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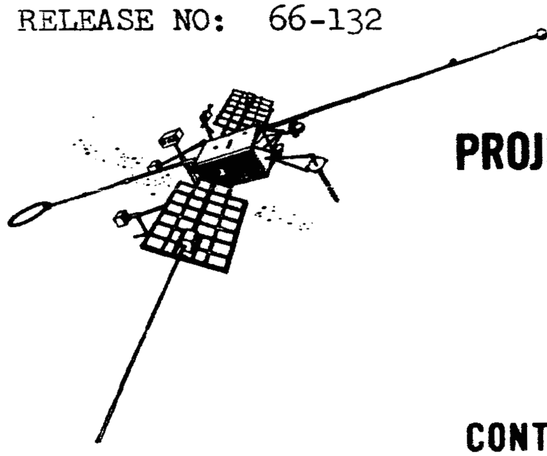

PROJECT: OGO-B

(To be launched no earlier than May 31, 1966)

CONTENTS

NEWS NASA
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SUNDAY
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GEOPHYSICAL OBSERVATORY LAUNCH MAY 31

The third in the United States' series of large observatory spacecraft to study the Earth's environment, the 1,135-pound Orbiting Geophysical Observatory -- packed with a record number of experiments -- is being readied for launch at Cape Kennedy, Fla.

OGO could be launched as early as May 31 but, because of the heavy launch schedule at Cape Kennedy, it is likely to be deferred until the earliest practicable date in June.

The National Aeronautics and Space Administration will use an Atlas-Agena B rocket to lift the observatory, designated OGO-B (OGO III in orbit) into an elongated orbit around the Earth. Apogee of the spacecraft will be about 76,000 miles, perigee 170 miles, with an orbital period of 48 hours and inclination of 31 degrees to the Equator.

OGO-B will fly 21 scientific experiments contributed by 10 U.S. universities, two NASA field centers and four other government agencies. This is the largest number of experiments ever carried by a U.S. scientific spacecraft.

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The overall objective of the OGO series is to study the relationship between our Sun and the nature of the Earth's environment. OGO spacecraft are designed to carry a large number of space experiments and to conduct simultaneous observations. This capacity for many diversified experiments permits scientists in different disciplines to cooperate in obtaining a better understanding of the many influences the Sun and other energy sources on the near-Earth environment on a time-correlated basis.

Taken together with data obtained from other sources and correlated with time, the information will serve to advance man's understanding of the Earth's environment.

Previous space exploration has revealed an extremely sensitive relationship between the Sun and the physical characteristics of the near-Earth environment.

Phenomena such as the solar wind, solar flares, terrestrial magnetic field disturbances, sudden ionospheric disturbances, radiation belt particle populations, aurora events, polar cap events, ionization, and variations in atmospheric density are part of a complex Earth-Sun-interplanetary space relationship.

The orbit planned for OGO-B is designed to permit complementary measurements with those presently being conducted by OGO's I and II launched September 5, 1964, and October 14, 1965 respectively. The apogee for the OGO-B orbit will carry it, initially, into the tail of the magnetosphere at an angle of about 160 degrees from the Sun-Earth line.

OGO I will also be in the magnetosphere tail at the same time, about 255 degrees from the Sun-Earth line. Therefore, simultaneous measurements by the two spacecraft at different locations within the magnetosphere, along with measurements by OGO II in its low-Earth orbit, are expected to provide an opportunity for significant studies.

The OGO program consists of a series of seven observatories.

They have been described as "street car" satellites because of their ability to carry many different experiments using the same basic structure, power supply, attitude control, thermal control, telemetry and command systems.

Individual experiments are mounted in the main body and on booms extending from the spacecraft which is planned to be stabilized in space in three axes. Some of the experiments must be so carried to keep them away from the disturbing influences of the main body itself. This feature gives the spacecraft an insect-like appearance, but it enables scientists to design their experiments to common specifications.

OGO I was launched into an elliptical orbit similar to the one scheduled for OGO B. OGO II was put into a near-Earth polar orbit.

Each observatory carried 20 experiments. Although problems with the attitude stabilization systems resulted in failures with both missions, OGO I and II did demonstrate the design adequacy of major spacecraft subsystems, and provided some significant scientific results.

Data are still being received from 17 of the 20 OGO I experiments. On OGO II, 19 of the 20 experiments are still working.

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

Development of the spacecraft was accomplished by the OGO prime contractor, TRW Systems, Inc., Redondo Beach, Cal., under the technical direction of Goddard. Contractors throughout the country provided various subsystems and instrumentation for the satellite.

Integration of the OGO-B experiments and subsystem assemblies as well as environmental testing of the spacecraft was accomplished at Goddard.

(END OF GENERAL RELEASE; BACKGROUND INFORMATION FOLLOWS)

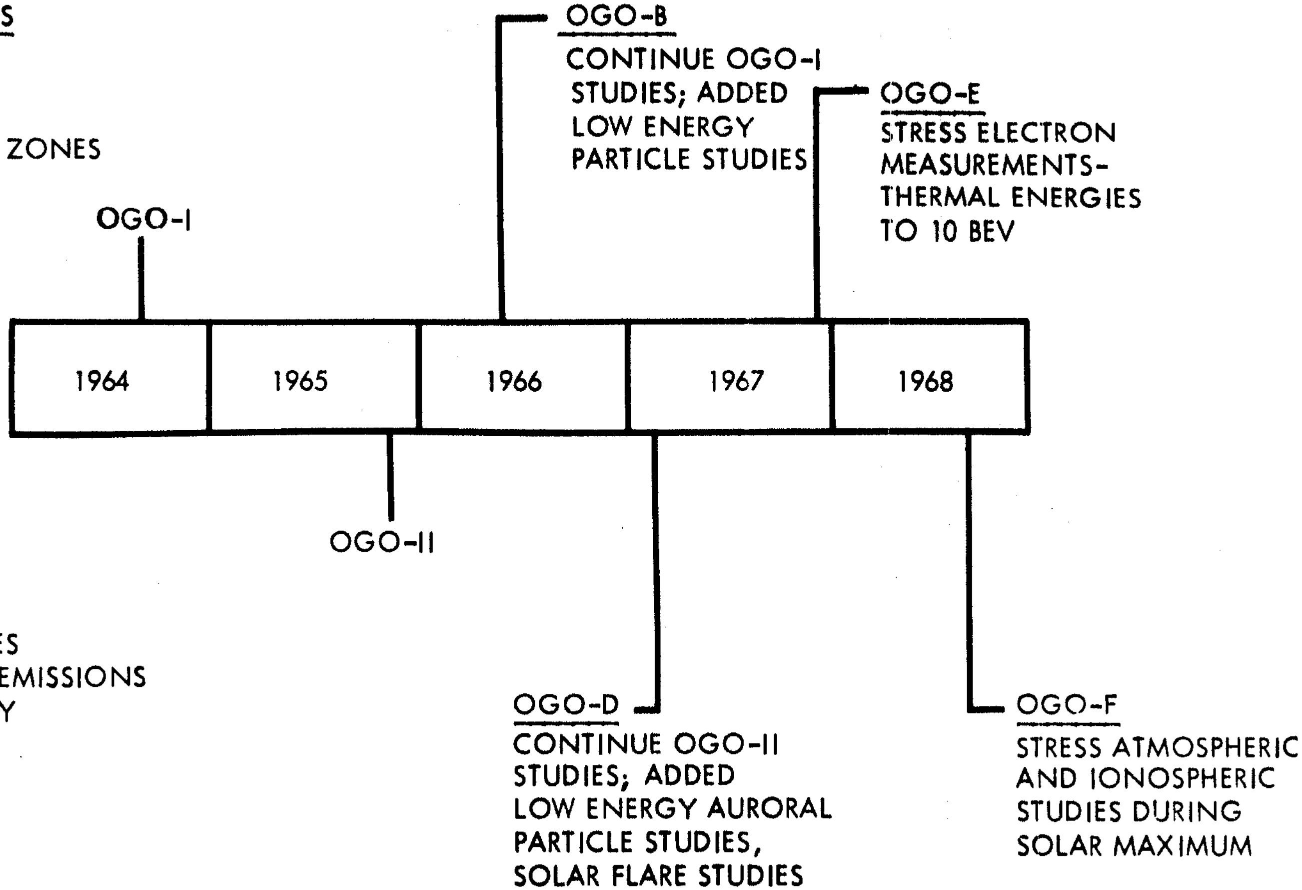
ORBITING GEOPHYSICAL OBSERVATORY
PRESENT PROGRAM

HIGHLY ELLIPTICAL - LOW INCLINATION ORBITS

EMPHASIZE STUDIES OF:
- INTERPLANETARY REGION
- SHOCK AND TRANSITION ZONES
- MAGNETOSPHERE
- RADIATION BELTS
- IONOSPHERE
- COSMIC RAYS
- SOLAR RADIATION
- MICROMETEORITES
- GEOCORONA

LOW ALTITUDE - NEARLY - POLAR ORBITS

EMPHASIZE STUDIES OF:
- NEUTRAL ATMOSPHERE
- IONOSPHERE
- PARTICLE INFLUX AT POLES
- AIRGLOW AND AURORAL EMISSIONS
- WORLD MAGNETIC SURVEY
- COSMIC RAYS
- SOLAR RADIATION
- MICROMETEORITES



OGO-B SCIENTIFIC OBJECTIVES

In general, the scientific objectives of the OGO-B mission are:

- To investigate the charged particle population and energy spectra of trapped radiation and the interrelationship with magnetic activity.

