NEWS

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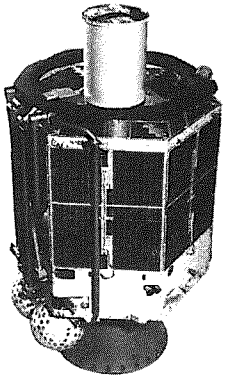

PROJECT: Air Density-Injun Explorer C

(To be launched no earlier than Aug. 8)

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TWO EXPLORERS SCHEDULED

Two National Aeronautics and Space Administration satellites will be launched Aug. 8 to continue the detailed scientific study of density and radiation characteristics of Earth's upper atmosphere at a time of high solar activity.

Successful separation of the two spacecraft will mark the second time NASA has orbited more than one satellite with a single Scout rocket.

The Scout will be launched from the Western Test Range, Lompoc, Calif., between 1:19 p.m. and 2:19 p.m. EDT.

The dual satellites, called Air Density-Injun Explorer C (AD-I C), will extend into the polar regions studies of complex radiation-air density relationships in the upper atmosphere. The project is managed by NASA's Langley Research Center, Hampton, Va.

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Once in orbit, the 178-pound payload will separate into a 12-foot polka-dotted sphere for air density and atmosphere heating research and a six-sided cylinder bearing 12 separate detectors to measure the bombardment of the atmosphere by energetic particles from space, as well as the intensity of very low frequency radio emissions.

The amount of energy brought into the Earth's upper atmosphere by these colliding particles is not fully known, but previous experiments have yielded evidence that such energy may be one of the factors governing the atmosphere's density, temperature and composition at high altitudes.

A variety of complex and interrelated events occur in the upper atmosphere, and the Air Density-Injun Explorer, constituting an interdisciplinary project in the areas of aeronomy, energetic particles and fields, and ionospheres and radiophysics, will enlarge existing knowledge.

A previous Air Density-Injun Explorer combination was successfully orbited Nov. 21, 1964 to coincide with the International Quiet Sun Year. The present launch is scheduled in the more active portion of the solar cycle.

Air Density Explorer (Explorer 39 in orbit) will extend upper air research in the polar regions and will be placed into an 82 degree orbit specifically for that purpose. It will continue to acquire information on density and temperature variations at intermediate latitudes and, by comparing results with earlier similar satellites will investigate sources of atmosphere heating and the seasonal and solar cycle variations in upper air density on a global basis.

Injun Explorer (Explorer 40 in orbit) will carry instruments to measure charged particles reaching the upper atmosphere, and to study those trapped in Earth's magnetic field, with particular attention to their ranges of energy, distribution in space, and changes with time. It will also be equipped to study very low frequency radio emissions in the ionosphere and their relations to the particle distribution.

The dual satellites are a program of NASA's Office of Space Science and Applications. The Air Density Explorer was fabricated at Langley Research Center while the Injun Explorer was built under contract by the University of Iowa, Iowa City. One of the Injun experiments was provided by the Air Force Cambridge Research Center.

Scientists have selected an 82-degree near-polar orbit inclination for both spacecraft. Apogee (high point) is planned to be about 1,550 statute miles with perigee (low point) about 435 miles. The two satellites will orbit Earth once every 118.2 minutes.

