DOCUMENT RESUME

ED 109 990 IR 002 254

TITLE	Applications Technology Satellite-6 (ATS-6).
INSTITUTION	National Aeronautics and Space Administration, Washington, D.C.
REPORT NO	NF-53-1-75
PUB DATE	75
NOTE	13p.
AVAILABLE FROM	Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402 (Stock No. 033-000-00600-4; $0.45)
EDRS PRICE	MF-$0.76 HC-$1.58 PLUS POSTAGE
DESCRIPTORS	Communications; *Communication Satellites; *Delivery Systems; Developing Nations; Educational Television; Experimental Programs; Experiments; *Health Education; Meteorology; *Rural Education; Teacher Education; *Technological Advancement; Technology; Telecommunication
IDENTIFIERS	Alaska; Appalachia; *Applications Technology Satellite 6; ATS 6; India; NASA; National Aeronautics and Space Administration

ABSTRACT

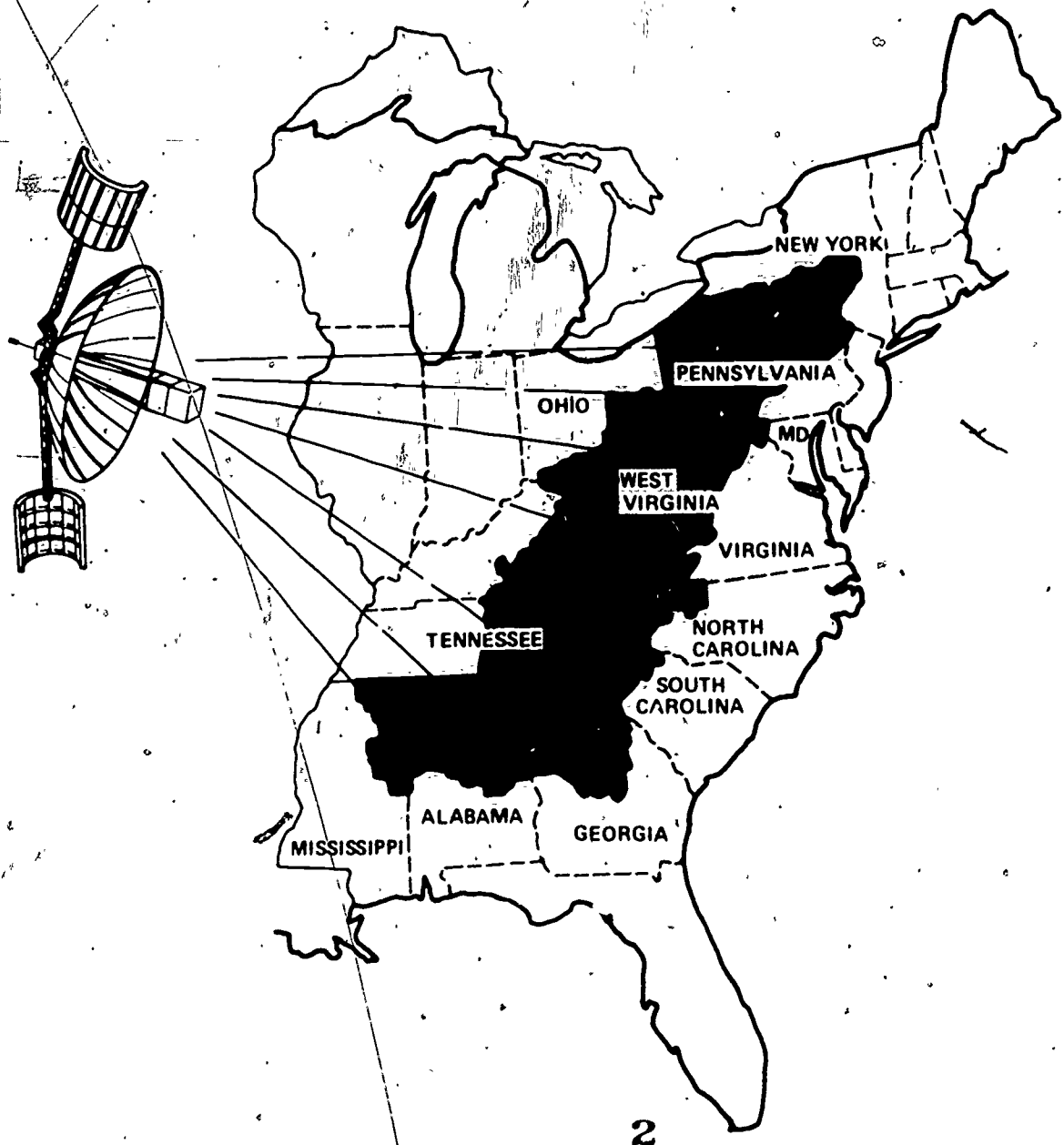
The Applications Technology Satellite-6 (ATS-6) pilot study being conducted by the National Aeronautics and Space Administration (NASA) includes 20 experiments in the use of satellites for educational delivery systems in rural areas and for scientific and technological information dissemination. Initial usage of the system has been in North America for health care and teacher education. Subsequent experiments will be undertaken in other parts of the world including India and the Galapagos Island. Diagrams and photographs of various aspects of the AST-6 project are provided, together with a summary of the prior satellites in the AST series. (DGC)