- To continue OGO I observations of particle and electro-magnetic fluctuations in the magnetosphere, at the magnetopause, in the transition region, and at the interplanetary shock wave.

- To obtain measurements of the interplanetary solar plasma and magnetic field for comparison with OGO I data obtained near solar minimum.

- To study galactic and solar cosmic rays and the modulation mechanisms associated with solar activity.

- To obtain an analysis of the charged portion of the atmospheric composition.

- To extend OGO I observations of the correlation between ion distribution, magnetic fields, and electron density.

- To obtain measurements of very low frequency noise of natural and man-made origin, of galactic emissions, and of planetary and solar bursts for correlation with magnetic field measurements, solar flare activity and electromagnetic radiation.

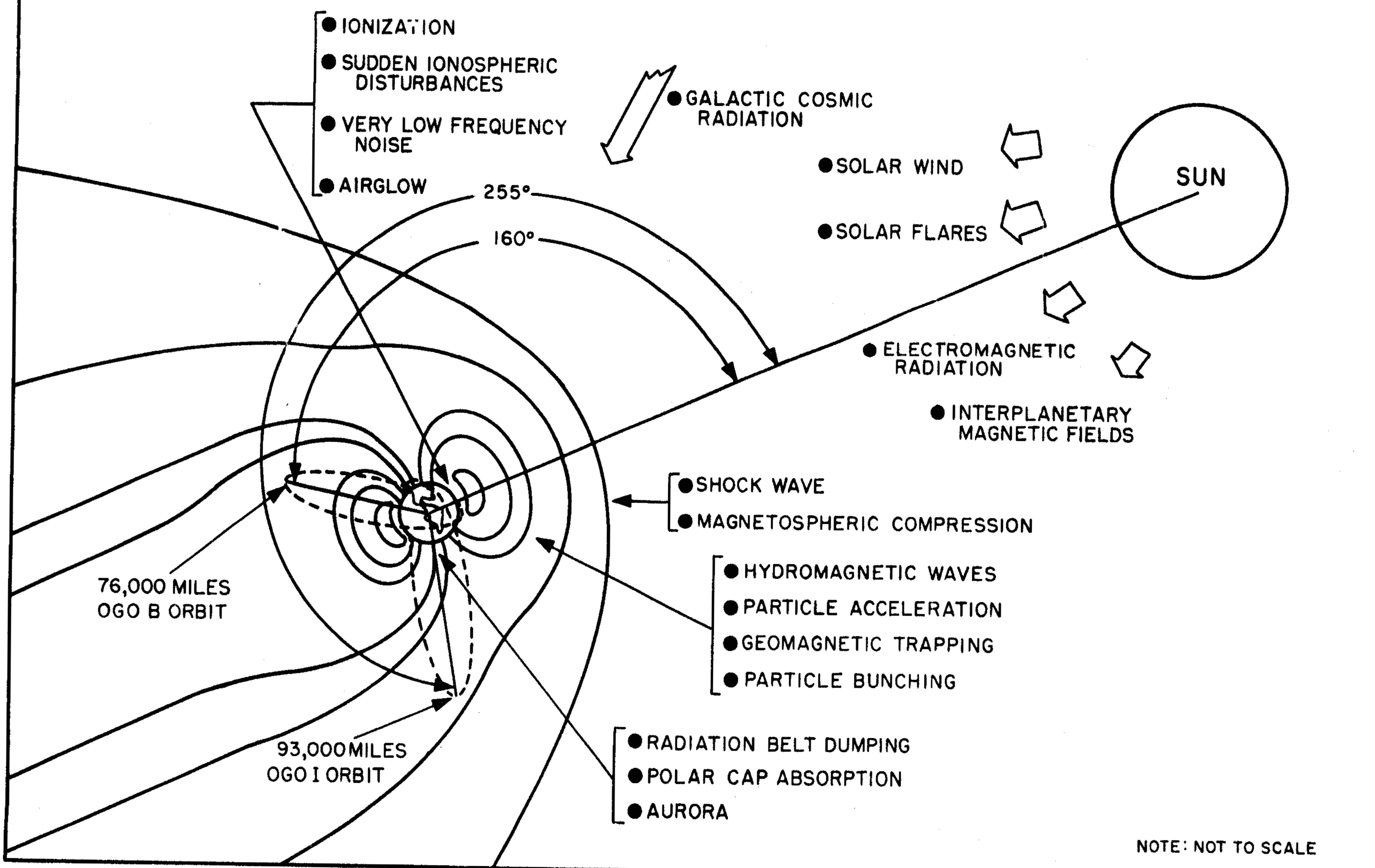
- To study the geocorona, the gegenschein and micrometeoroid distributions.

OGO-B EXPERIMENTS

Listed below in their eight areas of scientific investigations are the 21 experiments carried by OGO-B. The order in which they appear does not imply degree of scientific significance.

ORBITING GEOPHYSICAL OBSERVATORY

AREAS OF INVESTIGATION AND ORBITS, OGO I AND OGO B



NOTE: NOT TO SCALE

Cosmic Ray Experiments

Solar Cosmic Rays - University of California

This experiment consists of scintillation-type detectors to measure the form and time variations of the solar cosmic ray proton energy spectrum from 10 Mev to 90 Mev; search for solar-proton fluxes attributable to flares on the back side of the Sun, monitor X-rays from the Sun, measure the flux and energy of protons which arise in proton-producing flares, and measure protons in the galactic cosmic radiation near solar minimum. Energy measurement will be determined by penetration of shielding material and pulse height analysis.

Cosmic Ray Isotopic Abundance - Goddard Space Flight Center

A cosmic ray telescope composed of three scintillation detectors will be used to determine the charge and energy spectrum of the primary cosmic radiation to assist in the determination of the amount of inter-stellar matter through which the cosmic rays have passed between their source and the vicinity of the Earth. It will also study the modulation mechanisms which act on the cosmic rays, and the charge and energy spectra of cosmic rays produced by the Sun. By means of a system of detecting coincidence and anticoincidence events and pulse height analysis, precision separation of protons, electrons, alpha particles and heavy primaries can also be obtained.

Cosmic Ray Spectra and Fluxes - University of Chicago

The objectives of this experiment are to assist in the search for the acceleration mechanisms acting on cosmic rays and solar particles and to study the electrodynamic processes of solar origin which lead to the modulation of the galactic cosmic ray flux such as the 11-year cycle, the Forbush decreases, and the 27-day variation. Low energy galactic cosmic radiation, fluxes of protons above 0.2 Mev and other nuclei at higher energies will be investigated. Charged particles will be observed by energy loss in solid state detectors. Energy measurements will be determined by penetration of shielding material and pulse height discrimination.

Positron Search and Gamma Ray Spectrum - Goddard Space Flight Center and Institute for Defense Analyses

Knowledge of the presence or absence of positron (positively-charged electrons) fluxes will be valuable in understanding some of the basic processes in the production and acceleration of cosmic rays. This experiment will also investigate the possible existence of low-energy positrons (0 to 3 Mev) in the trapped particle belts, and the possible arrival of low-energy solar or interplanetary positrons at the edge of the Earth's magnetic field. The presence of positrons will be detected by a double gamma ray spectrometer observing the gamma ray pair resulting from positron annihilation. This experiment will also monitor solar photon bursts by measuring the flux of gamma rays in the energy range from 30 Kev to 1.2 Mev.

Plasma Measurements

Electrostatic Plasma Analyzer - Ames Research Center

The findings of this experiment will further the understanding of lower energy particles and their relationship to other geophysical, solar and cosmic phenomena. The distribution of plasma particles is particularly important in connection with understanding the distribution of magnetic fields in space. A curved plate electro-static spectrometer will investigate proton concentrations as a function of energy in the range of 0.2 to 20 Kev.