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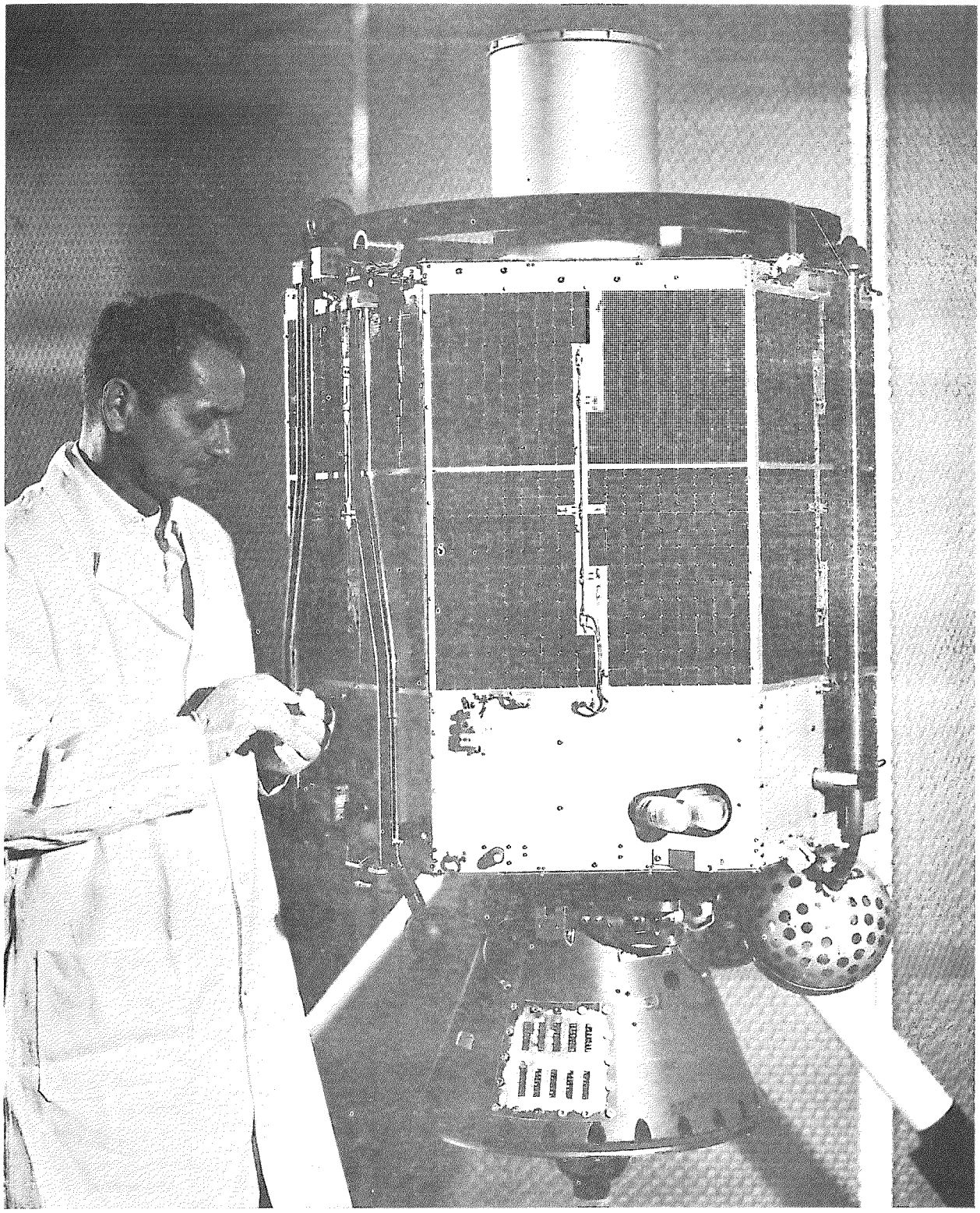

The 2-in-1 Air Density-Injun Explorer Satellite (density and radiation of upper atmosphere).

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ENERGETIC PARTICLES

As the Earth moves through space, its environment is constantly bombarded by a shower of energetic particles, originating at the Sun and from other sources in the universe.

Solar radiation is the major energy source for the Earth's atmosphere and the ionosphere. However, many scientists believe various observed phenomena should be attributed to the bombardment by energetic particles.

The Earth's magnetic field affects the motion of charged particles and, in special cases, traps those which come within its influence, forming the Van Allen radiation belts.

The charged particles entering the magnetic field are diverted from their original courses and some follow spiraling paths along the magnetic lines of force. Where the magnetic lines descend steeply toward the Earth at the polar regions, the downward spiraling energetic particles frequently collide with particles of air at the upper fringes of the atmosphere.

Such collisions release energy and heat the atmosphere. The Aurora Borealis in the North Polar regions and the Aurora Australis in the South Polar area represent the release of such energy in the form of light.

