.

VEHICLE STATISTICS

	Atlas booster	Agena-B upper stage
Height	66 feet	45 feet (including shroud)
Weight	250,000 pounds	about 16,000 pounds
Diameter	10 feet	5 feet
Thrust	360,000 pounds	16,000 pounds in space
Propellants	LOX and RP-1	UDMH (unsymmetrical dimethyl hydrazine) and IRFNA (Inhibited red fuming nitric acid)
Propulsion	2 Rocketdyne boosters 1 sustainer	Bell Aerosystems 8096 (restartable)
Guidance	G.E. radio-inertial	Minneapolis-Honeywell inertial guidance and Barnes horizon sensors

Since the OGO-A spacecraft operates on solar power, launch time on a given day is affected by the relative positions of the Sun and Earth. This launch window, is approximately one hour.

Confirmation of successful Agena second burn and spacecraft separation, some 55 minutes after lift-off, will come from the NASA station at Carnarvon, Australia. This station, about halfway around the world from the Cape, was built for Project Gemini. In recent Agena launches, such as the Ranger VII lunar spacecraft, confirmation of second burn has come from Pretoria, South Africa.

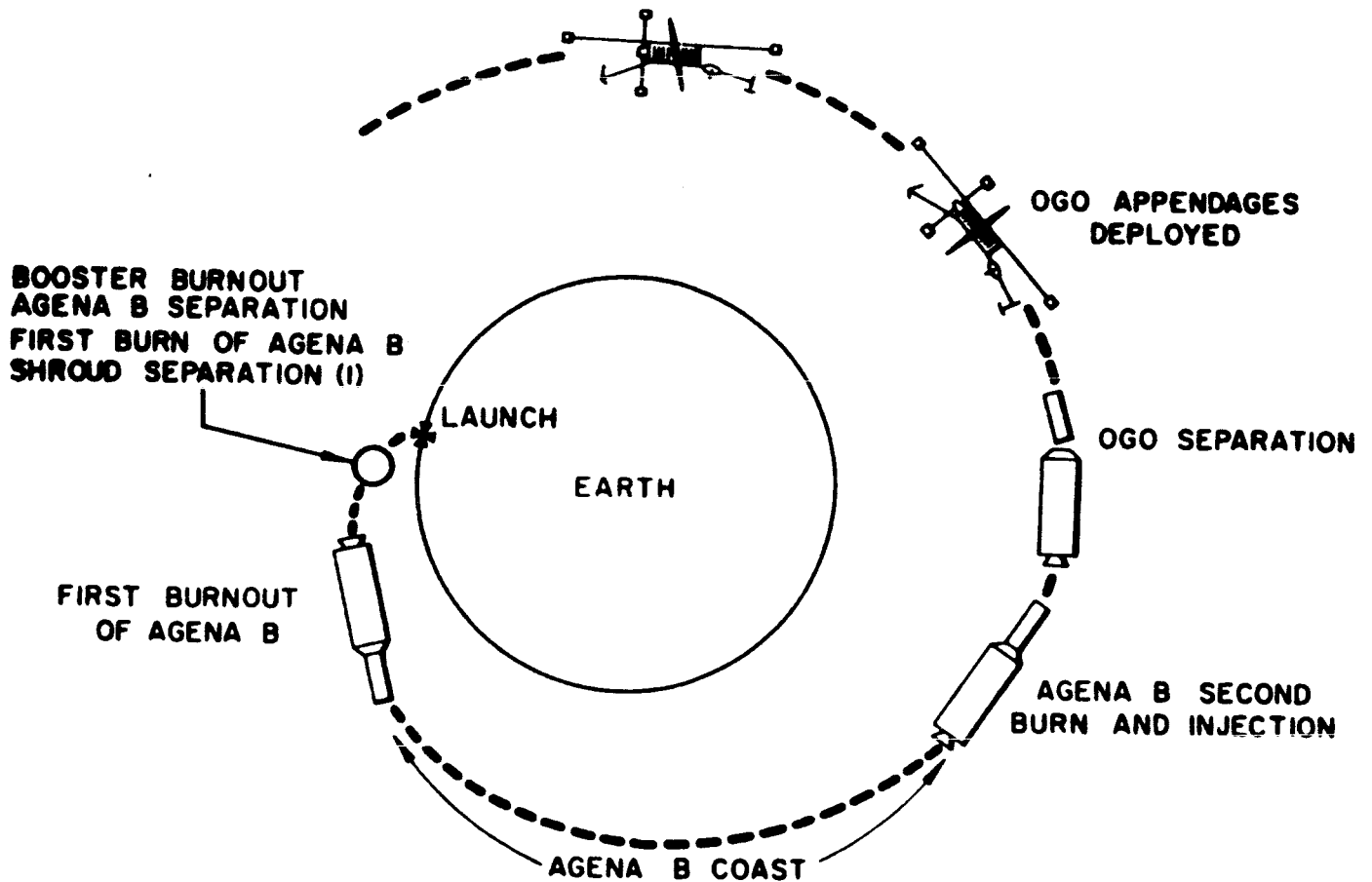
OGO LAUNCH SEQUENCE

All three main engines of the Atlas first stage power the 138-ton rocket at liftoff. The boost phase of Atlas flight lasts for about five minutes after which it will be jettisoned to fall away into the Atlantic Ocean. After Atlas separation, the Agena stage will be ignited for the first time. It will burn for about two and one-half minutes, after which the coast phase of the launch will occur. Meanwhile, after leaving the Earth's atmosphere and during the Agena first burn, the nose fairing which protects OGO from damage will be ejected.

The coast phase of the flight is programmed to last for more than 40 minutes. Then, about 52 minutes after launch, when it is about 170 miles above the central Indian Ocean, the second Agena burn phase will begin. This will last for about a minute and one-half. Thus, at about 55 and one-half minutes after launch, OGO will be injected into orbit. This will occur over the Indian Ocean off the northwest coast of Australia at an altitude of about 170 miles.