Plasma Faraday Cup - Massachusetts Institute of Technology

This experiment will study the properties of plasma (solar wind) from the Sun by measuring proton and electron flux, the energy spectrum, and the direction of flux. Temporal and spatial variations of these quantities in the energy range of 10 ev to 10 Kev will be correlated with measurements of the interplanetary magnetic field. Measurements of plasma flux and energy will be made by collection in a Faraday cup modulated by electric fields.

Low Energy Proton Analyzer - Goddard Space Flight Center

Cylindrical electrostatic analyzers and broom magnetic analyzers will be used to study energetic plasma. The absolute intensity and energy spectrum of protons in the little-explored energy range of 5 Kev to 100 Kev will be measured to determine both the spatial structures out beyond the magnetospheric boundary and the temporal variations of these particles.

Low Energy Electrons and Protons Measurements - State University of Iowa

The objective of this investigation is a general study of the spatial and temporal distribution of electrons and protons in the energy range of 100 ev to 50 Kev within and outside the Earth's magnetosphere with special interest in the "wings" and tail of the magnetosphere. A cylindrical electrostatic analyzer with channeltron-type detectors will study simultaneously electrons and protons.

Trapped Radiation Experiments

Trapped Radiation, Electron Spectrometer - University of Minnesota

The objective of this experiment is to study the injection, trapping and loss mechanism actions which occur in the radiation belts. The device used is a swept magnetic field electron spectrometer capable of making precision measurements of the electron energy spectrum in the range of 50 Kev to four Mev. Ionization and Geiger-Mueller counters will monitor the galactic cosmic radiation and the Earth's trapped radiation in the electron energy range of from 20 Kev up to 20 Mev.

Trapped Radiation Scintillation Counter - Goddard Space Flight Center

This experiment will provide further studies of the temporal and spatial variations of particle intensities, pitch-angle distributions, and energy spectra of electrons and protons trapped in the Earth's geomagnetic field. Of special interest are particle lifetimes, processes by which trapped particles are lost and the source and accelerating mechanism of the trapped particles. Particle flux in the energy range of 10 Kev to 100 Kev for electrons and 120 Kev to 4.5 Mev for protons will be detected by ion-electron scintillation in a phosphor layer. Directional intensities will be obtained by scanning action of the Orbital Plane Experiment Package (OPEP).

Magnetic Fields Experiments

Rubidium-Vapor and Flux-Gate Magnetometers - Goddard Space Flight Center

A combination of three-component flux-gate sensors and a rubidium-vapor magnetometer is intended to provide comprehensive field measurement with a known absolute accuracy. These will measure the magnitude (Rb-vapor magnetometer) and direction (flux-gate magnetometer) of the magnetic field vector over a range of 1 to 50,000 gamma (10^{-5} gauss.) to an accuracy of 1 gamma. This combination is expected to accurately measure the interaction of the solar and geomagnetic field (magnetopause, shock wave), local field sources such as ring currents, and provide an opportunity to study field fluctuations. Data from the experiment will be vital in interpreting and understanding particle measurements obtained by other experiments.

Triaxial Search Coil Magnetometer - Jet Propulsion Laboratory and UCLA

The nature of extremely low-frequency variations in the terrestrial geomagnetic field, in the interplanetary field, and in the vicinity of the magnetosphere will be studied to determine the relationship between fluctuations in these regions of space and the simultaneous variations at the Earth's surface. These studies are important to an understanding of the propagation of hydromagnetic waves and possible particle acceleration mechanisms. Magnetic fluctuations will be detected by signals induced in three (triaxial) search coils.

Ionospheric Experiments

Spherical Ion and Electron Trap - Air Force Cambridge Research Laboratory

Two spherical retarding potential analyzers will be used to measure densities of positively and negatively charged particles, energy distribution of these particles up to one Kev, and the potential of the spacecraft with respect to the undisturbed plasma. Over certain regions of the trajectory, ion and electron temperatures will also be obtained.

Planar Ion and Electron Trap - Environmental Science Services Administration

The density and energy distributions of charged particles in the low-energy or thermal ranges will be studied. These measurements are expected to provide data on low-particle densities in the transition region between the ionosphere and interplanetary space. The Planar Ion and Electron Trap will separate particles according to their polarity and energy. Information is also provided on ion masses, fluxes, directions of particle beams, and polarity and magnitude of the spacecraft potential.

Atmospheric Mass Spectrum - Goddard Space Flight Center

Three radio frequency ion mass spectrometer tubes will make direct measurements of the distribution of the positive ion composition of the Earth's atmosphere. The density of positive ions in the mass range from one to 50 atomic mass units will be determined by varying the retarding potential of the spectrometer tube and by adjusting the gain of the amplifier. Data from these measurements will be useful for a more complete determination of a model of the Earth's inner ionosphere and to extend our present understanding of the formation and function of the outer ionosphere.

Radio Propagation - Environmental Science Services Administration

A radio beacon operating at 40 mc and 360 mc with switched 20 kc and 200 kc modulation will continuously transmit signals to ground stations for accurate measurements of the electron density along the line of sight by determination of the Faraday rotations of two harmonically related, linearly polarized waves. Ground stations receiving these signals will be able to measure the magnitude of large-scale horizontal irregularities in the electron distribution of the ionosphere and exosphere and to determine the ratio of ionospheric to exospheric electrons along the line of sight to the spacecraft.

VLF Noise and Propagation - Stanford University

This experiment will continue studies of VLF and unexpected noise seen by OGO I in the outer magnetosphere. The frequency range of 15 to 100,000 cps will permit observation of proton whistlers at lower altitudes than previously detected and a search for helium whistlers. Both electric and magnetic fields will be measured to attempt a separation of related phenomena using a deployable nine-foot diameter loop antenna extending from one of the long booms. The strong diagnostic relationship of VLF and particle flux will provide data on the local density and temperature of protons and the densities of ionic constituents. Antenna biasing and electron current measurements are expected to provide data on field-aligned irregularities which could be responsible for whistler ducts.

Optical and Radio Emission Experiments

Radio Astronomy - University of Michigan

At present, ground observations of the brightness distribution of cosmic radio noise over the sky are limited to about 10 mc because of the blanketing effect of the Earth's atmosphere. This experiment will produce maps at two to four mc. These are expected to show significant changes from available maps. A sweep-frequency electrically-tuned receiver will measure the radio noise incident upon a 30-foot antenna to be deployed from a solar panel in orbit. The dynamic radio spectrum of solar radio-noise bursts, and radio bursts from the planet Jupiter should be observable. Additional observations to be made are: cosmic noise intensity, ionospheric electron densities, atmospherics, auroral noise and noise generated in the terrestrial ionosphere and in the interplanetary plasma.

Geocoronal Lyman-Alpha Scattering - Naval Research Laboratory

The Lyman-Alpha glow in the night sky probably originates from either a geocorona or the interplanetary medium. To distinguish the relative contribution of these two sources, it is necessary to make measurements from great altitudes which will permit separation of the sources of the resonantly scattered light. Four collimated ion chambers will detect the Lyman-Alpha radiation.