Collisions of energetic particles with the Earth's upper atmosphere occur to a much lesser extent over the rest of the Earth. Scientists suspect that in some cases charged particles penetrate to low altitudes at mid-latitudes and may be a cause of some of the faint glow of the night sky. It is also thought that these moving particles can give rise to the radio signals observed as "very low frequency emission."

These collisions may also contribute to the formation of the upper ionosphere, the region of ionized air in the upper atmosphere which serves man as an electronic reflector to carry radio waves around the curvature of the globe.

SCIENTIFIC OBJECTIVES

The extent to which energy is brought into the Earth's upper atmosphere by these colliding energetic particles is of prime interest to scientists. The amount of energy is not fully known.

To learn more about complex radiation-air density interrelationships, the dual satellites have been designed specifically to measure particle flux, energy, VLF emissions and atmospheric density at the same time and in the same general location. In this way, data from each set of measurements can be used to interpret data from the other.

Air density is measured by using lightweight satellites in eccentric Earth orbits. These satellites experience drag (atmospheric resistance) at their perigees (lowest points in their orbits). This resistance is measured and translated into atmospheric density data.

AIR DENSITY EXPLORER

Existing knowledge of the Earth's upper atmosphere and its density has been gathered mainly by observing satellite orbit variations.

Although the atmosphere rapidly becomes less dense as one moves away from the Earth's surface, enough gas molecules and atoms exist at altitudes of 300-500 miles to provide small but measurable amounts of resistance to moving spacecraft.

This resistance, called drag, can be measured with high accuracy only by special instruments.

Air Density Explorer satellites are considered ideal for drag measurements at the fringes of the atmosphere. Their large size and light weight makes them exceptionally sensitive to the small quantities of drag they are intended to measure. Moreover, their spherical shape simplifies the correct interpretation of drag measurements because they always present the same frontal area to the atmosphere.

Several previous lightweight spherical satellites launched by NASA have collected much useful information about upper atmosphere densities. They include Explorer IX, launched from Wallops Station, Va., Feb. 16, 1961; Explorer XIX, launched from Western Test Range Dec. 19, 1963; and Explorer XXIV, launched in combination with an Injun Explorer from WTR Nov. 21, 1964.

Two remain aloft. Explorer XIX, in a 78 degree orbit, is expected to survive in space until some time in 1969. Explorer XXIV, operating in an 82 degree orbit, probably will reenter the dense atmosphere before the end of 1968.

All these satellites have laid the foundations for a scientific understanding of the upper atmosphere which did not exist a decade ago. They have established that variations in the atmospheric density are correlated with the solar cycle, but that there are rather large short-term variations related to solar radiation changes.

Regular changes in density connected with the changing seasons on Earth have been measured. A semi-annual density variation--unknown before the Explorer measurements--has been found, but remains unexplained.

The new Air Density Explorer is intended to further these studies by making its measurements during a time of high activity in the 11-year solar cycle. It will likewise add to knowledge of changes related to latitude, to variations between day and night and changes in altitude.

The Air Density Explorer is built of four alternating layers of 0.5-mil-thick aluminum foil (a mil is one-thousandth of an inch) and 0.5-mil plastic film known as Mylar (polyethylene terephthalate). The inner layer is plastic, the outer aluminum foil which reflects sunlight and radio waves so the satellite can be tracked by both optical and radar techniques. It was built by technicians of NASA's Langley Research Center, who bonded together 40 flat triangular sections of the aluminum-Mylar sandwich to form a sphere.

Temperature control while the satellite is in sunlight is provided by 4,000 white spots evenly distributed over the sphere and covering about one-fourth of its total area. Each 2.5-inch-diameter spot is formed by zinc oxide pigmented methyl silicone elastomer paint.

The area covered by the spots was selected to balance the heat absorption and emission characteristics of the differing surfaces so that the spacecraft's temperature inside will be maintained within an acceptable range.

