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PROJECT: S-55c

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NEWS NASA

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NASA TO LAUNCH METEOROID DETECTION SATELLITE AT WALLOPS

A satellite designed to gather information on the hazards spacecraft encounter from minute particles in space will be launched no earlier than Nov. 5 from Wallops Station, Va., by the National Aeronautics and Space Administration.

The satellite, called S-55c by NASA, will be launched by a Scout rocket in a southwesterly direction from Wallops Island. Its orbit is expected to have an apogee of 637 statute miles and a perigee of 285 miles with an inclination of 52 degrees to the equator. The satellite is expected to circle the Earth every 99.6 minutes.

The spacecraft is the successor to S-55b, now called Explorer XVI, which was launched Dec. 16, 1962. This satellite made the first statistically significant sampling of meteoroids in near-Earth space. S-55c is expected to expand this information gathered by Explorer XVI's useful seven months in space.

S-55 satellites are designed to provide spacecraft designers with accurate knowledge of the penetration capabilities of meteoroids and the resistance of various materials to penetration.

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The S-55c is a cylinder 24 inches in diameter and 92 inches long. It is built around the fourth stage of the Scout rocket which is an integral part of the spacecraft. Weight in orbit will be 295 pounds. A heat shield protecting the satellite during launch will be jettisoned in space, exposing four types of sensative meteoroid detection sensors and a solar cell degradation experiment.

The S-55 project is under the direction of NASA's Office of Advanced Research and Technology with project management by NASA's Langley Research Center, Hampton, Va. Goddard Space Flight Center, Greenbelt, Md., also is participating.

RESEARCH OBJECTIVES

Primary objective of S-55c is to gather direct experimental data needed for the efficient design of spacecraft structures capable of operating for long periods in near-Earth space.

The primary sensors, designed to record the rate of meteoroid penetration in two different thicknesses of stainless steel, will meet the main objective of the flight.

A secondary objective will be the first extended flight test of a capacitor-type penetration detector to determine effects of high energy radiation. The capacitor device shows promise of being useful for deep space exploration, because it has light weight, large surface area and reusability.

A third experiment will be carried aboard the Scout to measure air loads on the vehicle during its ascent through the atmosphere between 25,000 and 40,000 feet.

The Meteoroid Satellite S-55c

Explorer I, Vanguard III, Explorer VII, Explorer VIII, and Explorer XVI are among satellites which made significant meteoroid measurements, including the discovery of showers of cosmic dust. Meteoroid streams of various densities cross the Earth's orbit, sporadically and in showers traveling at extremely high speeds.

Meteoroids are composed of iron, silicates and other substances. Some are derived from the asteroids which revolve around the sun between Mars and Jupiter. Some are believed to come from comets in the outermost regions of our solar system.

Meteoroids burn (become meteors) as they enter the atmosphere. Those which reach the Earth are called meteorites. Scientists have determined that several thousand tons of minute meteorites settle on the Earth in a single day.

These small particles may strike a satellite at velocities ranging from seven to forty-five miles per second, or even faster.

The S-55c, carrying meteoroid sensors over its entire usable surface, should record a larger number of meteoroid penetrations than Explorer XVI. It is designed to yield as much data as possible during its useful lifetime of one year.

The four kinds of meteoroid detectors in the satellite are pressurized cells, cadmium sulphide cells, impact detectors (sounding boards) and capacitor detectors. NASA's Langley Center developed the pressurized cells, impact detectors and capacitor detectors. The Goddard Center developed the cadmium sulphide cells. All types except the capacitor detectors have been flown previously. The capacitor detectors will be flown only to test environmental performance and will not collect meteoroid data.

Two test groups of window-like silicon solar cells on the forward face of the satellite will compare performance of protected and unshielded solar cells to be used in future spacecraft. The solar cell degradation experiment uses the N-on-P cellto study effects of high energy electron radiation.

One of the two solar cell groups is unprotected while the other is protected by a 3/16-inch covering of quartz. The quartz-covered cells are identical with the 10 trays of solar cells which will furnish power for S-55c. Telemetered measurements of the experimental cells will provide some indication of the performance of the power cells.

An aspect sensor, which is itself a solar cell device, is associated with the solar cell degradation experiment to indicate the angle of the spacecraft with respect to the Sun.

A series of temperature measurements at selected places throughout the satellite will give additional data.

