SCOUT VEHICLE DEVELOPMENT FLIGHT
(MICROMETEOROID SATELLITE EXPERIMENT)

National Aeronautics and Space Administration will launch the fifth in a series of Scout research rocket vehicles from the NASA Wallops Station, Wallops Island, Virginia, in a continuation of the NASA Scout development program and to orbit a novel payload designed to provide information on the characteristics of micrometeoroids in an area from about 240 to 675 statute miles above the earth.

Principal purpose of the flight is to give scientists another opportunity to study the performance, structural integrity and environmental conditions of the 72-foot, 36,600-pound, four-stage Scout launch vehicle and guidance-controls system. Scout has been under development under direction of the NASA Langley Research Center since mid-1958 to provide the United States with a small, reliable and flexible solid-fuel booster capable of space probes and orbital missions.

Thus far, the Scout development program has included two ballistic flights and two orbital efforts. In the last flight-- February 16, 1961-- Scout injected into orbit the 12-foot-diameter inflatable spherical satellite Explorer IX now being used in air density-drag measurement investigations.

This flight marked the first time a satellite had been placed in orbit by a booster fueled entirely with solid propellants; and it was the first satellite launched into orbit from Wallops Island since the NASA facility was established in 1945.

NASA scientists-- recognizing that one of the hazards of the space environment is the possibility of damage to space vehicles by collision with
micrometeoroids-- devised the NASA micrometeoroid satellite to allow a more accurate estimate of the probability of penetration by sparsely distributed particles and material debris in certain areas of space. The direct measurements to be obtained as a result of this flight are expected to be useful in planning the design and operation of future spacecraft.

The cylindrical micrometeoroid satellite (S-55) is about 24 inches in diameter and approximately 76 inches long and is installed around the 18-inch-diameter, 72-inch-long Altair rocket motor-- fourth stage of the Scout launch vehicle. A thin heat shield which protects the satellite during ascent will be jettisoned in space, exposing five types of highly-sensitive detectors to impact by high-velocity space particles as the payload orbits the earth.

The experiment will give a direct measure of the puncture hazard of micrometeoroids in spacecraft structural skin samples and will measure micrometeoroid flux rates. In addition, the satellite will provide data regarding the erosion of spacecraft materials due to small particles in space, and will record information for the design of solar cells for spacecraft power through a comparison of measurements obtained from protected and unprotected solar cells.

Scientists plan to launch the satellite in an easterly direction, injecting it into orbit some 1,060 statute miles down range about eight minutes after lift-off from Wallops Island. The elliptical near-earth orbit is expected to reach an initial apogee of 434 statute miles on its first pass over Australia and an initial perigee of 243 statute miles over the Atlantic Ocean as it begins its second trip around the earth. Initial orbital period is estimated at 98.7 minutes. The satellite is programmed to travel at a velocity of about 17,545 mph as it is injected into orbit and at perigee. Satellite speed at apogee will be approximately 16,085 mph.
The belt covered by the initial orbits will extend 38 degrees north and south of the equator. On its first orbit, the satellite will cross the southern portion of Africa, mid-Australia, and the southern section of the Hawaiian Islands-- then pass over the central area of continental United States beginning north of San Diego, California, before it reaches the Atlantic Ocean just south of the launch site.

The combination experimental payload and burned-out fourth stage will go into orbit attached to the micrometeoroid satellite. Total satellite payload weight, including the various sensors, other scientific equipment, and mounting hardware, will be 125.50 pounds. The spent fourth-stage rocket will weigh about 50 pounds and the upper transition section which connects the fourth stage to the third stage will tip the scales at 11.73 pounds, for a total orbiting satellite weight of 187.23 pounds.

The following is a satellite weight breakdown: Nose cone, including sounding boards, power solar cell trays, test solar cell trays, heat transfer ring, antennas, cadmium-sulfide cells, mounting hardware, and wiring, 27.57 pounds; bulkhead assembly, including telemeter system, batteries, hardware, plugs, and wiring, 33.93 pounds; pressurized cells, including mounting hardware, plugs, and wiring, 46.93 pounds; grid detectors, including mounting hardware, 4.78 pounds; gage detectors, including mounting hardware, 6.50 pounds; payload support, 4.37 pounds; heat shield bumper ring, 1.42 pounds, for a total payload weight of 125.50 pounds. This figure, added to the 50-pound burned out rocket motor and 11.73-pound weight of the transition section gives a total satellite weight of 187.23 pounds.

