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(NOTE TO EDITORS: On Aug. 4, 1963 NASA issued Release No. 63-157, "NASA to Launch Polar Ionosphere Beacon Satellite." That launch, scheduled for Aug. 15, 1963, was postponed and now has been rescheduled. Because of a number of changes in the mission, this press kit should be used in place of NASA Release No. 63-157.)

(NASA-News-Release-64-60) NASA TO LAUNCH IONOSPHERE BEACON EXPLORER (NASA) 32 p
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NASA TO LAUNCH IONOSPHERE BEACON EXPLORER

The National Aeronautics and Space Administration will launch no earlier than March 17, a lightweight, windmill-shaped satellite designed to make the most comprehensive survey of the Earth's ionosphere ever undertaken.

The Beacon Explorer satellite, formerly designated the S-66, will be launched by a three-stage Delta rocket from Cape Kennedy, Fla., into a circular, high-inclination (70°) orbit about 750 miles above Earth.

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Launch will be within an approximate two-hour launch window from about 4:30 a.m. to 6:30 a.m. EST.

The 120-pound satellite will transmit a continuous series of radio signals to a network of more than 80 ground stations operated by some 50 scientific groups in 32 countries.

This international scientific effort, the most extensive yet in a U.S. space project, is possible because the Beacon Explorer transmits uncoded radio signals. Most satellites send information by coded telemetry to a limited number of specialized stations.

The uncoded radio signals are transmitted from the Beacon Explorer at wavelengths that cause changes in the characteristics of the signals as they pass through the ionosphere. Scientists can get information on the ionosphere by studying the nature of the satellite's radio signals as they are received on the ground.

Scientists around the world have accepted invitations to participate in the program. The Beacon Explorer's signals can be received by a simple do-it-yourself ground station costing less than $5,000 and consisting of an antenna, two radio receivers, a timing device and a recorder. The ionosphere information obtained by the stations will be exchanged through a Scientific Data Center operated by the Goddard Space Flight Center, Greenbelt, Md.

The satellite built by Johns Hopkins' Applied Physics Laboratory, also will carry an experiment to measure electron densities and temperatures in its immediate vicinity. Information obtained from this experiment will be sent by coded telemetry to ground stations of the NASA STADAN network.

In addition to making major ionosphere studies, the Beacon Explorer will serve as a test bed for tracking experiments related to the science of geodesy -- the study of the size and shape of the Earth.

In one experiment, a LASER (Light Amplification by Simulated Emission of Radiation) device located near NASA's Wallops Station, Va., will direct a beam of light toward glass reflectors on the satellite as it passes within range of the station. If the LASER beam strikes the reflectors, it will be returned to the source enabling very precise measurements to be made of the satellite's position in space.

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Secondly, the Beacon Explorer will transmit on two frequencies which will permit precision tracking by ground stations. This tracking system, similar to that used on previous U.S. Navy Transit satellites, will continue study of the Doppler method of satellite tracking and of the influence of the ionosphere on Doppler tracking.

If these experiments are successful, a back-up Beacon Explorer is being considered for more extensive experiments in geodesy -- involving both the LASER and Doppler method of satellite tracking.

Beacon Explorer is the last of five satellites in the first phase of the NASA ionosphere exploration program. These satellites fall into three general types depending upon their assigned tasks.

The first type, called direct measurement Explorers, is designed to measure in detail the characteristics of both positively-charged particles (ions) and negatively-charged particles (electrons) which form the ionosphere. Measurements are made only in the immediate vicinity of the satellite. Two such satellites were launched successfully by NASA, the U.S. Explorer VIII, Nov. 3, 1960, and the U.S.-United Kingdom Ariel I, April 26, 1962.

The second type, called topside sounders, transmits radio signals of varying wavelengths which are reflected from the topside of the ionosphere with the echo being received back at the satellite. Topside sounder satellites by such a radar-like technique permit the study of electron structure as a function of altitude but only in the topside of the ionosphere. NASA has two topside sounder satellites, the Canadian-built Alouette, launched Sept. 29, 1962, and the Ionosphere Explorer, which is currently scheduled for launch at the Pacific Missile Range.