Experimental information will be handled through two separate telemetry systems housed within the forward section of the satellite. Four erectable antennas serve the two systems.

Each of the sensors is capable of producing an electrical signal which can be stored and subsequently telemetered from the orbiting payload to the Minitrack Receiving Station Network.

The Meteoroid Detectors

1. Pressurized Cells: These stainless steel detectors, the primary sensors of the experiment, consist of 216 half cylinders in two different thicknesses. They are arrayed in seven rows around the fourth stage Altair II rocket motor, leaving the cylindrical portions exposed.

Six of the rows contain 32 cells; the seventh 24. Six cells are inactive and will not record penetrations.

A type of stainless steel designated 302 is the structural material for the sensors. Pressure cell thicknesses of one-thousandth inch will be used for 70 cells. Two-thousandths inch material will be used for 140 cells.

The exposed cells contain helium under pressure, so that a meteoroid puncture will cause the gas to leak away, causing a pressure-sensitive switch to open, and signal a penetration. The pressurized cell experiment exposes about 22 1/3 square feet of area to the impacts of meteoroids.

The pressurized cell detectors were designed, developed and fabricated by Langley to provide information on the ability of various thicknesses of metal to withstand penetrations. (On Explorer XVI the pressurized cells were made of beryllium copper rather than stainless steel.)

2. Cadmium-sulphide cells: Two of these detectors, developed by Goddard, will be mounted on the forward face of the satellite 180 degrees apart. Each detector consists of a cadmium-sulphide cell mounted beneath a sheet of Mylar coated with evaporated aluminum on both sides. The exposed surface area of the Mylar is approximately 3 3/4 square inches per cell. One detector is covered with 1/4-mil Mylar and the other covered with 1/8-mil Mylar.

In flight, extremely small particles striking the ultra-sensitive detector will penetrate the Mylar film and allow light to focus on the cadmium-sulphide cell, changing its resistance, and permitting it to record information on the size of impacting meteoroids.

3. Impact detectors: Twenty-four triangular aluminum sounding board impact detectors are mounted around the forward section of S-55c just aft of the solar cell power trays. Each one is 0.051 inch thick and has a piezoelectric element fixed to its under side. A meteoroid impact on any part of the sounding board is detected by the piezoelectric element, and an appropriate signal is sent to the telemetry units.

The impact detectors are Langley experiments and provide 223 square inches of area exposed to impacts. They are capable of detecting three levels of meteoroid momentum.

4. Capacitor Detectors: Two 6.6-by-8-inch capacitor detectors will be flown on S-55c for their first extended test in the environment of space. They are mounted in an area provided in the forward row of pressurized cells. The capacitor detectors will not collect meteoroid data as a scientific objective, but their performance will be examined closely.

The capacitors are electrical devices built as a thin sandwich of mylar film between an outer layer of one thousandth inch stainless steel and an inner layer of copper. Both metals conduct electricity but the mylar does not. In flight, the capacitor detectors will be charged to about 14 volts by the spacecraft batteries.

When a meteoroid penetrates the capacitor, a small amount of the material of which it is made is vaporized and ionized in the area of the penetration. As a result, a momentary short circuit occurs and the capacitor discharges. The current flow resulting from the discharge is monitored and recorded. The ionization disappears in less than a millionth of a second and the capacitor quickly recharges. Thus it exhibits a "self healing" characteristic which makes it particularly attractive for long term use in space.

Telemetry

Mounted to a bulkhead inside the forward or nose portion of the S-55c are two separate telemeter canisters, broadcasting through four flexible antennas which extend from the nose cone after the heat shield is jettisoned.

The telemeters are as independent as possible to improve reliability of the entire system. Separate solar cells and nickel-cadmium batteries supply power for each unit, and each has separate electronics for data gathering and handling. The telemeters are turned on by command codes from a ground station.

The experiment sensors are divided into two nearly equal groups; each group is served by its own telemetry system. One telemeter operates at 136.08 mc; the other at 136.86 mc. An internal timer turns off each telemeter after one minute of transmission, and a separate timing device will end all transmissions after one year in orbit, thus releasing the frequencies for other uses.

In addition to storing experimental data and relaying it to ground stations when commanded, one of the telemeters contains a radio beacon which will help to measure the orbit of S-55c during the first few days after launch. The beacon's batteries are expected to keep it operating for about seven days after launch.