After the Agena rocket's fuel is burned, a separation signal will fire explosive bolts to release the OGO from the interstage device holding it to the Agena. Separation will be aided by four coil springs which will help eject the satellite away from a possible collision with the empty Agena stage.

# OGO LAUNCH SEQUENCE



## OGO LAUNCH EVENTS (TIMES APPROXIMATE FROM LIFTOFF)

ATLAS SEPARATION:	5 MINUTES
AGENA FIRST BURN:	6 MINUTES
AGENA CUT-OFF:	9 MINUTES
AGENA SECOND BURN:	52 MINUTES
AGENA CUT-OFF:	53 <sup>1</sup> / <sub>2</sub> MINUTES
OGO SEPARATION:	55 <sup>1</sup> / <sub>2</sub> MINUTES

Then the deployment of the booms, antennas and experiment packages which have been jack-knifed around the main body during launching will begin. First the solar panels and the two long booms will be extended. This sequence is scheduled to begin about 65 seconds after separation from the Agena.

After the satellite has become somewhat stabilized, the booms carrying jet controls, the OPEPs and the transmitting antennas will be deployed. In less than one minute from the beginning of deployment, all of the OGO appendages should be properly locked into position.

The attitude control system will help position OGO's Sun sensor to acquire the Sun. Then its Earth sensors will also acquire the Earth, the experiments will be turned on, and the satellite can begin full operation.

#### THE OGO TEAM

The following key officials are responsible for the Orbiting Geophysical Observatory satellite program:

#### NASA Headquarters

Dr. Homer E. Newell, Associate Administrator for Space Science and Applications

Dr. John E. Naugle, Director, Physics and Astronomy Programs

C. Dixon Ashworth, OGO Program Manager

Dr. Alois W. Schardt, OGO Program Scientist

J.B. Mahon, Agena Program Manager

NASA-Goddard Space Flight Center

Dr. Harry J. Goett, Director

Dr. John W. Townsend, Jr., Associate Director, Office of  
Space Science and Satellite  
Applications