The Beacon Explorer represents the third type of ionosphere satellite. Its radio transmissions are made at wavelengths which penetrate through the ionosphere to the ground. Thus, it will transmit "raw" cross-section data on the structure of both the top and bottomside (without altitude discrimination) of the ionosphere directly to ground stations. This worldwide network of stations forms a nucleus for the data collection that will make possible a long-sought global survey of the ionosphere. Expected operating lifetime of the satellite is more than two years.

It is the ionosphere, a region of electrically charged gases, beginning about 35 miles above the Earth, which makes possible long-range radio communications. The ionosphere changes as rapidly as does the Earth's weather. A global survey of this enormous electrified mirror will be as important to predicting communications frequency variations and blackouts as the TIROS weather satellite pictures of global cloud cover have been in predicting the weather.

The Beacon Explorer satellite program is part of the scientific space exploration program of NASA's Office of Space Science and Applications. Project management of the satellite is directed by the NASA Goddard Space Flight Center.

In addition to Goddard, the major participants in the program are the University of Illinois, Pennsylvania State University, Stanford University and the Central Radio Propagation Laboratory of the National Bureau of Standards, an agency of the U.S. Department of Commerce.

Under an agreement between NASA and the Bureau of Naval Weapons, the satellite was designed and built by the Applied Physics Laboratory of Johns Hopkins University, Silver Spring, Md.,under direction of the Goddard Space Flight Center. The electron density experiment was contributed by the Goddard Space Flight Center.

The LASER experiment is in the program of NASA's Office of Advanced Research and Technology, with project direction assigned to Goddard. The LASER device for use in the tracking experiment was built by Goddard. The glass reflectors were produced by the Corning Glass Works, Corning, N.Y., and assembled into an array by General Electric's Space Technology Center, Valley Forge, Pa.

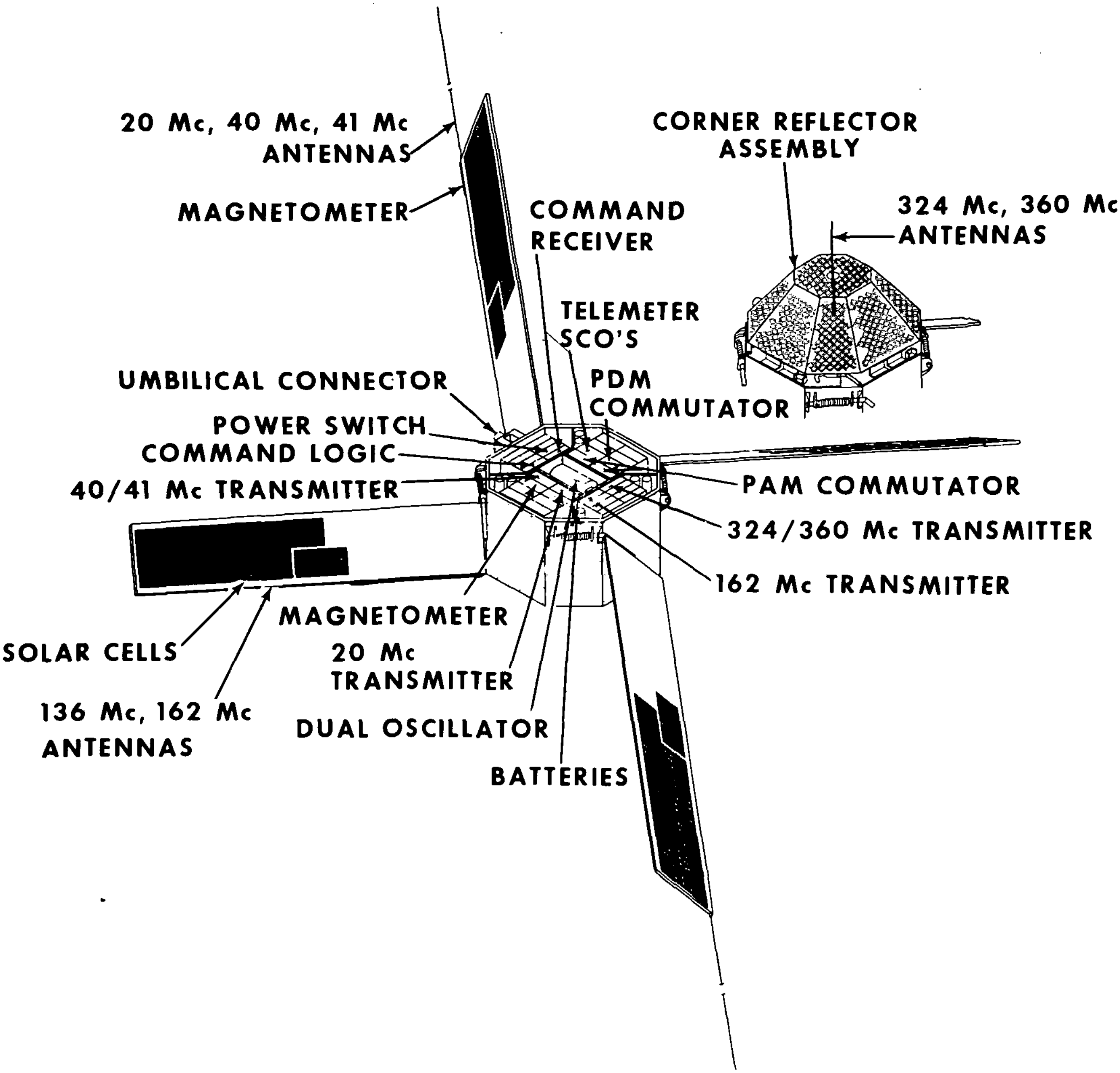
The three-stage Delta launch rocket is fabricated by the Douglas Aircraft Co., Santa Monica, Calif. It will be reaching for its 23rd consecutive successful satellite launching -- a record for reliability unmatched in U.S. space history.