Gegenschein Photometry - Goddard Space Flight Center and University of Illinois

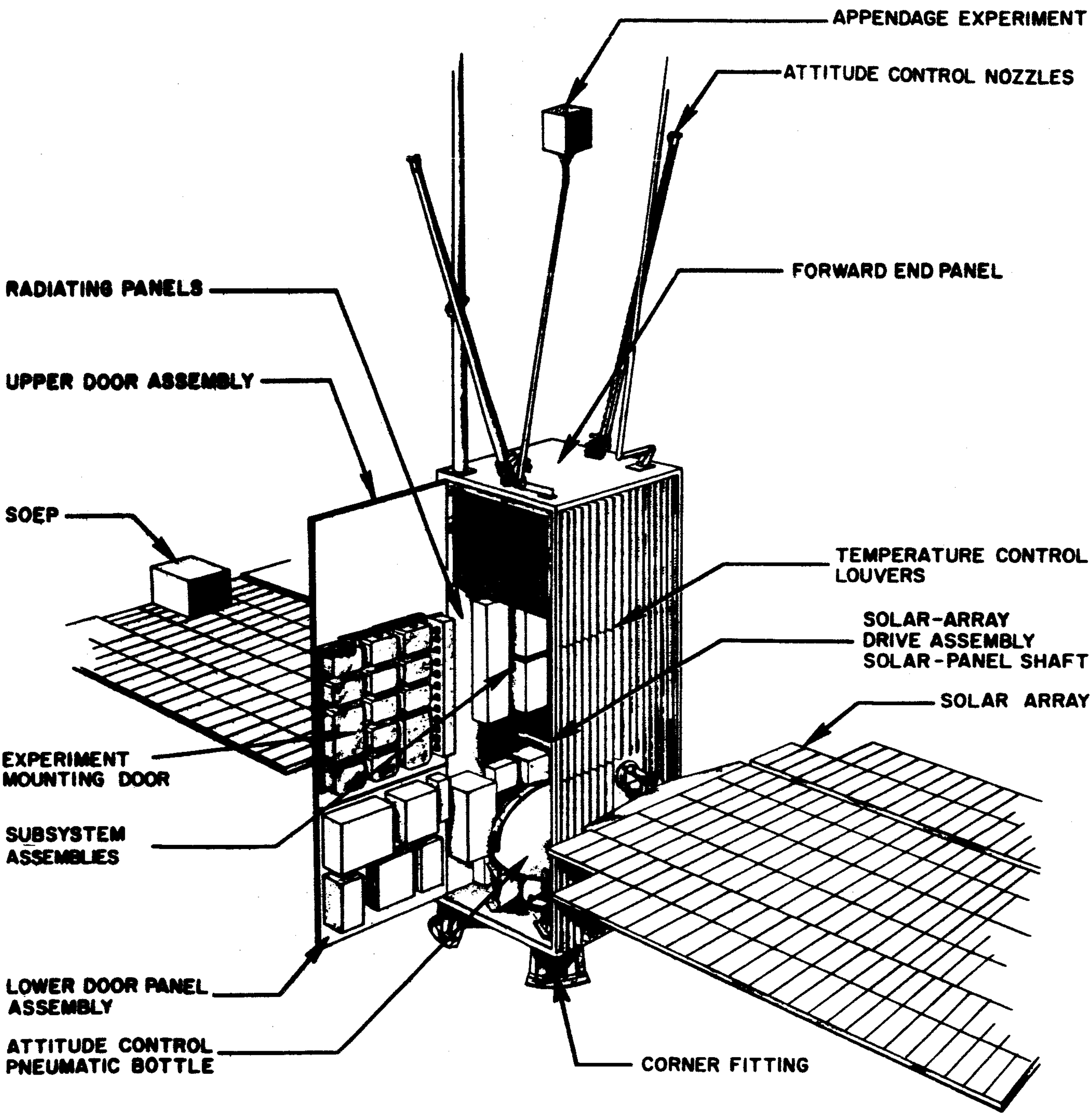
The gegenschein (counterglow) is an approximate ten-degree wide patch of light in the antisolar direction visible to the naked eye under ideal conditions. The question as to where the gegenschein originates in space has defied solution by ground observers for nearly two centuries, and is not likely to be solved until an observation is made sufficiently far from the Earth to show a parallax. This experiment will obtain low resolution images of the sky in the antisolar direction to determine the location and spatial extent of the gegenschein. Information will be obtained on the degree of polarization and the infrared brightness. Data will be taken in the ultraviolet, green and infrared regions.

Micrometeoroid Experiment

Interplanetary Dust Particles - Temple University

This experiment will measure the velocity, mass and density distribution of interplanetary dust particles of micron size. The findings of this experiment will extend the mass-distribution curve down to the radiation pressure limit. Four detectors are used. These are cylindrical tubes containing acoustical sensors and elements for collecting charge for minute plasma clouds. A particle entering the tube penetrates a thin metallic film and produces a plasma cloud. A second plasma cloud is produced at impact with the acoustical sensor. Timing of the plasma clouds and the impulse at impact determine the velocity and mass of each particle.

OGO MAIN BODY SHOWING EXPERIMENT MOUNTING



THE SPACECRAFT

The OGO Structure

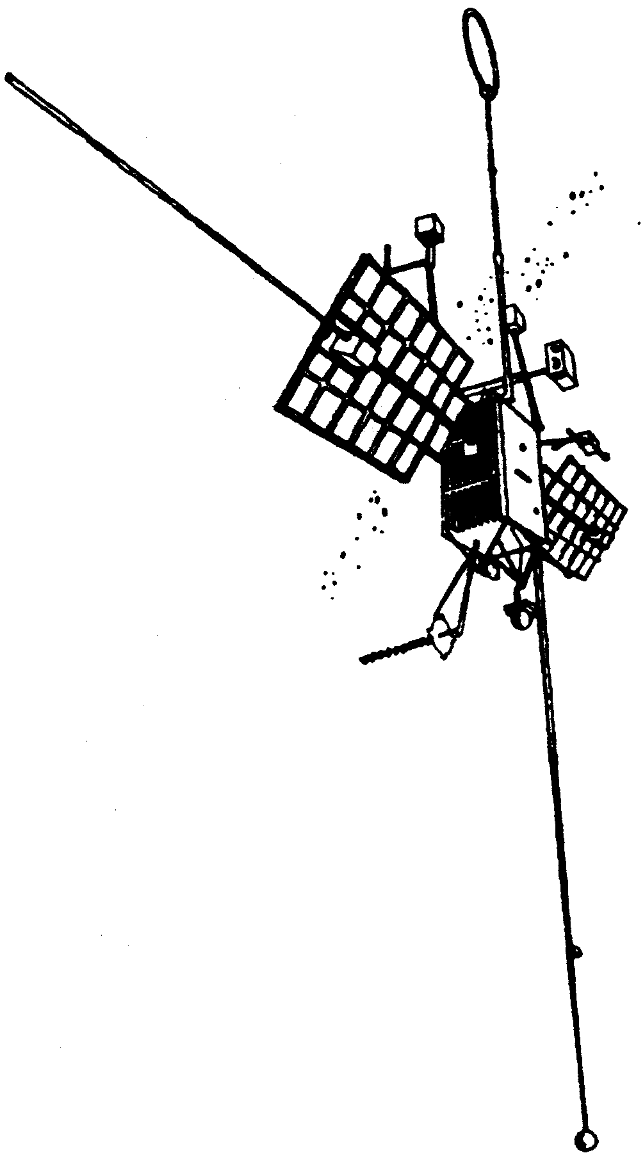
OGO-B -- like all spacecraft in the series -- consists of a rectangular main body approximately six feet long by three feet square. Attached to this main body are the booms and antennas which give OGO its insect-like appearance. These include two 22-foot-long booms with sensitive magnetometers mounted on the ends which must be kept away from the main body because of possible magnetic and electric interference, one five-foot boom for the high-gain antenna, and four, four-foot-long booms at various locations to carry somewhat less sensitive experiments. OGO-B transmitting antennas are mounted away from the main body to take advantage of improved antenna patterns made possible by this technique.