NASA FACTS

AN EDUCATIONAL PUBLICATION OF THE
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

NF-53/175

APPLICATIONS TECHNOLOGY SATELLITE -6 [ATS-6]



2

ATS-6

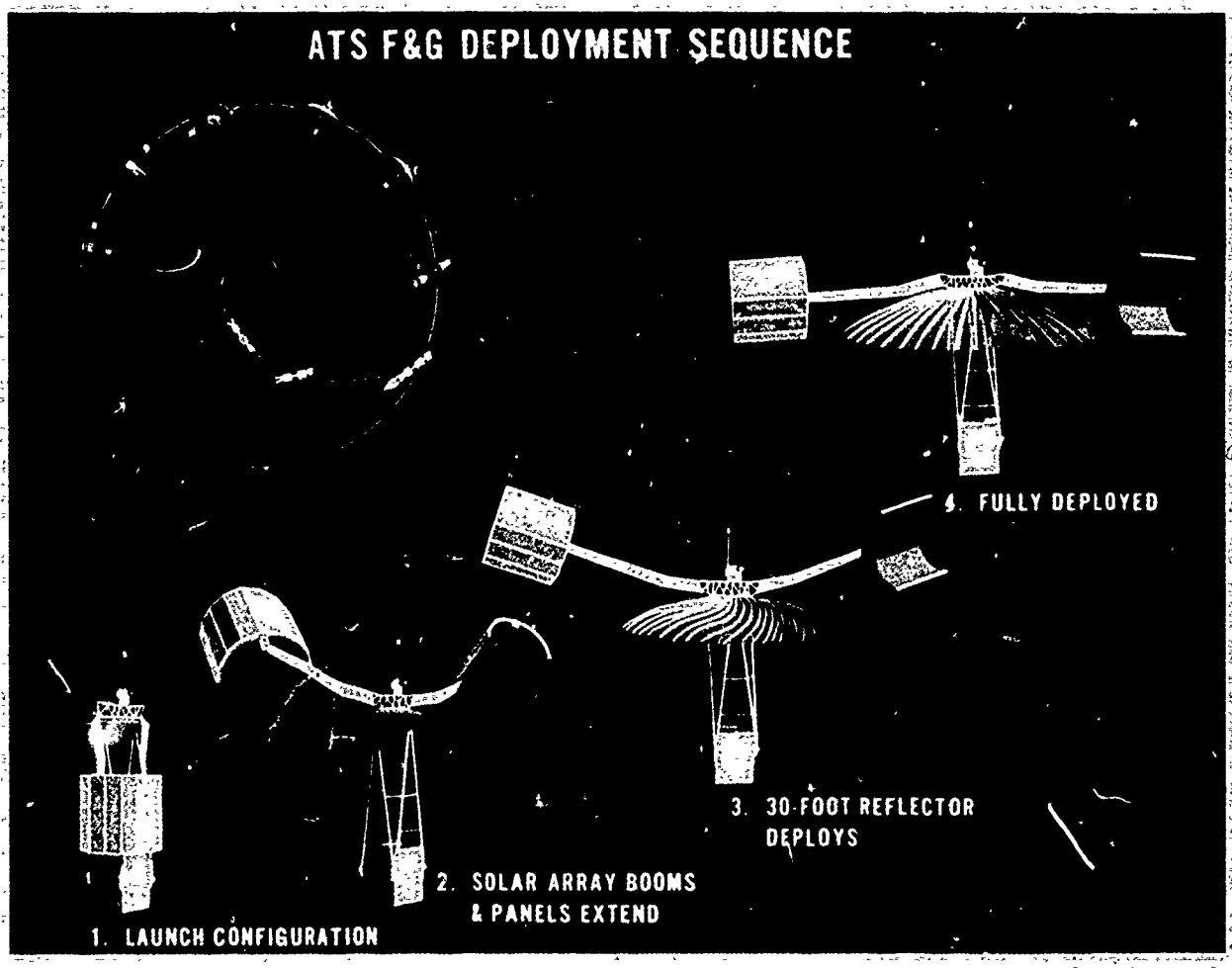
The first educational course ever taught via satellite television started July 2, 1974, employing NASA's experimental Applications Technology Satellite-6 (ATS-6). More than 600 elementary school teachers in eight Appalachian states participated in the graduate-level studies. Thus began the multi-use career of ATS-6.