THE BEACON EXPLORER SATELLITE

The Beacon Explorer is an octagonal-shaped satellite with four solar panels extending from its sides like the blades of a windmill. It weighs about 120 pounds.

The shell is 18 inches in diameter and 12 inches high. It is made of honeycomb nylon and Fiberglas. Protruding from its top and bottom are the short antenna-like poles used for the electron probe experiment.

IONOSPHERE BEACON SATELLITE
CUTAWAY VIEW



The solar panels are covered with cells to convert energy from the Sun into electricity to recharge nickel-cadmium batteries which provide the power to operate the satellite. The panels are 10 inches wide and five and one-half feet long. Twice as many solar cells as are needed for initial power have been fixed to the satellite blades. As the cells deteriorate because of radiation effects, reserve banks of solar cells will be commanded into the operating system to provide electrical energy.

Extending from the ends of opposite solar panels are two five-foot whip antennas and two dipole antennas for the beacon transmitter.

Four signals will be transmitted at power levels over 100mw to ensure good signal-to-noise ratios for ionospheric experiments. Three lower frequency signals -- at 20, 40 and 41 megacycles -- will be transmitted from the two dipole antennas mounted on solar blades. The fourth ionospheric signal -- at 360 megacycles -- will be transmitted from a dipole antenna mounted on the top and bottom of the satellite body.

Two signals will be transmitted for the Doppler tracking experiment. One -- at 324 mc -- will be transmitted with the 360 mc signal from the dipole antenna mounted on the satellite body. The second 162 mc signal will be transmitted from a dipole antenna mounted on two solar blades along with a 136 mc signal which will provide information on satellite temperatures, voltages, current and attitude to the NASA Satellite Tracking and Data Acquisition Network (STADAN).

During launch, the four solar blades are folded over the third stage of the Delta rocket. They are held in place by cables used for a "yo-yo" despin mechanism. An adapter mates the satellite to the Delta third stage and contains switches that are timed to release the despin device about 11 minutes after third stage burnout. About five minutes later, the satellite will separate from the third stage.

The LASER reflectors are one-inch prisms mounted on an eight-sided pyramid on the satellite. These reflectors -- mounted in such a manner that they will reflect the LASER light from almost any angle -- are cubes of fused silica, an extremely pure type of glass. There are 360 reflectors on the satellite. Two bar magnets, five and three-fourths inches long and seven-eighths of an inch in diameter mounted inside the spacecraft shell will passively orient the Beacon Explorer along the Earth's magnetic field. This will keep the LASER reflectors pointing toward the Earth while the satellite is in the Northern Hemisphere and, in addition, provide more stable radio signals for the ionospheric experiments.