Wilfred E. Scull, OGO Project Manager

Abraham Leventhal, Assistant OGO Project Manager

Dr. George H. Ludwig, OGO Project Scientist

Dr. Enrico P. Mercenti, OGO Experiment Coordinator

A.L. Thalhamer, OGO Tracking and Data Systems Manager

Robert H. Gray, Manager, Goddard Launch Operations

Robert E. Russey, OGO Agena Coordinator

NASA-Lewis Research Center

Dr. Seymour C. Himmel, Agena Project Manager

Richard C. Dillon, OGO-A Agena Project Engineer

TRW Space Technology Laboratories, Inc.

Dr. A.K. Thiel, Director, Spacecraft Systems Program  
Management

Dr. George J. Gleghorn, OGO Program Director

THE OGO INDUSTRIAL TEAM

Prime Contractors

Spacecraft design, development and construction, TRW  
Space Technology Laboratories, Redondo Beach, Calif.

Atlas booster, Astronautics Division of General Dynamics,  
San Diego, Calif.

Agena B stage, Lockheed Missiles and Space Co. Sunnyvale,  
Calif.

Major Subcontractors

Battery Cells, Gulton Industries, Inc., Metuchen, N.J.

Gyroscopes, Minneapolis-Honeywell Corp., Boston, Mass.

Horizon scanners, Advanced Technology Laboratories,  
Mountain View, Calif.

Power converters, ITT Industrial Products Div., San  
Fernando, Calif.

Reaction wheels, Bendix Eclipse Pioneer Div., Teterboro,  
N.J.

Solar cell modules, Hoffman Electronics, Corp., El Monte,  
Calif.

Solar cells, International Rectifier Corp., El Segundo,  
Calif.

Static inverters, Kinetics Corp., Solana Beach, Calif.

Tape recorders, RCA Astro-Electronics Division, Princeton,  
N.J.

Tape transporters (in vans), Ampex Corp., Redwood City,  
Calif.

SCIENTIFIC EXPERIMENTS

<u>Experiment Number</u>	<u>Experimenter</u>	<u>Experiment Title</u>	<u>Brief Description</u>
1	Dr. K. A. Anderson (University of California)	Solar Cosmic Rays	Scintillation detector to measure cosmic ray fluxes
2	Dr. J. H. Wolfe (Ames Research Center)	Solar Plasma Electrostatic Analyzer	Electrostatic analyzer to measure proton concentrations
3	Dr. H. J. Bridge (Massachusetts Institute of Technology)	Solar Plasma Faraday Cup	Faraday cup plasma probes to measure proton flux and energy spectrum, and their variations
4	Dr. T. L. Cline (Goddard Space Flight Center) Dr. E. W. Hones, Jr. (Institute for Defense Analysis)	Position Search and Gamma Ray Spectrum	Double gamma ray spectrometer to measure positrons and to monitor solar photon bursts
5	Dr. A. Konradi (Goddard Space Flight Center)	Trapped Radiation Scintillation Counter	Detector to observe trapped radiation and auroral particles
6	Dr. F. B. McDonald and Dr. G. H. Ludwig (Goddard Space Flight Center)	Cosmic Ray Isotopic Abundance	Cosmic ray telescope to study galactic cosmic rays and isotopic abundance
7	Dr. J. A. Simpson (University of Chicago)	Cosmic Ray Spectra and Fluxes	Charged particle telescope to investigate low energy galactic cosmic radiation, protons and other nuclei at high energies
8	Dr. J. A. Van Allen (State University of Iowa)	Trapped Radiation Omnidirectional Counter	Geiger tubes to measure omnidirectional intensities of electrons
9	Dr. J. R. Winckler and Dr. R. L. Arnoldy (University of Minnesota)	Trapped Radiation Electron Spectrometer	Spectrometer to measure electron energy
10	Dr. E. J. Smith (Jet Propulsion Laboratory) and Dr. R. E. Holzer (UCLA)	Triaxial Search Coil Magnetometer	Magnetometer to study magnetic field fluctuations