A stainless-steel nose-cap and Fiberglas-bodied heat shield which protects the payload from aerodynamic heating during ascent will be jettisoned just prior to third-stage ignition at about 344,000 feet-- a point where
scientists believe no appreciable aerodynamic heating can occur to damage the 
delicate exposed micrometeoroid experimental devices.

Preflight ground tests to determine temperatures of the satellite during 
ascent and to establish that no damage would be experienced by the payload 
at ejection of the heat shield were conducted for NASA by Vought Astronautics 
Division of Chance Vought Aircraft, Dallas, Texas. The test program consisted 
of externally heating the shield and measuring temperatures at various 
stations; and climaxing the test with ejection of the protective cover. No 
damage to the satellite prototype due to heating or separation of the heat 
shield was apparent and the heat shield itself was free of damage due to 
heating.

After launch, Scout's first stage remains connected to the vehicle until 
it is blasted off at second stage ignition at 130,000 feet. After second 
stage burnout at about 257,000 feet, the remaining three attached stages 
coast to 344,000 feet, where the fourth stage heat shield is released— 
permitting the folded antennas to become erect and exposing the micrometeoroid 
detectors in the satellite to the space environment. This is followed immedi-
ately by third stage ignition and separation of the second stage. The third 
stage burns out at about 516,000 feet, but it remains attached to the fourth 
stage to provide guidance and control during coast to the apogee of the 
ascent trajectory—242.9 statute miles. Then the fourth stage, spun to 
about 190 rpm by small spin rockets, is ignited and released from the third 
stage. The velocity increment gained during fourth stage burning is suffi-
cient to place the payload as well as the fourth stage, which remains 
attached to the payload, into orbit. Time from liftoff to injection into 
orbit is planned to be 8 minutes and 18 seconds.
The micrometeoroid satellite experiment is a cooperative effort of three NASA research centers, including the Langley Research Center, Langley Field, Virginia; the Lewis Research Center, Cleveland, Ohio, and the Goddard Space Flight Center, Beltsville, Maryland. Langley has the responsibility for payload integration as well as the overall satellite system. Langley, Lewis, and Goddard designed and fabricated various types of micrometeoroid detectors and Langley designed the impact detecting transducers for determining micrometeoroid flux rates.

The five micrometeoroid detectors in the satellite will include pressurized cells, foil gages, and wire grids, providing a total of $\frac{25}{4}$ square feet of area exposed to the penetration hazard, and cadmium-sulfided cells, and impact sensors, which will have a combined total of $\frac{4}{3}$ square inches exposed for impact detection. Five test groups of window-like silicon solar cells on the nose of the satellite will determine what protection solar cells in future space experiments will require. Five cells are shingled for each group: two groups will be unprotected, two groups will have 6-mil glass slides covering the sensitive area, and one group will have a 62-mil quartz window protecting them. A series of temperature measurements at selected places throughout the satellite will give additional data. A telemeter system with erectable antennas will be located in the nose section to transmit data to ground receiving stations.

Each of the sensors installed in the satellite is capable of producing a measurable electrical signal that can be stored and subsequently telemetered from the orbiting payload to the Minitrack Receiving Station Network of the Goddard Space Flight Center. The following is a description of the five micrometeoroid detectors installed in the satellite:
Pressurized cells: These beryllium copper detectors, the primary sensors of the experiment, include 160 half-cylinders ranging in thickness from one-thousandth to five-thousandths of an inch. The 2-inch-wide flat area of each of the 7-1/4-inch-long half cylinders is mounted in five rows of 32 cells each around the circular exterior of the Altair rocket motor, leaving the can-like cylindrical portion exposed to micrometeoroids. The pressurized cells occupy about a 38-inch-long section of peripheral space in the center of the satellite. The exposed cells will be pressurized with helium so that a puncture by a micrometeoroid will allow pressure to leak out. By means of a pressure-activated switch in the end of each cell, the pressure loss will be detected and telemetered at the proper time to ground receiving stations. The penetration area of the 160 cells to be exposed to micrometeoroids totals about 17-1/4 square feet. The pressurized cell detector system was designed and fabricated by Langley to provide information on the ability of certain thicknesses of metal to resist penetration by micrometeoroids.