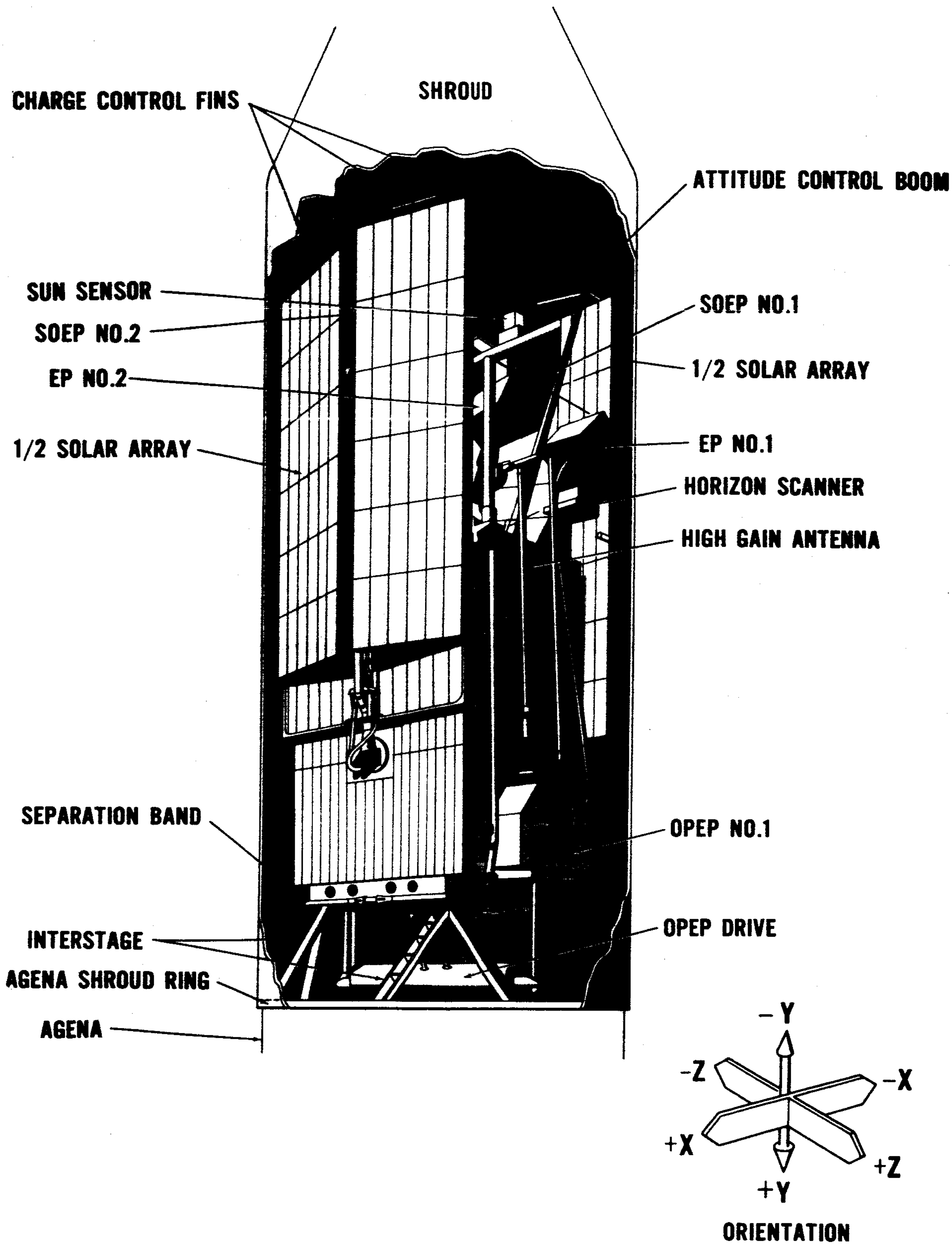
Other external characteristics of the satellite include two additional box-like experiment-carrying packages. These packages, known as the OPEPs (Orbital Plane Experiment Packages) are 17 inches long, and eight by eight inches square. On OGO-B they carry experiments which will make scientific observations 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 the spacecraft in order to increase the "lever arm" action needed to help stabilize OGO 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.

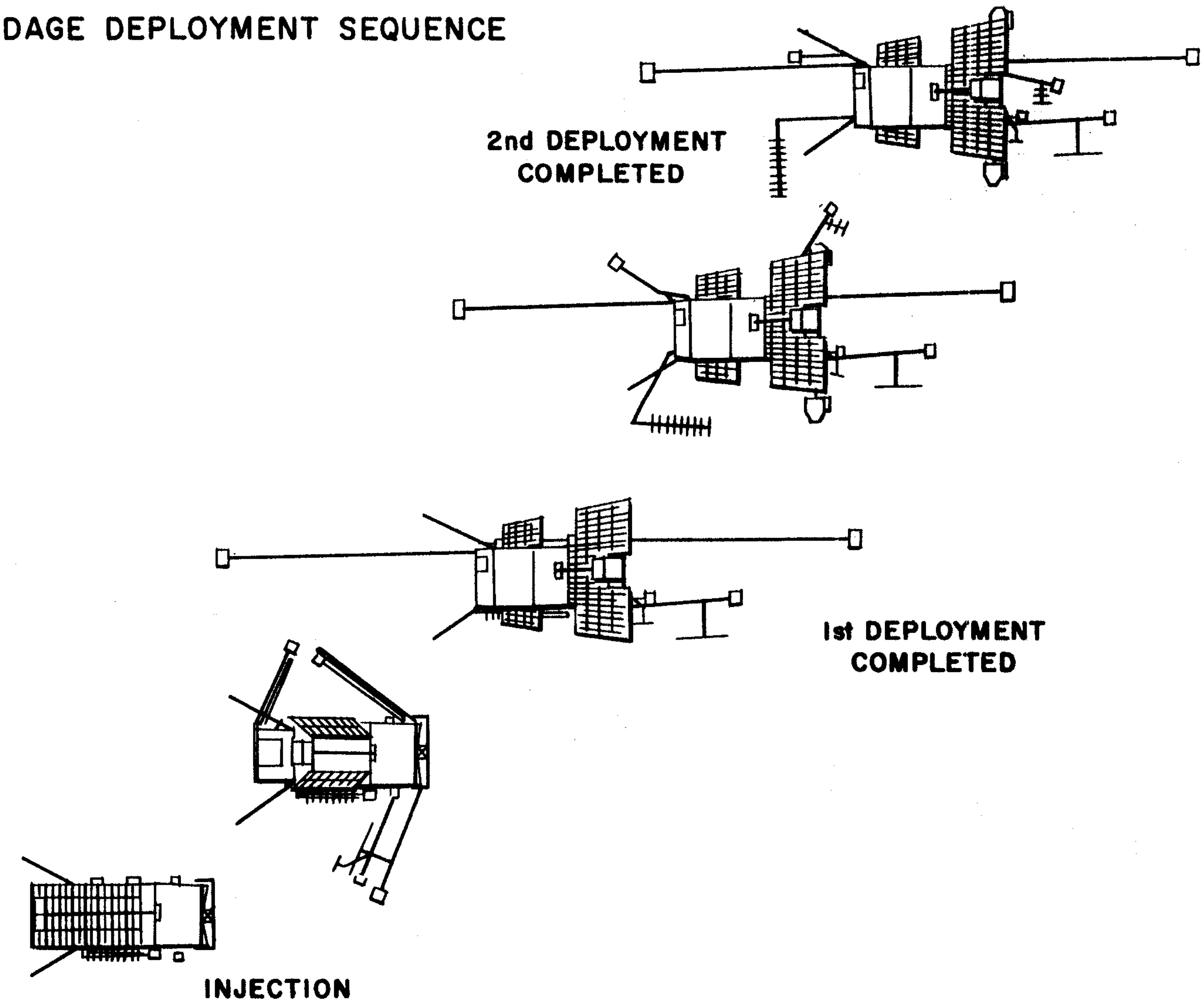
OGO spacecraft incorporate a number of unusual engineering techniques. For example, experiments not sensitive to the satellite's local environment are mounted inside two large hinged doors, similar in manner to the tray-doors on refrigerators. These doors can be opened to allow installation of equipment 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.