As the Scout and payload accelerate upward through the atmosphere, an experiment will be performed to measure flight loads and obtain time histories. Objective is to obtain engineering data on such loads as the rocket encounters wind shear and turbulence through the air mass level between 25,000 and 40,000 feet.

In order to obtain maximum data from the experiment the flight will be scheduled so as to encounter winds aloft of 70 mph or higher. The flight may be delayed to meet this objective.

The instruments for this experiment are distributed over the three upper stages. The heat shield will carry and angle-of-attack indicator and a side-slip sensor mounted on a projecting boom, plus two transverse accelerometers in the same general location. The third stage carries a set of strain gages and thermocouples attached to the motor case. The second stage will be similarly instrumented, with an additional set on the motor nozzle. Telemetry for the test is located between the second and third stages.

The special instruments were installed on the Scout by Ling-Temco-Vought, Inc., Scout prime contractor, and calibration was performed on the Wallops launcher by contractor and NASA personnel.

SCOUT LAUNCH VEHICLE

Scout is a multi-stage launch vehicle using four solid propellant rocket motors capable of carrying payloads of varying sizes on orbital, space probe or reentry missions. Scout is 72 feet long and weighs 20 tons at lift-off.

Scout was developed by NASA's Langley Research Center, Hampton, Va. It is manufactured by Ling-Temco-Vought, Inc., Dallas.

The four motors are interlocked with transition sections which contain guidance, control, ignition, instrumentation systems, separation mechanisms, and spin motors. Guidance is provided by a strapped-down gyro system and control is achieved by a combination of aerodynamic surfaces, jet vanes, and hydrogen peroxide jets.

Scout is capable of placing approximately 240-pounds into a 300-mile orbit or of carrying a 100-pound scientific probe some 7,000 miles away from Earth.

Scout stages include the following motors:

First stage: Algol 11b - 105,000 pounds thrust, burning time 68 seconds.

Second stage: Castor I - 62,000 pounds thrust, burning time 42 seconds.

Third stage: Antares II (ABL X-259) - 22,000 pounds thrust, burning 36 seconds.

Fourth stage: Altair II (ABL X-258) - 5,800 pounds thrust, burning 24 seconds.

TRACKING AND DATA ACQUISITION

The meteoroid satellite will be tracked and data obtained by stations of the NASA Minitrack network operated by Goddard Space Flight Center. During ascent, the vehicle will be tracked by radar from Wallops Island, Va., Blossom Point, Md., Bermuda, Antigua, and Trinidad. The station at Antigua will also make one data interrogation of the satellite just after fourth-stage burnout to establish reference information on the penetration instruments aboard.

All later data interrogations, expected to occur about once each orbit at the outset, will be made by Minitrack stations, the first by the Fort Myers station near the end of the satellite's first pass. Later, three daily interrogations are expected to be sufficient.

Telemetry data will be recorded on magnetic tapes, shipped to Goddard for review and then to Langley for data reduction. Reduced data will be sent to the individual experimenters for analysis and evaluation.

PERSONNEL

The following scientists and engineers have had active roles in the development of S-55c and its experiments:

Langley Research Center

Earl Hastings, Jr., project manager;;Hugh C. Halliday, technical project engineer; Leon V. Taylor, instrumentation project engineer; Jose M. Alvarez, operations manager; Charles A. Gurtler, experimenter, pressurized cells; Alfred G. Beswick, experimenter, impact detectors; James H. Siviter, Jr., experimenter, capacitor detectors; James Bene, experimenter, solar cell degradation experiment; Eugene D. Schult, head, Scout Project Office; James D. Church, Scout project field operations director; C.T. Moore, Jr. payload coordinator; Leo Forrest, systems integration engineer; Clarence Robins, mission assurance engineer; Kermit G. Pratt, project manager, Scout flight loads experiment; Moses J. Long, systems engineer, flight loads experiment; Charles J. Laird, instrumentation engineer, flight loads experiment.

Goddard Space Flight Center

Luc Secretan, experimenter, cadmium sulphide detectors.

Wallops Station

Charles E. Manion, project engineer; Robert T. Duffy, Launch Director.

NASA Headquarters

Milton B. Ames, Jr., director space vehicles, Office of Advanced Research and Technology; Clotaire Wood, chief, vehicle technology flight experiments, OART; Charles T. D'Aiutolo, chief, Meteoroid Technology Program, OART; Warren A. Guild, manager Scout Program, Office of Space Science and Applications.

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