An unusual automatic temperature control system has been built into the satellite. Vacuum insulation between instruments and the shell of the satellite shields the interior from the great variations of temperature on the outside. When the internal temperature of the spacecraft drops below the desired 70 degrees F., eight Mercury thermostats trigger an onboard power system fed by a special bank of solar cells which supply the power necessary to maintain the desired internal temperature. Such uniform internal temperature is expected to improve reliability and increase the operating lifetime of the satellite components.

THE IONOSPHERE EXPERIMENT AND HOW IT WORKS

The overall scientific objectives of the Beacon Explorer can be summarized briefly as follows:

-Study the behavior and electron population of the ionosphere as it varies in time and space on a worldwide scale.

-Relate ionospheric behavior to the solar radiation which produces ionization. This objective is important because it is solar activity that exerts the major influence on the ionosphere and consequently on long-range communications.

-Determine the geometry and distribution of irregularities in the ionosphere.

Most of the satellite's investigations will be concerned with a search for variations in the structure of the ionosphere. It will do this by measuring the total number of electrons between itself and the ground.

Measurements of electron distribution along the line of sight between the satellite and a ground station will be made in two ways. These are the Doppler Shift and Faraday Rotation methods. Both depend upon the influences that the ionosphere exerts upon the signal sent out by the satellite's radio beacons.

The Doppler Shift Method. One of the characteristics of a signal received from a satellite moving in orbit is that its radio signals are subject to a phenomenon called the Doppler shift. When the satellite moves toward the receiving station, the frequency of the received signal is slightly higher than that sent by the satellite. When the satellite is moving away from the station, the received frequency becomes slightly lower than the transmitted one. This shift of frequency is called a Doppler shift, and varies with both the satellite velocity and electron density. By comparing the Doppler shifts at several frequencies, the electron content between the observer and the satellite can be obtained.

The Faraday Rotation Method. This is a rotation of the plane of polarization of the radio waves that is produced by the waves passing through the ionosphere. However, if waves are sent through a layer of charged particles, such as the ionosphere, then the plane of polarization is gradually twisted along a helical path. It is like taking a long, slender curtain and twisting it into a corkscrew shape. This twisting is called the Faraday rotation, and is the result of interactions between the radio waves and the geomagnetic field surrounding electrons in the ionosphere. If the number of times the plane of polarization has been rotated between satellite and Earth can be determined, the electron content can be calculated. This is most easily accomplished by measuring the rotation at several frequencies.

By using a straight dipole antenna on the ground, a maximum strength signal will be received when the polarization of the incoming radio wave is parallel to it, and a minimum signal will be received when it is perpendicular to the antenna.

Variations in the received signal strength also may reveal a patchiness in the ionosphere. The study of such variations should reveal new information on the sources of these localized variations of electron density.

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Thus, with simple radio receivers and antennas, a great deal of data can be acquired on the ground.

The extent to which variations in the electron content of the ionosphere can be measured then is limited only by the number and locations of ground stations. And, each station will be able to make a real time measurement each time the satellite passes within radio range.

THE LASER EXPERIMENT

The Beacon Explorer will carry a 10-pound array of fused silica glass reflectors designed to return back to Earth light signals aimed at it from a LASER.

Mounted on the satellite's body are 360 one-inch diameter glass prisms called "cube-corner" reflectors. These are constructed in such a way that light striking them from almost any angle will be returned to its source. They are arranged in the form of an eight-sided truncated pyramid, designed and built by General Electric Space Technology Center.

A LASER mounted on an 18-inch diameter optical telescope housed in a 60-foot high tower located 20 miles south of NASA's Wallops Station, Va., will direct a pulsing beam of red light toward the satellite.

Goddard experimenters plan to attempt the first illumination of the satellite reflectors during the early night-time passes over Wallops Island. This may occur as early as 36 hours after launch. A planned orbital altitude of 750 miles will place the Beacon Explorer at a typical slant range of approximately 1,000 miles and it will appear by reflected sunlight as a star of about the ninth magnitude -- 20 times fainter than a star which can be seen by the naked eye.

The LASER system is mounted on an IGOR (Intercept Ground Optical Recorder) telescope normally used by Wallops personnel to track sounding rockets. Operators will aim the telescope along the predicted path of the Beacon Explorer and when they see it, they will "flash" the LASER light at a rate of one flash per second.

If all goes according to plan, the reflector array will be illuminated and will return a small portion of the light energy to the telescope. The reflected signal will be automatically amplified by a photomultiplier tube (a device that converts optical impulses to electrical signals). A digital counter will record how long it took for the light signal to go and come back.