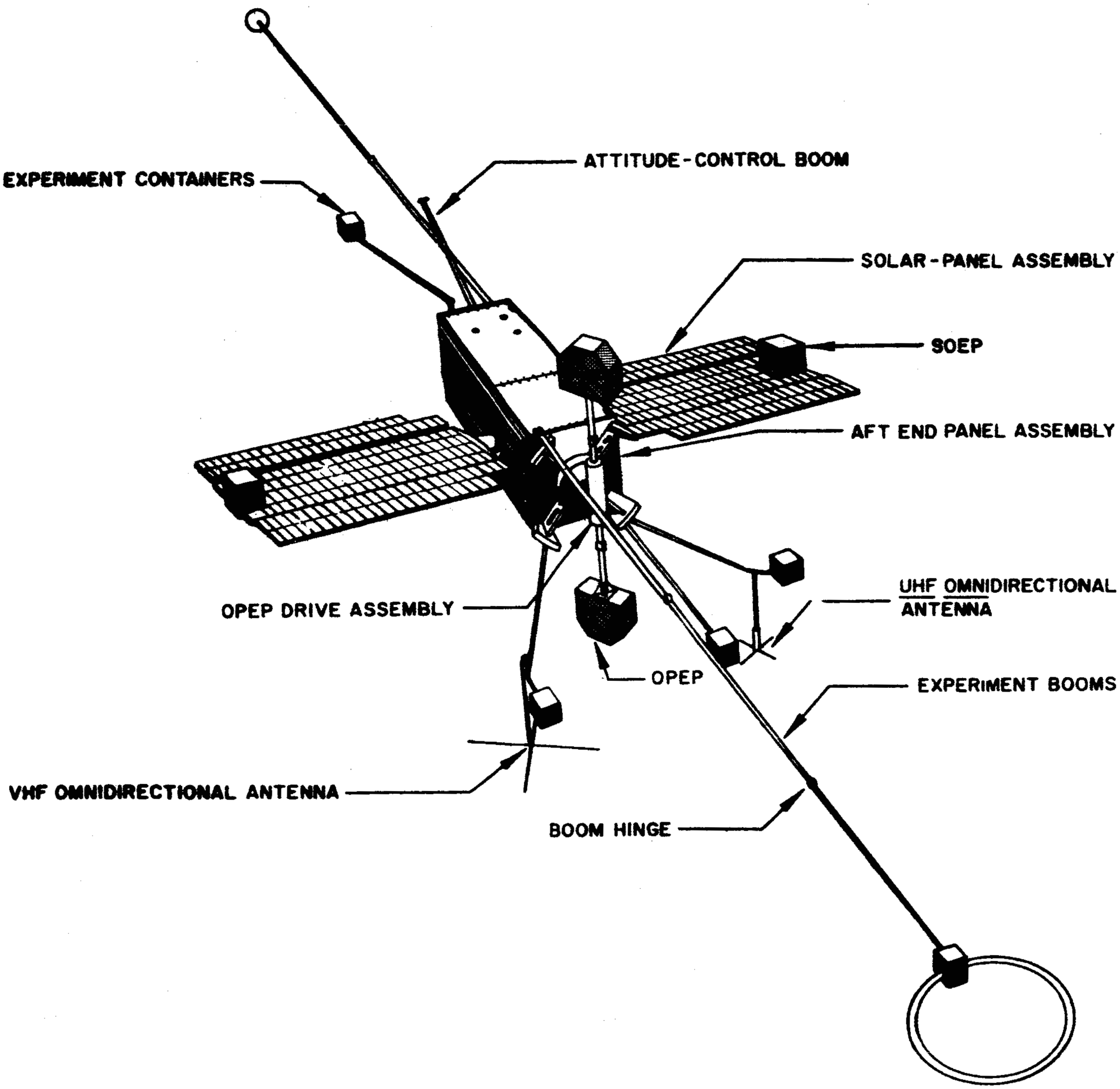

SHROUD
CHARGE CONTROL FINS
ATTITUDE CONTROL BOOM
SUN SENSOR
SOEP NO.1
SOEP NO.2
1/2 SOLAR ARRAY
EP NO.2
1/2 SOLAR ARRAY
EP NO.1
HORIZON SCANNER
HIGH GAIN ANTENNA
SEPARATION BAND
OPEP NO.1
INTERSTAGE
OPEP DRIVE
AGENA SHROUD RING
AGENA
-Y
-Z
-X
+X
+Z
+Y
ORIENTATION

ORBITING GEOPHYSICAL OBSERVATORY

APPENDAGE DEPLOYMENT SEQUENCE



OGO FULLY DEPLOYED IN ORBIT



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

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 (yaw) 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 plane 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 OPEP's 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-actuacted 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-B communications and data handling systems is designed to provide for tracking and command functions both for satellite "housekeeping" and experiment data, and experiment telemetry. The main telemetry is 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 compatible with the Goddard Space Flight Center's Tracking and Data Acquisition Network (STADAN).

Data Processing

OGO-B, like its predecessors, will have the capability of producing a vast amount of scientific data. If it operates for a period of one year, for example, it could provide (at the maximum data rate) up to 200 billion nine-bit or word measurements.

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 Information Processing Division located at the Goddard Space Flight Center. Tracking data will also be sent to Goddard for use by OGO-B 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 an 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 operating, 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. At a later date these data will be assembled at the NASA Space Science Data Center at the Goddard Space Flight Center, where they will be available to scientists throughout the world.

THE FIRST TWO MISSIONS

OGO I was launched into a low inclination, highly elliptical orbit extending 93,000 miles from Earth.

Two boom appendages failed to fully deploy, and one is presumed to have obscured the view of the Earth-seeking horizon scanner. Use of control gas to correct the problem of orientation resulted in depletion of control gas and caused the observatory to settle in a spin-stabilized mode.

An operational plan was established to obtain data of scientific value from the OGO I in this unplanned spin condition. It has been successful in achieving a considerable portion of the planned data acquisition over a period beyond the one-year design lifetime of the spacecraft.

The OGO I mission has verified the design adequacy of major spacecraft subsystems, and continues to provide significant scientific data. However, it was classified a failure because it did not achieve three-axis stabilization.

An investigation into the OGO I boom failure led to:

(1) A new appendage hinge design and the addition of positive kick-off springs.

(2) Relocation of the scanner.

(3) An increase in ground testing associated with environmental simulation of appendage deployment.

(4) The addition of diagnostic instrumentation for a ready indication of in-flight status. (This technological approach was confirmed by the successful in-flight deployment of all twelve OGO II appendages.)

Following the OGO II launch, all spacecraft systems functioned, the Earth and Sun were acquired, and three-axis stabilization -- something not achieved on OGO I -- was sucessfully accomplished. During stabilized flight, however, an anomalous response of the infrared horizon scanners to the presence of high altitude cold clouds in the tropic regions resulted in depletion of attitude control gas during the first ten days of the mission.

Intermittent periods of stabilization under reaction wheel control continued for several days. However, the observatory eventually settled into a spin stabilized mode, similar to that of OGO I, but at a much lower spin rate.

The horizon scanner response to cold clouds has been investigated, both theoretically and experimentally. These results show that the problem could be corrected by modifying the spectral range and sensitivity of the infrared sensor to reduce the response to cold clouds.

Other minor spacecraft design changes have also been made to protect against recurrence of the horizon scanner problem. These design modifications were incorporated into the OGO B spacecraft.

In addition, the experience with OGO I has demonstrated that significant scientific data can still be acquired in the highly elliptical orbit with a spinning spacecraft. As a result OGO B modifications include, as a secondary mode, a spin-up capability which would extend the lifetime of the observatory.

The OGO I and II missions have demonstrated the feasibility of the functional aspects of spacecraft design. Together they have achieved all technological objectives, except the design period of stabilized lifetime. In addition, the extensive ground command capability and the redundancy associated with the observatory-type spacecraft, have proved invaluable in "saving" a spacecraft in trouble.

SCIENTIFIC RESULTS FROM OGO-I AND OGO-II

Analysis of experimental results from OGO-I and OGO-II is in progress. A number of preliminary results have already been reported at scientific meetings, and substantial scientific achievements have been attributed to findings from both spacecraft.

The first OGO-I results were presented in four papers at the American Geophysical Union meeting at Seattle, Wash., in December 1964 -- three months after launch. Since then there have been few space science meetings at which results based on OGO-I and OGO-II were not reported. More than 43 reports on preliminary results have been made and some eight formal papers have been published.

One of the more significant scientific findings has been the correlation observed between ion concentrations and the geomagnetic field by H. A. Taylor of the Goddard Space Flight Center. Taylor reports that thermal ions apparently are controlled by lines of the magnetic field and are confined to a belt which appears to contract and expand with magnetic activity. Correlation with variations in the interplanetary magnetic field are indicated. The plateau in the ion concentration plotted against magnetic coordinates correlates well with the electron density "knee" deduced from equatorial "whistler" measurements.

A prime objective of the OGO program has been the exploration of the geomagnetic field, which was measured very accurately with OGO-II over many parts of the globe.

It was found that past presentations of the field are accurate to 0.005 per cent in many places; however, a maximum error of about one per cent was found in one place. These data will form the major part of the U.S. contribution to the World Magnetic Survey of the International Quiet Sun Year.

At 40,000 to 60,000 miles from Earth, the interaction region between the solar wind and the terrestrial magnetic field was explored with OGO-I. Oscillations in the magnetic field were found with frequencies ranging all the way up to 1000 cycles per second; large amplitudes occurred around 0.8 to 1.2 cycles per second.

These observations are expected to play a vital role in understanding the "collisionless shock" phenomenon which occurs in this region. The location of the interplanetary shock front and magnetospheric boundary was observed to fluctuate rapidly and the character of the plasma in the transition region frequently displayed a filamentary structure with significant changes in electron and ion density. Instruments on OGO-I determined the energy spectrum of the superthermal electrons occurring in this region.

A comprehensive survey of magnetospheric electrons is being undertaken with OGO-I. Detailed measurements of electron fluxes and their energy spectra are being studied. The time variability previously found in the outer radiation belts with simpler instruments was found to involve both the total flux and the energy spectrum of the electrons. Correlations of these changes with other phenomena such as magnetic field fluctuations are in progress.

In still other areas, very low frequency (VLF) radio noise, measured near apogee by OGO-I, in the tail of the magnetosphere, correlates with local plasma frequencies and may be associated with highly variable fluxes of low energy electrons.

OGO-II observations of VLF noise have confirmed an asymmetry in North-South emissions and may have indicated the extent of VLF dispersion. Analysis of proton whistlers observed by OGO-II is expected to result in an extension of VLF measurements as diagnostic tools for studying proton density and temperature, much the same as electron whistlers provide information on electron density and temperature.