To supplement optical tracking, a radio tracking beacon is mounted inside the skin of the satellite, diametrically opposite a group of nickel-cadmium batteries which form a part of the power supply. Four groups of solar cells, protected from radiation damage by quartz windows, are located on the outer surface of the satellite. They provide energy to recharge the batteries and electrical power to operate the tracking beacon. All elements of the beacon electrical system are interconnected by ribbon wire.

A strip of plastic at the equator of the sphere divides it in half so that both metallic hemispheres can serve as antennas for the tracking beacon.

A small telemeter is carried to report skin temperatures, internal temperatures and solar cell voltages.

Total weight of the satellite and its instruments is 20.8 pounds.

INJUN EXPLORER

The 157-pound Injun Explorer is a hexagonal cylinder 29 inches tall and 30 inches across its widest dimensions. Permanent magnets inside the spacecraft make it a stable platform for the instruments aboard.

Within the Injun Explorer and extending slightly from its upper surface is the cylindrical tube in which the folded Air Density Explorer will ride into orbit, plus the ejection and inflation equipment needed to expand the folded satellite into a sphere.

Attached to the spacecraft and folded during launch for later deployment in space are five hinged booms -- three mounting antennas and two carrying particle analyzers.

Ten other particle sensors for measuring radiation of differing kinds and intensities are mounted inside the shell of the Injun spacecraft, completing the total of 12 instruments aboard. The VLF antennas are mounted on folding booms.

After the spacecraft separates from the fourth-stage rocket motor, a dry nitrogen gas system will reduce the spin rate to five or less revolutions-per-minute. Magnetic damping rods will then overcome any remaining spin or tumble to allow the permanent magnets to align the satellite with the Earth's magnetic lines of force, as a compass needle aligns itself parallel to magnetic force lines.

Four major groupings of experiments will be flown on the Injun Explorer C. They include:

Low Energy Proton Electron Differential Energy Analyzer (LEPEDEA) experiments

In this category are three LEPEDEA detectors and three Geiger-Mueller tubes. The LEPEDEAs have a limited field of view. They are mounted in the spacecraft with a special magnetic alignment; they will admit energetic particles that are either traveling nearly parallel to magnetic lines of force, trapped in orbits perpendicular to the magnetic field line or reflected back up a field line.

Unlike instruments previously flown, they can measure particles of very low energy, down to five electron volts (5eV), as well as those of higher energy levels. Earlier measurements were in the range of 400eV and above.

One of the Geiger-Mueller tubes is omni-directional while two are mounted perpendicularly to the magnetic field for further studies of energetic electrons in the inner and outer radiation belts.

Solid State Detector Experiment

Two instruments comprise this experiment, a proton-electron telescope (PET) and an alpha particle (helium nuclei) detector. The PET covers a 30-degree field of view, operates in either a proton or an electron mode, and has four channels for measuring particles of differing energies. The alpha detector, also a four-channel instrument for measuring particles in the higher range of energies, covers a 22-degree field of view.

Very Low Frequency (VLF) Experiment

To investigate the very low frequency radio noise phenomena, which have been observed by Earth-based instruments, the Injun Explorer is fitted with a magnetic receiver with a loop antenna and an electric receiver with two spherical antenna elements. The magnetic loop antenna is carried on a nine-foot folding boom and will be aligned with the Earth's magnetic field. The two spherical antennas, on shorter booms, will be perpendicular to the field. Radio emissions at frequencies between 30 Hz (cycles) and 10 KHz (10,000 cycles) will be reported.