The versatile spacecraft climaxes NASA's ATS Program that, since 1966, has been advancing significantly the frontiers of knowledge in communications and meteorology. In addition, ATS-6 is demonstrating how widespread applications of presently available technology could contribute to lessening ignorance, poverty and inadequate health care and lead to better lives for millions of people worldwide.

ATS-6 is in a nearly circular Earth orbit about 35,680 kilometers (22,300 miles) above the equator. This is called a geostationary orbit, one in which a satellite more or less keeps pace with and remains over one spot on our rotating globe.

Because of its high altitude, the geostationary ATS-6 can provide communications coverage for about 40 percent of our planet and take usable photographs of cloud cover over approximately 25 percent of the Earth.

The July 1974 educational TV transmission was the first experiment to be conducted with ATS-6. At that time, the spacecraft, capable of being relocated east or west, was positioned at its first orbital station, over the Galapagos Islands, a point west of Ecuador and due south



of Kansas City. From this first orbital position, ATS-6 can, among other tasks, provide communications coverage to Alaska and the 48 mainland states.

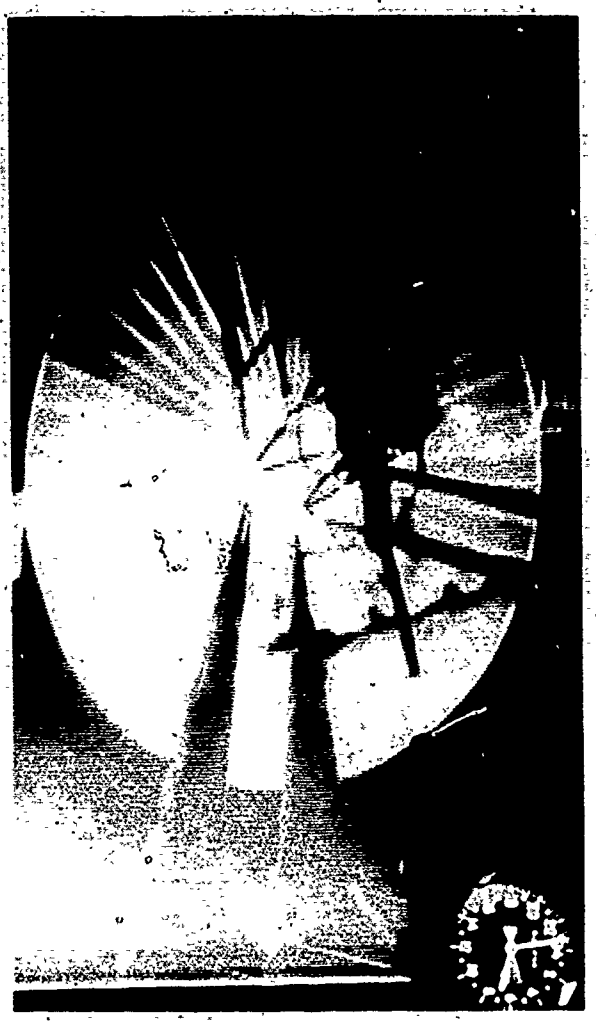
Antenna Has Key Role

A principal feature of the 1402-kilogram (3090-pound) ATS-6 is its 9-meter (30-foot) diameter mesh antenna which was folded into a tight package at launch, May 30, 1974, and unfurled in orbit.

The antenna can be pointed to within one-tenth degree of arc, enabling ATS-6 to relay strong television signals directly to suitable augmented small TV receivers on the ground. At present, huge ground stations are needed to receive and amplify the relatively faint signals from communications satellites before images can be retransmitted via conventional methods to home TV sets.

Satellite broadcasts to such inexpensive augmented ground receivers as used with ATS-6 could bring high-quality education and health information at comparatively low cost to remote, sparsely distributed, or widespread populations. Two of the approximately 20 ATS 6 experiments are designed to provide a basis for comparison of the cost and effectiveness of satellite and ground communications for these purposes. Regardless of the outcome, in the future, the quality of education and health services available to people may no longer depend upon where they live.

Technicians furl large ATS-6 antenna reflector into 1.7-meter (5.5-foot) diameter package that will house it during launch. Reflector's transparent, copper-coated Dacron mesh is sewn to flexible aluminum ribs.



Photograph taken by on-board, fish-eyed TV camera confirms that big reflector opened as planned. Solar panels are outboard.