The OGO observations are contributing greatly to a continuing study of cosmic ray composition and energy spectra. In particular, the abundance of the elements from helium to neon were determined. These results will contribute toward the study of generation mechanisms of galactic cosmic rays.

A unique opportunity occurred in 1965 to conduct simultaneous cosmic ray measurements near Mars with Mariner IV and near the Earth with OGO-I. As expected galactic cosmic ray fluxes were essentially identical. Considerable differences, however, were found in the character of the solar cosmic rays. These differences have been ascribed to the larger distances the particles had to travel to get to Mars and to different propagation conditions in interplanetary space which are controlled by the solar magnetic field. For example, the proton flux from one solar flare was more intense near Mars than near the Earth because the solar magnetic field shielded the Earth from the most intense flux.

Many diverse measurements have been performed with the two OGO satellites. Complete evaluation of all the data will take many years. High on the list of future analysis are correlations between different observations which are related to the same cause. In this way, scientists believe we will gain a more comprehensive understanding of the highly variable, time-dependent near-Earth environment.

ORBITING GEOPHYSICAL OBSERVATORY-B

OBSERVATORY

Weight: About 1,135 pounds, Including

Experiments:	195 pounds
Power Supply:	205 pounds
Spacecraft Structure and Thermal Control System:	226 pounds
Communications and Data Handling Systems:	140 pounds
Spacecraft Integration Element and Wiring:	183 pounds
Stabilization and Attitude Control System:	156 pounds
Interstage and Separation Mechanism:	22 pounds
Range and Range Rate System:	8 pounds

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

Appendages:
Two long booms, 22 feet long
One high gain antenna boom, five feet long
Four short booms, four feet long
Two gas jet booms, 3 3/4 feet long
Two solar panels, six feet wide, seven and one-half feet long with approximately 78 square feet total area covered with 32,256 P/N solar cells.

Two orbital plane (OPEP) experiment packages, 17 inches long,8 inches wide and 8 inches deep.

Overall Dimensions:
Length, booms extended 49 feet
Width, solar panels extended: 20 feet six inches.

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 (twelve-hour capability at 1,000 data bits per second)
Special Purpose Telemetry (FM/PM):	One 500-mw, 400-mc RF transmitter One signal combiner and AGC unit
Tracking:	Two 100-mw, 136-mc beacons One 10W 136 mc beacon (apogee tracking) One Range and Range Rate Transponder
Command:	Two Receivers at frequency of 149 mc PCM/FM/AM

LAUNCH PHASE

Launch Site:	Complex 12, Cape Kennedy, Fla.
Launch Rocket:	Atlas-Agena B
Orbit:	Apogee, 76,000 statute miles; Perigee, 170 statute miles
Angle of Inclination:	31 degrees
Orbital Period:	About 48 hours

TRACKING AND DATA ACQUISITION STATIONS*

Primary Stations:	Rosman, North Carolina Fairbanks, Alaska
Secondary Stations:	Quito, Ecuador Johannesburg, Republic of South Africa

*All S/C tracking and telemetry stations are operated by the Goddard Space Flight Center.

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

Range and Range Rate Stations

OGO-B SCIENTIFIC EXPERIMENTS

Cosmic Ray Experiments

Experimenter	Experiment	Brief Description
Dr. K. A. Anderson (University of California)	Solar Cosmic Rays	Scintillation detector to measure cosmic ray fluxes
Dr. F. B. McDonald (Goddard Space Flight Center)	Cosmic Ray Isotopic Abundance	Cosmic Ray telescope to study galactic cosmic rays and isotopic abundance
Dr. J. A. Simpson (University of Chicago)	Cosmic Ray Spectra and Fluxes	Charged particle telescope to measure low energy galactic cosmic radiation, protons and other nuclei at high energies
Dr. T. L. Cline (Goddard Space Flight Center) Dr. E. W. Hones, Jr. (Institute for Defense Analyses)	Positron Search and Gamma Ray Spectrum	Double gamma ray spectrometer to measure positrons and to monitor solar photon bursts

Plasma Experiments

Experimenter	Experiment	Brief Description
Dr. J. H. Wolfe (Ames Research Center)	Electrostatic Plasma Analyzer	Electrostatic analyzer to measure proton concentrations
Dr. H. J. Bridge (Massachusetts Institute of Technology)	Plasma Faraday Cup	Faraday cup probes to measure proton flux, energy spectrum and variations

Plasma Experiments (Cont.)

Dr. D. S. Evans (Goddard Space Flight Center)	Low Energy Proton Analyzer	Electrostatic and broom magnet analyzers to study intensity and energy spectrum of protons
Dr. J. A. Van Allen (State University of Iowa)	Low Energy Electron and Proton Measurements	Electrostatic analyzer with channeltron detectors to measure electrons and protons simultaneously

Trapped Radiation Experiments

Dr. J. R. Winckler (University of Minnesota)	Trapped Radiation	Electron spectrometer to measure electron energy spectrum. Ionization and Geiger-Mueller counters to monitor galactic cosmic radiation and earth's trapped radiation
Dr. A. Konradi (Goddard Space Flight Center)	Trapped Radiation Scintillation Counter	Detector to observe trapped radiation

Magnetic Fields Measurements

Dr. J. P. Heppner (Goddard Space Flight Center)	Magnetometers	Rubidium vapor and flux-gate magnetometers to measure magnitude and direction of magnetic fields
Dr. E. J. Smith (Jet Propulsion Laboratory) Dr. R. E. Holzer (UCLA)	Triaxial Search Coil Magnetometer	Magnetometer to study magnetic field fluctuations

Ionospheric Measurements

Dr. R. C. Sagalyn (AF Cambridge Research Laboratory)	Spherical Ion and Electron Trap	Ion trap to measure concentration and energy distribution of charged particles
Mr. E. C. Whipple	Planar Ion and Electron Trap	Ion trap to measure concentration and energy distribution of charged particles in the low energy or thermal range
Mr. H. A. Taylor, Jr. (Goddard Space Flight Center)	Atmospheric Mass Spectrum	Direct measurements of distribution of positive ions in the Earth's atmosphere
Dr. J. K. Hargreaves (Environmental Science Services Administration)	Radio Propagation	Measure magnitude of large-scale horizontal irregularities in electron distribution using ground stations to receive signal
Dr. R. A. Helliwell (Stanford University)	VLF Noise and Propagation	Measurement of terrestrial and other emissions in VLF frequency range

Optical and Radio Emission Experiments

Prof. F. T. Haddock (University of Michigan)	Radio Astronomy	Measurement of dynamic radio spectra of solar radio-noise bursts
Dr. P. M. Mange (Naval Research Laboratory)	Geocoronal Lyman-Alpha Scattering	Ultraviolet ion chamber to measure Lyman-Alpha scattering in the geocoronal and interplanetary medium

Dr. C. L. Wolff (Goddard Space Flight Center) Dr. S. P. Wyatt (University of Illinois)	Gegenschein Photometry	Conduct Gegenschein photometry in the ultraviolet, green and infrared regions of the spectrum
	Micrometeorite Investigation	
Prof. J. L. Bohn (Temple University)	Interplanetary Dust Particles	Detector to measure spatial density, mass distribution and velocity of dust particles

The OGO-B spacecraft will be launched into its highly eccentric orbit by an Atlas-Agena-B launch vehicle. This Agena-B will be the last of its type to be flown by NASA. The booster, however, is a newly standardized Atlas--the SLV-3. Thus, the OGO-B launch vehicle is unique in NASA's space-science series.

Kicking the heavy OGO spacecraft into an orbit extending a third of the way to the Moon requires the two-burn capability of the Agena upper stage. The Atlas booster and the Agena first burn carry the upper stage-spacecraft combination into a near-Earth orbit some 100 miles high. They then coast more than halfway around the world to a point near Australia before the Agena engine re-ignites to elongate the orbit to its final shape.

Confirmation of successful Agena second burn and spacecraft separation, some 55 minutes after liftoff, will come from the NASA station at Carnarvon, Australia.

THE LAUNCH SEQUENCE

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 its first burn of about 2 1/2 minutes. During this first burn, after leaving the Earth's atmosphere, the nose fairing around OGO will be separated.

The coast phase of the flight lasts some 40 minutes until the upper stage is about 170 miles above the Indian Ocean. At this point, the Agena engine is re-ignited to send OGO out some 76,000 miles from the Earth. Second burn lasts about a minute and a half before OGO is injected into its elliptical Earth orbit from a point above the northwest coast to Australia.