Spherical Retarding Potential Analyzer Experiment

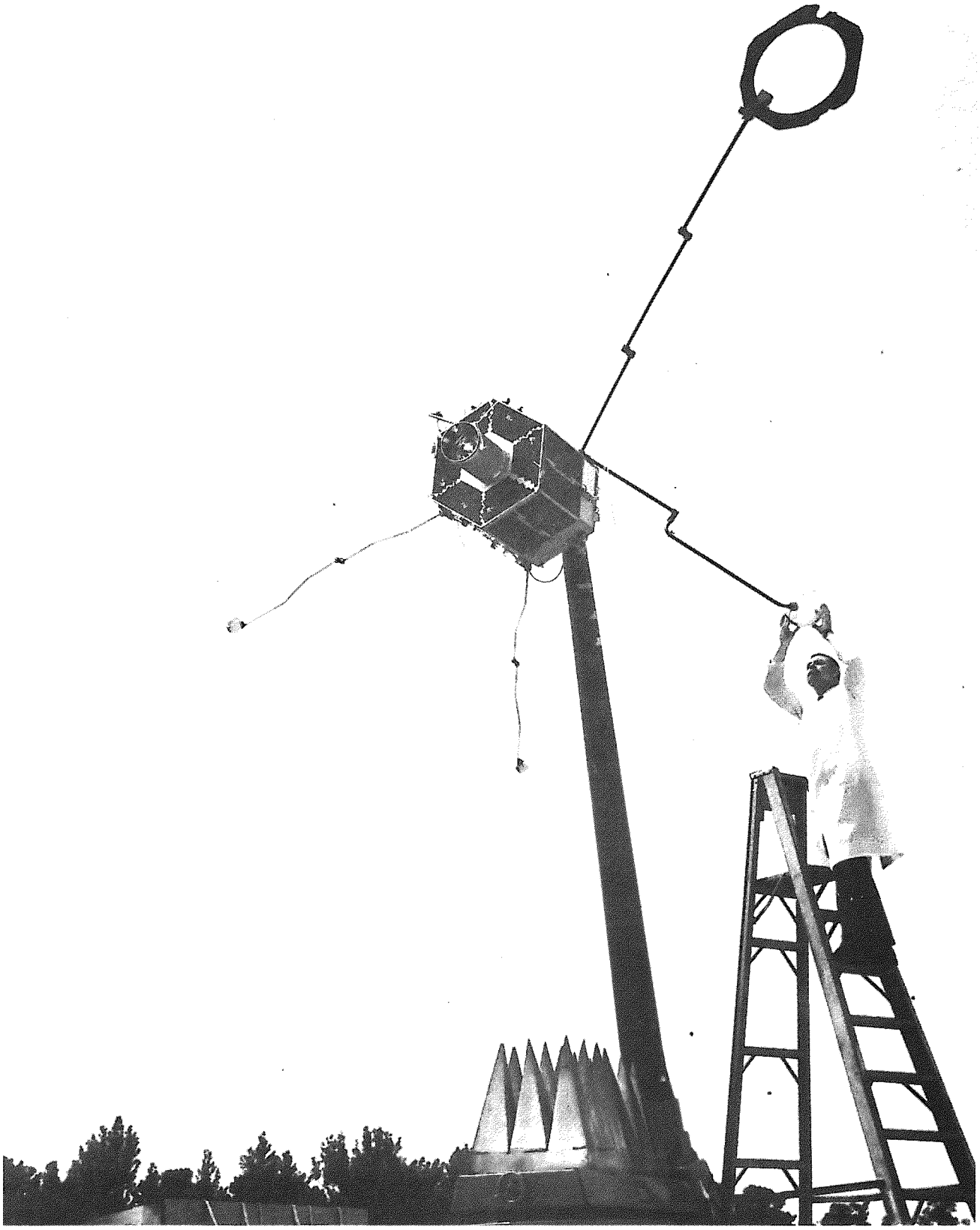
Two spherical analyzers, mounted on folding booms, are attached to the Injun Explorer. One will record electrons, the other positive ions, in the lower ranges of electron voltage. The experimental equipment was furnished by the Air Force Cambridge Research Laboratories.

The Injun Explorer carries a command receiver, a two-channel tape recorder, a low power telemeter (250 milliwatts) and a high power telemeter (800 milliwatts).

By means of the command receiver, various experiments can be turned on and off as required. The data measured can be directed into the tape recorder for delayed playback or it can be sent directly to ground stations as they are gathered. The low power telemeter serves a double function by providing a beacon signal for satellite tracking.