Pioneering Space Services

The first of the significant social experiments on ATS is called HET for Health/Education Telecommunications experiments. HET pioneers delivery via space of advanced educational and health services to millions of Americans in hundreds of small villages in remote areas of the Rocky Mountain and Appalachian regions and in Alaska where TV reception via ground facilities is difficult and costly. It was a HET experiment, the educational telecast, that began shortly after ATS 6 was maneuvered to its first orbital station. The satellite's attitude (orientation) is adjusted as required for direct broadcasts to ground equipment in Alaska, Appalachia, or the Rockies. ATS 1 and 3, launched earlier, supplement ATS 6 voice and data capabilities for HET.

An important feature of ATS 6 is that each of its two-color TV signals has four separate voice channels. This means that the same telecast can be made to four separate audiences, each with a different language, who would hear it simultaneously in their own tongues; for example, English, Eskimo, an American Indian dialect, and Spanish.

Cooperating Agencies

HET is a joint project of NASA and the Department of Health, Education and Welfare (HEW).

NASA is responsible for controlling ATS 6 and provides access to ATS 6 ground stations as needed by experimenters from organizations participating in the project. HEW is responsible for other transmitting and receiving facilities. HEW is the HET principal investigator.

The Federation of Rocky Mountain States (FRMS), the Appalachian Regional Commission, the Alaska Office of Telecommunications, and the U.S. Indian Health Service coordinate activities in their respective areas. FRMS is responsible for coordinating installation of ground terminals for HET. There are about 120 ground terminal systems, each consisting of a TV set augmented by a special antenna and a converter. Each FRMS receiving system cost less than $4000.

Education

The educational TV tests cover both student instruction and in-service teacher training and development. Professionals and volunteers are working along with the school staffs to provide guidance for and evaluate the use of educational TV. Among the educational areas covered are the following:

In the Appalachian region, two graduate courses in education are being provided teachers via ATS 6. One—the course in reading—is designed to help elementary school teachers diagnose and correct pupil reading problems. The other—career education—will examine the function of such education at all school levels.

Rocky Mountain educational TV via ATS 6 focusses on junior high school students. Career education programs help the students assess their needs, interest, aptitudes, and skills; tell them about different fields; and guide them toward preparation for their selected fields.