THE COUNTDOWN

Significant milestones in the 6 1/2-hour prelaunch countdown. The launch window varies with the launch day from 45 to 90 minutes in length, late (around 10 p.m., EDT) in the day.

T minus time (minutes)	Event
395	Start Count
155	Agena fuel tanking
130	Gantry back
90	Agena oxidizer tanking
60	Built-in 1 hour hold
45	Start Atlas LOX tanking
7	Built-in 10-minute hold
0	Liftoff

FLIGHT SEQUENCE

(seconds)	
0	Liftoff
129	Booster Engine Cutoff (BECO)
288	Sustainer Engine Cutoff (SECO)
308	Vernier Engine Cutoff (VECO)
311	Agena Separation
360	Start Agena First Burn
369	Jettison Shroud
510	Agena first cutoff
3142	Start Agena second burn
3230	Agena second cutoff
3326	Spacecraft separation

VEHICLE STATISTICS

	Atlas Booster	Agena-B Upper Stage
Height	70 feet	37 feet (including shroud)
Weight	261,000 pounds	about 16,000 pounds
Diameter	10 feet	5 feet
Thrust	388,000 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; 2 verniers	Bell Aerosystems 8096 (restartable)
Guidance	G. E. radio-inertial	Minneapolis-Honeywell inertial guidance and Barnes horizon sensors
Prime Contractor	General Dynamics/ Convair, San Diego, California	Lockheed Missiles & Space Corp., Sunnyvale, California

THE OGO-B PROGRAM TEAM

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

NASA Headquarters

Dr. Homer E. Newell, Associate Administrator for Space Science and Applications
Jesse E. Mitchell, Director, Physics and Astronomy Programs
Marcel J. Aucremanne, Geophysical Observatories, Program Manager
Thomas L. Fischetti, Associate Program Manager, OGO
Dr. Alois W. Schardt, OGO-B Program Scientist
Vincent L. Johnson, Director, Launch Vehicle and Propulsion Programs
J. B. Mahon, Agena Program Manager

Goddard Space Flight Center

Dr. John F. Clark, Director
Dr. John W. Townsend, Jr., Deputy Director
Robert E. Bourdeau, Assistant Director for Projects
Wilfred E. Scull, OGO Project Manager
Abraham Leventhal, Assistant OGO Project Manager
Dr. George H. Ludwig, OGO-B Project Scientist

Kennedy Space Center

Robert H. Gray, Assistant Director for Unmanned Launch Operations
Harold Zweigbaum, Agena Project Mgr., ULO

Lewis Research Center

Dr. Seymour C. Himmel, Assistant Director for Launch Vehicles
H. Warren Plohr, Agena Project Manager

TRW Systems, Inc.

Dr. A. K. Thiel, Director, Spacecraft Systems Program Management
E. T. Wiggins, OGO Program Director

THE OGO-B INDUSTRIAL TEAM

Prime Contractor

Spacecraft design, development and fabrication, TRW Systems, Inc. Redondo Beach, Calif.

Major Subcontractors

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

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

Horizon Scanners, American Standard, Advanced Technology Division, Mountain View, Calif.

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

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

Major Subcontractors (Cont.)

Solar Cell Modules, Hoffman Electronics Corp., El Monte, Calif.

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

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

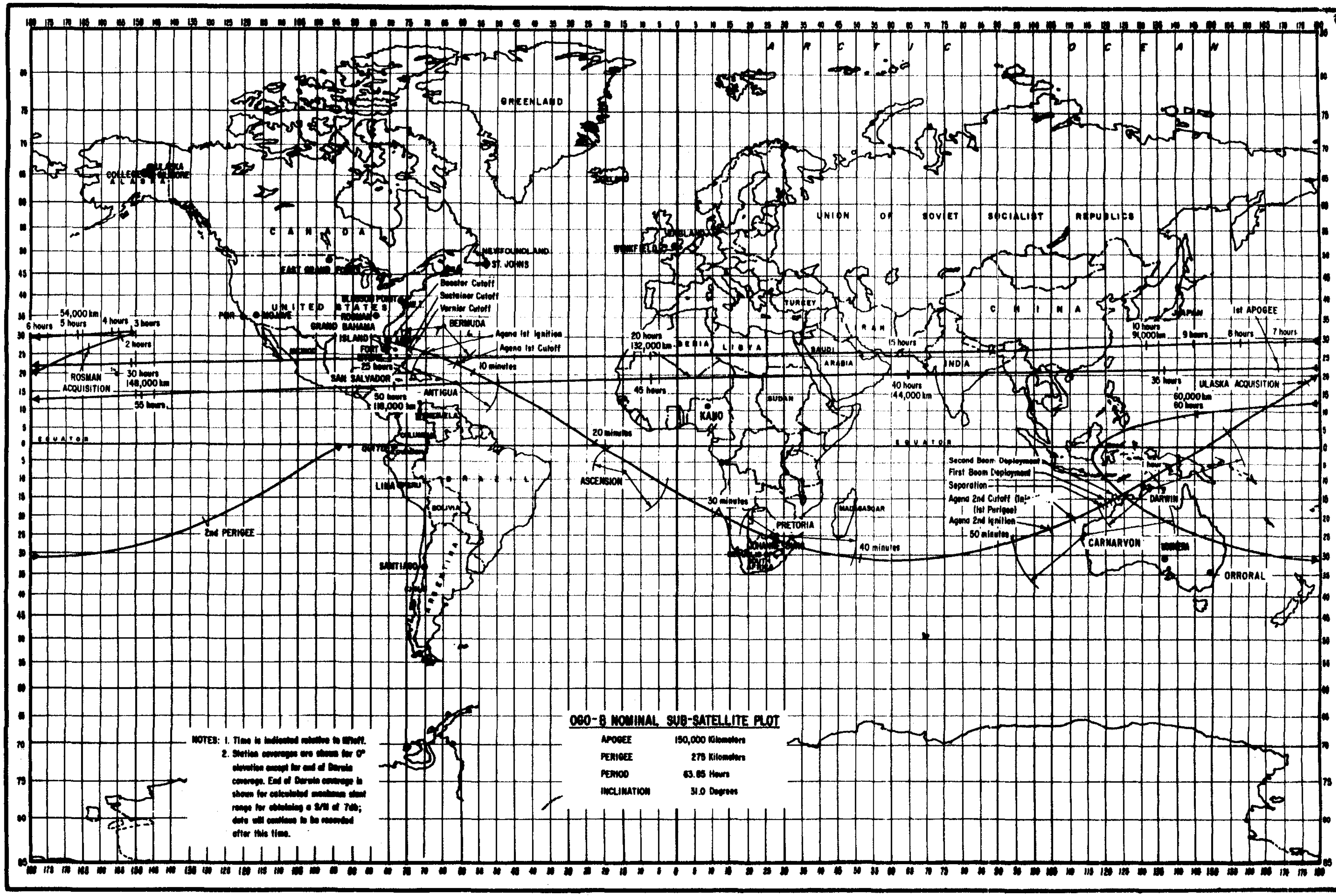
Tape Recorders, RCA Astro-Electronics Division, Princeton, N.J.

Tape Transponders (in Ground Support Equipment), Ampex Corp., Redwood City, Calif.

SPACECRAFT INTEGRATION AND TEST

Experiment and subsytem assemblies were integrated at the Goddard Space Flight Center. Environmental testing and pre-launch checkout were also accomplished by the Center.

End-


OGO-6 NOMINAL SUB-SATELLITE PLOT
APOGEE 150,000 Kilometers
PERIGEE 275 Kilometers
PERIOD 63.85 Hours
INCLINATION 31.0 Degrees
GREENLAND
CANADA
UNITED STATES
NEWFOUNDLAND
ST. JOHNS
Booster Cutoff
Sustainer Cutoff
Vernier Cutoff
BERMUDA
Agena 1st Ignition
Agena 1st Cutoff
10 minutes
GRAND BAHAMA
ANTIGUA
SAN SALVADOR
ROSMAN ACQUISITION
2nd PERIGEE
ASCENSION
20 minutes
30 minutes
40 minutes
50 minutes
PRETORIA
MADAGASCAR
KANO
SUDAN
ARABIA
TURKEY
INDIA
CHINA
JAPAN
1st APOGEE
ULASKA ACQUISITION
DARWIN
CARNARVON
ORRORAL
Second Boom Deployment
First Boom Deployed
Separation
Agena 2nd Ignition
UNION OF SOVIET SOCIALIST REPUBLICS
ARCTIC OCEAN
EQUATOR