The two-channel tape recorder can store the measurements of all the Injun Explorer instruments for an eight-hour period. When the satellite is over a receiving station, the high power telemeter can replay the stored data in 22 minutes or less. The high power telemeter can be selected to provide different rates of data transmission.

The Injun was designed and built by the University of Iowa, Iowa City, under contract to the Langley Center.



Air Density-Injun Explorer C telemetry antenna undergoing reliability checks.

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MISSION SEQUENCE

Air Density-Injun Explorer C will be launched in a southerly direction with injection into orbit occurring about 1,495 miles downrange, 10.7 minutes after launch. Initial apogee will occur over the Malagasy Republic.

About 10 minutes after liftoff, a spacecraft timer is started to begin the sequence of events necessary to establish the Air Density and Injun spacecraft in their selected orbits.

After burnout of the Scout's fourth-stage rocket motor and while the combined payloads and the fourth stage are spinning approximately 160 rpm, the timer will activate squibs to open a valve on a steel inflation bottle containing nitrogen gas compressed to 1,800 pounds-per-square-inch. The squibs will fire about 25 minutes after launch.

Nitrogen gas immediately flows into a bellows which expands to push the folded Air Density Explorer out of its cylindrical container. A wire cable limits the distance the folded satellite may move beyond the container, and when the cable becomes taut, the nitrogen gas passes through a disconnect mechanism, thereby inflating the 12-foot sphere. Inflation will slow the spin rate of the entire assembly.

When pressure in the bellow decreases to a pre-set level, the disconnect mechanism releases the satellite from its container and a separation spring shoves it away from the Injun Explorer and the fourth-stage assembly.

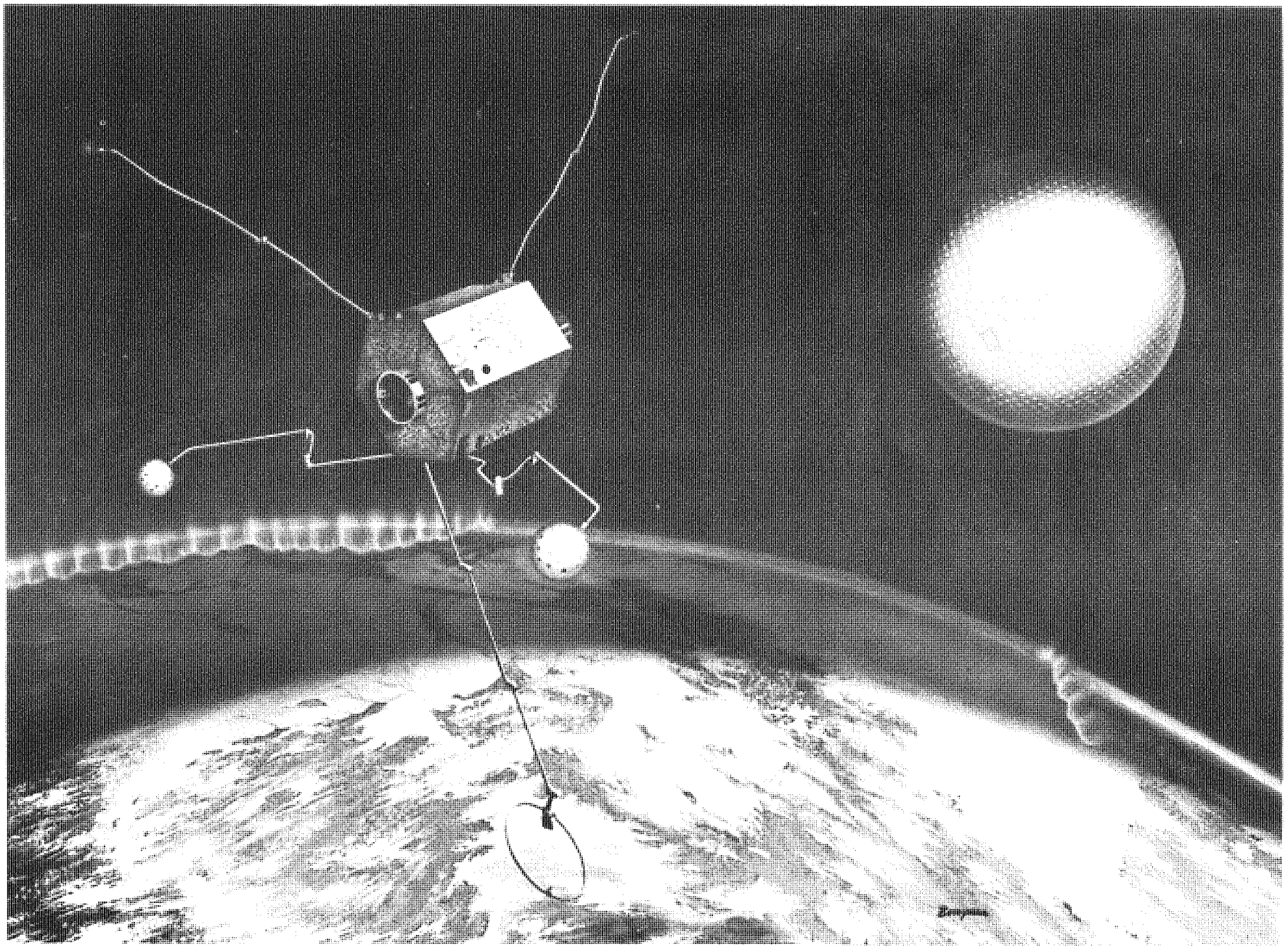
After separation, the nitorgen inflation gas is immediately allowed to escape from the sphere through the open valve stem, reducing the internal pressure to that of the space environment.