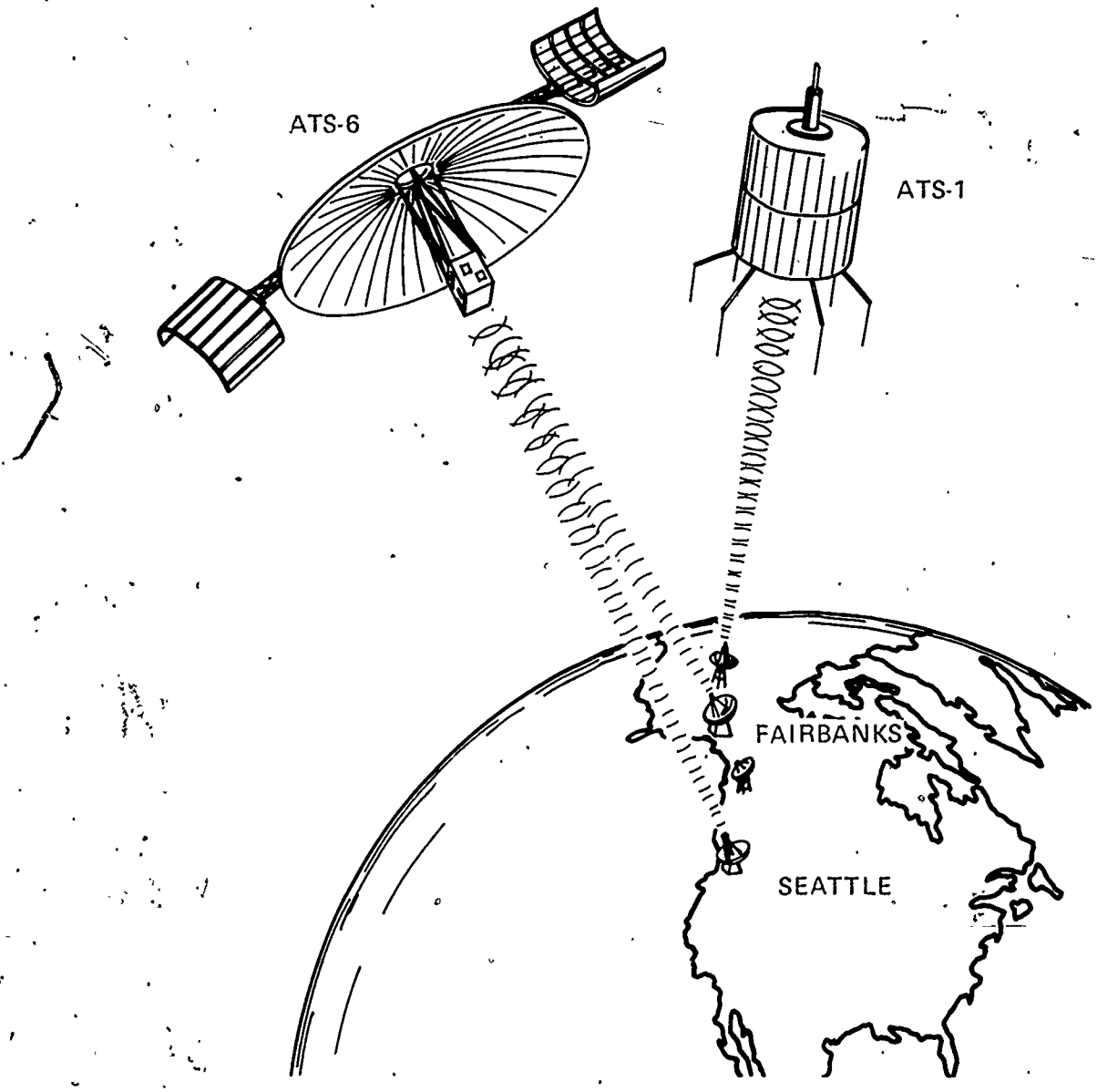
The Alaska tests include: educational TV courses for teachers; other TV courses designed for presentation to elementary school pupils;