Foil gages: Sixty foil gage detectors, each in the shape of an equilateral triangle with a 4.68 inch base, are installed around the forward useable half of the fourth-stage launch vehicle support structure. They were developed and built by the Lewis Research Center. Each detector consists of a printed circuit about 60 microinches thick attached to quarter-mil Mylar and mounted on the underside of 304-stainless steel skin samples— with 50 of the skin samples being 3-mil thick and 10 of 6-mil thickness. Micrometeoroids which penetrate the stainless steel skin samples and break the printed circuits will cause a change in the resistance level of the gages— thus recording basic information that can be later telemetered to earth. Through the use of two thicknesses of stainless steel, valuable design data will be obtained.
sensitivity will be employed: the sounding board portion of the satellite has the capability of recognizing micrometeorite impacts of two different velocity levels to help identify micrometeorite particle masses. Correlation of the cumulative number of impacts of each momentum level with the number of penetrations of the various materials in the pressure cell area may provide the possibility of identification of particle masses by statistical data analysis methods. Similarly, the pressure cell transducer portion of the satellite is sensitized to micrometeoroid impacts at a certain level. An additional expectation from this portion of the experiment is that the lower momentum sensitivity level employed may afford some correlation between this type of experiment, and the pressurized cell experiment.

The electronics which form part of the satellite payload will perform two functions: as a radio beacon during orbital tracking; and as experiment telemeters during the approximately one year lifetime of the scientific package. The radio beacon will be activated to transmit until its batteries are exhausted. Two separate telemeters—working independently to enhance reliability—will be used for storing and telemetering data to be collected by the orbiting satellite. Separate solar cells and batteries will supply power as well as separate electronics for handling data. The telemeters will be turned on at prescribed periods by a command from the ground and after one minute of data transmission will be turned off by an electronic internal timer until the next transmission command is given. Communication with the satellite will be on two frequencies: 136.860 megacycles and 136.200 megacycles.

During launch and through the first three orbits, it is planned that the satellite will be tracked by Minitrack stations at Johannesburg, South Africa; Woomera, Australia; San Diego, California; and Blossom Point,
Maryland. First interrogation of the satellite on the initial orbit will be by Blossom Point. In addition, telemeters will be read-out at Wallops Island to permit a quick-look at the experiments. Tracking stations at Wallops Island, Bermuda, and Blossom Point will track the ascent of the vehicle. During the first two weeks, the satellite will be interrogated once per orbit by the Minitrack network in South Africa and Australia. Any changes in data acquisition plans will depend on data penetration rates and changes in the satellite orbit. Data will be recorded on magnetic tape and sent to Langley, where they will be reduced through use of automatic data processing equipment. Scientists at the respective NASA centers cooperating in the program will analyze the data for application to future space flight programs.
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SEQUENCE OF EVENTS

<table>
<thead>
<tr>
<th>TIME (Seconds)</th>
<th>EVENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>First stage ignites.</td>
</tr>
<tr>
<td>41</td>
<td>First stage burns out.</td>
</tr>
<tr>
<td>76</td>
<td>Second stage ignites; third stage heat shield released; first stage separated.</td>
</tr>
<tr>
<td>116</td>
<td>Second stage burns out.</td>
</tr>
<tr>
<td>139</td>
<td>Fourth stage heat shield released; payload antennas erected.</td>
</tr>
<tr>
<td>140</td>
<td>Third stage ignites; second stage separated.</td>
</tr>
<tr>
<td>180</td>
<td>Third stage burns out.</td>
</tr>
<tr>
<td>455</td>
<td>Spin motor ignites.</td>
</tr>
<tr>
<td>457</td>
<td>Fourth stage ignites; third stage separated.</td>
</tr>
<tr>
<td>498</td>
<td>Fourth stage burns out; satellite injected into orbit.</td>
</tr>
</tbody>
</table>
LISTING OF PERSONNEL

There follows a listing of personnel, their affiliations, and responsibilities in connection with the Scout development flight and the micrometeoroid satellite experiment:

LANGLEY RESEARCH CENTER

Charles T. D'Aiutolo, payload manager and in charge of Langley's responsibilities for providing micrometeoroid detectors; William E. Stoney Jr., Head of the Scout Project Office; James R. Hall, NASA project engineer for the orbital flight; Hugh C. Halliday, payload coordinator; and Walt C. Long, payload telemetry. E. C. Hastings, thermal design.