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In the event of overcast or inclement weather, illumination attempts will be delayed until optical sightings are possible.

The measurements of time between initiation of the light signal and reception at the photomultiplier will give the precise distance of the satellite for each second of time. These values will be recorded at the telescope site and later sent to Goddard where they will be compared with distances calculated from other tracking instruments, such as NASA's Space Tracking and Data Acquisition Network (STADAN). These distance measurements are expected to be more precise than those obtained through other tracking procedures and may be used to define the Beacon Explorer satellite orbit more accurately.

Results of the experiment may lead to a more definite determination of the Earth's shape and development of improved systems for future optical tracking and communications.

The LASER system employs a six-inch synthetic ruby rod which becomes highly energized as it gathers energy from a xenon gas-filled flash-lamp mounted closely parallel to it in a barrel-like metal and glass housing. The rod is designed so that both ends are polished to act like mirrors. The green light from the flash-lamp excites chromium atoms within the ruby rod which then re-emit red light of a uniform color.

As this red light is reflected back and forth inside the rod, the bouncing rays hit other excited chromium atoms and "stimulate" them to give off more red rays. It is from this stimulated emission that the LASER (Light Amplification through the Stimulated Emission of Radiation) gets its name. These rays are in phase with each other and are parallel to each other as they bounce back and forth between the reflecting rod ends. Scientists term this "coherent" light, in contrast with random sources having diffuse characteristics such as the Sun, electrical and neon gas lamps.

Within a fraction of a millionth of a second this chain reaction builds to a powerful beam that "bursts" out one end of the rod which has been made more transparent than the other. The LASER light can be directed into a narrow pencil beam which does not lose its effective strength before reaching the target.

THE DELTA LAUNCH VEHICLE

The NASA-developed, three-stage Delta rocket, built by Douglas Aircraft Co. will be used to launch the Beacon Explorer into orbit. If successful, this will be the 23rd consecutive satellite launched into orbit by Delta. To date, the Delta record includes 22 successes. One failure occurred during its first launch attempt. The Delta program is managed by the Goddard Space Flight Center.

<u>Delta has the following general characteristics:</u>

Height:	90 feet
Maximum Diameter:	8 feet
Lift-off Weight:	About 57 tons

<u>First Stage</u>: Modified Air Force Thor, produced by Douglas Aircraft Co.

Fuel:	Liquid (Kerosene with liquid oxygen as oxidizer)
Thrust:	170,000 pounds
Burning Time:	About two minutes and 25 seconds
Weight:	Over 50 tons

<u>Second Stage</u>: Aerojet General Corp., JA 10-118 propulsion system

Fuel:	Liquid
Thrust:	About 7,500 pounds
Burning Time:	About two minutes, 40 seconds
Weight:	Two and one-half tons

<u>Third Stage</u>: Allegany Ballistics Laboratory X-248 motor

Fuel:	Solid
Thrust:	About 3,000 pounds
Burning Time:	40 seconds
Length:	57.5 inches
Diameter:	18 inches
Weight:	about 516 pounds

During first and second stage powered flight, the Bell Telephone Laboratory radio-guidance system is used for inflight trajectory corrections. It also commands second-stage cutoff when the desired position, velocity and altitude have been achieved.

Following second stage cutoff, an 11-minute coast period occurs. Near the end of this period, small rockets mounted on a table between the second and third stages ignite and spin up the third stage and the satellite to 160 rpm. The second stage then separates and third stage ignition occurs, giving the satellite its final boost toward orbital injection.

Eleven minutes after burnout of the third stage, the "yo-yo" despin mechanism will unwind and reduce the spin rate to 40 rpm and solar panel erection will take place. The inertia of the panels coupled with the effect of the despin mechanism will result in a further despin to about four rpm. Separation will occur about five minutes later. The spin rate will be gradually reduced, after several days in orbit, to zero by the effect of magnetic despin rods located in the panels.

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The following key officials are responsible for the Beacon Explorer satellite program:

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T. Bland Norris, Delta Program Manager

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Roland H. Chase, LASER Project Scientist, OART

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Pennsylvania State University

Stanford University

Central Radio Propagation Laboratory, U.S. Bureau of Standards

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IONOSPHERE BEACON SATELLITE OBSERVATORIES