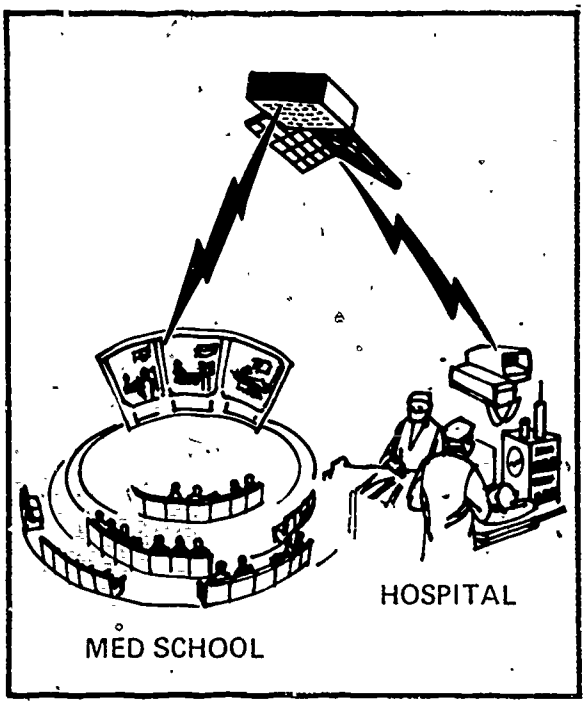
and weekly telecasts of a half-hour show called "Alaska Native Magazine," featuring such items of local interest as land claims, pipeline impact, and native culture. In another activity, network telecasts in the 48 contiguous states are relayed simultaneously via ATS 6 to Alaskan receivers. Alaskans receive few live network TV shows, and even their taped evening news programs may be delayed as long as 30 hours after broadcast in the contiguous 48 states.

The ATS-6 educational TV tests are designed to determine whether satellite systems offer an effective way of providing high quality educational programs and services to people in out-of-the way rural areas. Regardless of how the tests turn out, they are opening new doors to knowledge and have contributed to ending decades of relative isolation.

Health Care

The Veterans Administration, the Health Science Administration of the University of Washington, and the Alaska Health Department are among those involved along with HEW and NASA in the HET medical information networking experiments. The immediate objective of the tests is to demonstrate how health care of people in remote areas can be improved by expanded communications facilities, such as are provided by ATS-6.





One of the experiments is in telemedicine in which a physician can actually prescribe treatment from a distance. The telemedicine experiments are being conducted in Alaska. They expand the health care experiments being conducted with ATS 1, launched in 1966.

A second experiment, participated in by Alaska and the University of Washington Medical School, tests the feasibility of instructing medical students via TV. This experiment involves two-way voice and video communication between students and teachers.

Ten Veterans' Administration hospitals in the Appalachian region (shown on cover) are participating in the Exchange of Medical Information projects of HET. A year-long series of telecasts via ATS 6 are being presented to hospital medical personnel. The telecasts include such programs as:

- *Video seminars* with groups at the VA hospitals asking questions and commenting over a return audio channel.
- Participatory Grand Rounds in which viewers can follow a physician on his daily rounds of hospital patients.
- *TV tele-consultation* in which doctors at VA hospitals consult with specialists at teaching institutions.

The HET medical communication tests could open new windows for the benefit and advancement of medical students and health professionals everywhere by enabling them to observe and discuss unique or advanced medical procedures, regardless of where performed. In addition, global video seminars could be held on difficult medical problems. And an individual's complete medical file, regardless of where it is located, could be provided immediately for emergency diagnosis if the individual should fall seriously ill or be badly hurt when away from his or her home community.

While engaged in HET, ATS 6 is also used in other technical experiments in advanced communications. Examples are PLACE and TDRE, described later in this publication.

Available to India

Approximately a year after launch, ATS 6 will be moved from its position over the Galapagos Islands eastward to a station over Lake Victoria in central Africa. From this location, it will be able to cover India. In this cooperative experiment, it will be made available to the Government of India for four to six hours daily for about a year to conduct the Satellite Instructional TV Experiment (SITE). During other hours, additional technical experiments will be carried out by experimenters from the United States and abroad.