The aluminum-Mylar sandwich structure is sufficiently rigid to maintain the spherical shape even after the inflation gas leaves the 12-foot sphere.

The Air Density Explorer should be completely inflated and separated from the Injun Explorer about 28 minutes after launch.

At 58 minutes after launch, the timer sets off an explosive bolt device which separates the Injun Explorer from the fourth-stage motor case, and the separation sequence is then complete.

After separation, the Injun Explorer is despun and the five booms are deployed. Boom deployment is completed 70 minutes after liftoff.



Artist's concept of Air Density Explorer and Injun satellites in orbit.

LAUNCH VEHICLE

Scout is a four-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 liftoff.

Developed by NASA's Langley Research Center, Hampton, Va., Scout is manufactured by LTV Astronautics Division, Dallas.

The four motors are connected with sections which contain guidance, control, ignition, instrumentation systems, separation mechanisms and the spin motors required to stabilize the fourth stage. Guidance is provided by a strapped-down gyro system and control is achieved by a combination of aerodynamics surfaces, jet vanes and hydrogen peroxide jets.

Scout is capable of placing a 300-pound payload into a 300-mile orbit or of carrying a 100-pound scientific package 10,000 miles away from Earth.

Scout Stages:

First Stage	Algol IIB - 101,000 pounds average thrust burning 80 seconds.
Second Stage	Castor II - 61,000 pounds average thrust burning 39 seconds.
Third Stage	Antares II (ABL X-259) - 21,000 pounds average thrust burning 35 seconds.
Fourth Stage	FW- 4S - 5,800 pounds average thrust burning 31 seconds.

TRACKING

Tracking for the forthcoming launch is divided into two phases, the first during the ascent trajectory flight and the second after the two satellites are operating in orbit.

Launch vehicle tracking will be accomplished by the normal radar facilities of the Western Test Range, supplemented by a range ship stationed near the insertion point.

After orbit is achieved, the two satellites will be tracked by NASA's STADAN network, operated by Goddard, and the Smithsonian Astrophysical Observatory Baker-Nunn Camera network. During the first orbit, data from the Injun Explorer will be read out by STADAN stations at Johannesburg, South Africa, and College, Alaska.

The University of Iowa, which maintains a tracking station at Iowa City, will track and interrogate the Injun Explorer in addition to the NASA STADAN stations.

AIR DENSITY-INJUN TEAM

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