GODDARD SPACE FLIGHT CENTER


LEWIS RESEARCH CENTER

Elmer Davison, in charge of the Lewis detectors.

WALLOPS STATION

Robert Duffy, Wallops Station range supervisor for the orbital flight.

NASA HEADQUARTERS


VOUGHT ASTRONAUTICS DIVISION, CHANCE VOUGHT AIRCRAFT

Billy H. Kilgore, Wallops Base supervisor of Chance Vought operations.
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SCOUT RESEARCH VEHICLE

The Scout concept originated at the Langley Research Center—in the Applied Materials and Physics Division, which has conducted a variety of aero-space research programs at Wallops Island, using solid fueled research vehicles having from one to seven rocket stages. A special Scout Project Group, including several veterans of Wallops Island research launchings, was formed at Langley to develop the vehicle.

Scout, which has been under development under Langley's direction since mid-1958, is still in the development phase. As an operational vehicle, it is designed to place a 150-pound satellite into a circular orbit approximately 300 miles above the earth or to loft a 50-pound scientific probe to an altitude of about 8,400 miles. In reentry body tests, Scout will permit simulation of conditions expected by a space vehicle returning to the earth's atmosphere. With a ballistic trajectory, it will be possible to obtain almost two hours of zero-gravity environment with 100-pound experiments.

Major contractors and vendors in the program since mid-1958 have been:

Vought Astronautics Division of Chance Vought Aircraft, Dallas, Texas — launch tower fabrication and installation, airframe and motor transition section manufacturer.

Allegany Ballistics Laboratory, a Navy Bureau of Weapons facility operated by Hercules Powder Company at Cumberland, Maryland — third and fourth stage motor developments.

Aerojet-General Division of General Tire and Rubber Company, Sacramento, California — first stage motor development.
Redstone Division of Thiokol Chemical Corporation, Huntsville, Alabama - second stage motor development.

Aeronautical Division of Minneapolis Regulator Company, Minneapolis, Minnesota - guidance.

Walter Kidde, Clifton, New Jersey - Hydrogen-peroxide controls.

Chance Vought Aircraft Company is now vehicle prime contractor for the Scout launch vehicle system, including responsibilities for final assembly and launch. Under the new arrangement, announced by NASA October 20, 1960, at the time a $6 million contract was awarded to Chance Vought as vehicle prime contractor, Langley retains technical direction of the four-stage Scout vehicle.

The following is a description of the four Scout rocket stages and the vehicle's auxiliary parts:

First Stage: Algol, 30 feet long, 40 inches in diameter, and developing 103,000 pounds of thrust, is fin-stabilized and controlled in flight by jet vanes. The largest solid rocket flown in the United States, its sole operational application to date is as the Scout first stage. Algol is named for a fixed star in the constellation Perseus.

Second Stage: Castor is 20 feet long, 30 inches in diameter and has a thrust of over 62,000 pounds. A modification of the Sergeant motor, it has been used successfully in a cluster in NASA's Little Joe program in support of Project Mercury. On the Scout, the Castor is stabilized and controlled by hydrogen-peroxide jets. Castor is the "tamer of the horses" in the constellation Gemini.

Third Stage: Antares is 10 feet long and 30 inches in diameter with a thrust in excess of 13,600 pounds. Stabilized and controlled by hydrogen-peroxide jets and utilizing lightweight plastic construction throughout its
design, Antares is a scaled-up version of the fourth stage and is the only motor developed specifically for Scout. Antares is the brightest star in the constellation Scorpio.

Fourth Stage: Altair, six feet long, 18 inches in diameter, and having 2,800 pounds of thrust, is the smallest of the four Scout stages. The spin-stabilized Altair formerly was known as X-248. It is the third stage on the Able and Delta launch vehicles and was the first fully developed rocket to utilize lightweight plastic construction throughout. Altair is a star of the first magnitude in the constellation Aquilae, or Eagle.

Auxiliary Parts: The added Scout airframe parts consist of control surfaces surrounding the nozzle of the first stage, transition sections connecting the four rocket stages, a Fibreglas-phenolic protective heat shield which covers the third and fourth stages plus payload, the fourth-stage spin-up table, and the payload attachment structure.

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