SITE will evaluate the potential of satellite technology for rapidly establishing mass communication facilities in developing countries, enabling them to leapfrog the stage of expensive ground-based communications networks. SITE represents an important expression of United States policy to use space technology for the benefit of all mankind.

From a ground station at Ahmedabad (north

Geostationary Orbit

The geostationary orbit in which ATS-6, for example, stays over one point on the equator, was pioneered by NASA's experimental Syncom communications satellite project (1963-1964). It is employed in the present-day INTELSAT global commercial communications satellite network and in domestic satellite systems such as the Westar, owned and operated by Western Union Corporation, and the Anik, owned and operated by Telesat Canada. NASA launches commercial communications satellites and is reimbursed by their owners for launch vehicles and launch services.

of Bombay), the Indian Space Research Organization (ISRO) will telecast educational programs via ATS 6 to some 5000 Indian villages. About 2000 of these will have suitably augmented receivers for direct reception from ATS 6. Others will have standard TV sets and receive signals via ground microwave relay stations.

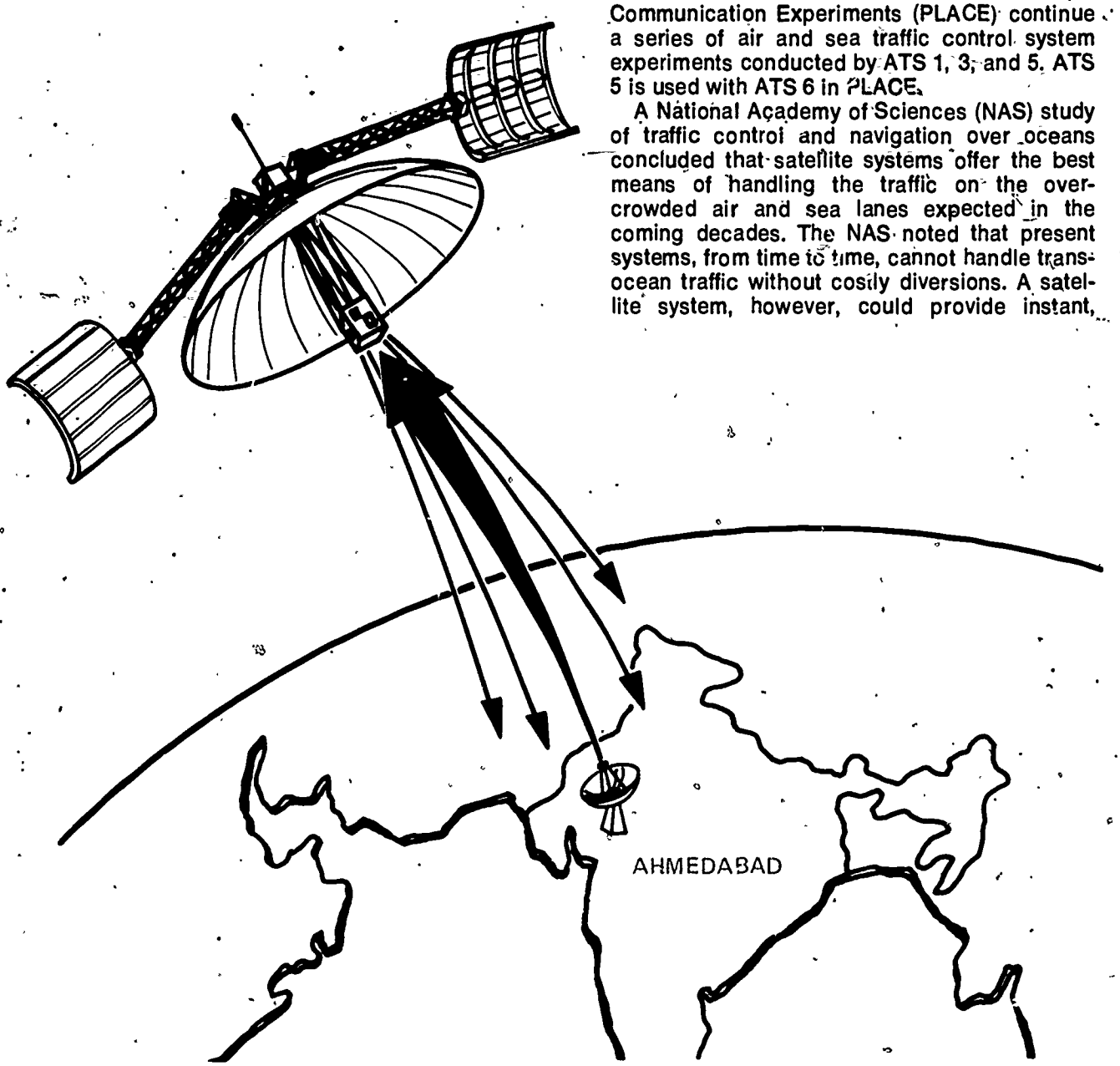
ISRO is responsible for television programming and for designing, manufacturing, and maintaining receivers, associated ground equipment, and antennas. Its programming is to be directed toward improved agricultural techniques, family planning, hygiene, school instruction, and national integration. Assuming success of the experiment, India is planning its own follow-on domestic TV satellite system.

Upon completion of SITE, ATS 6 will be maneuvered back to the Western Hemisphere for continued experiments.

Air and Sea Lanes

An important technology that ATS 6 will advance is satellite air traffic control and communications. Its Position Location and Aircraft Communication Experiments (PLACE) continue a series of air and sea traffic control system experiments conducted by ATS 1, 3, and 5. ATS 5 is used with ATS 6 in PLACE.

A National Academy of Sciences (NAS) study of traffic control and navigation over oceans concluded that satellite systems offer the best means of handling the traffic on the overcrowded air and sea lanes expected in the coming decades. The NAS noted that present systems, from time to time, cannot handle trans-ocean traffic without costly diversions. A satellite system, however, could provide instant,



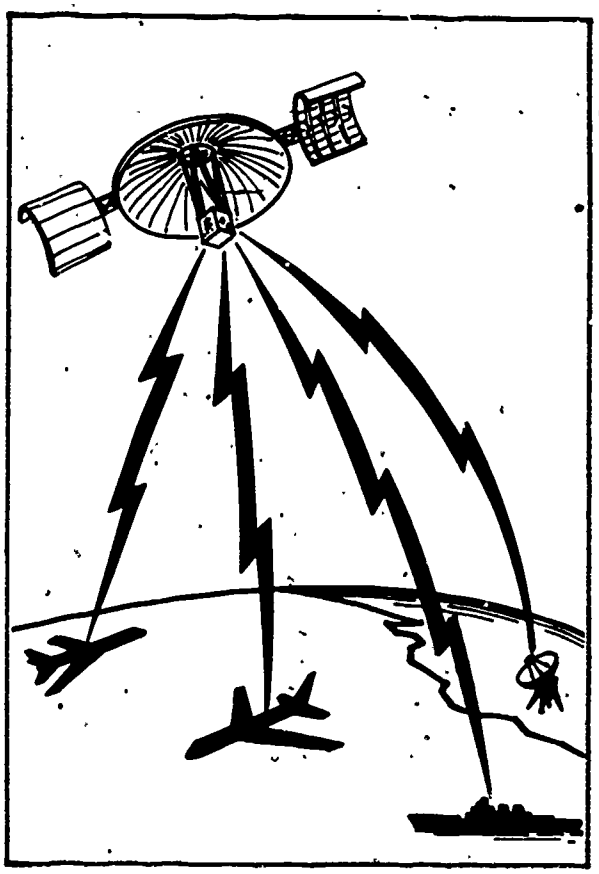
continuous, and automatic plotting of routes and communication with pilots over vast ocean areas.

The Federal Aviation Administration, the Transportation Systems Center, and the U. S. Coast Guard, all of the Department of Transportation, and the Maritime Administration of the Department of Commerce are participating in PLACE.

The effort is also crossing national boundaries with participation by the European Space Agency and Canada's Department of Communication and Ministry of Transport.

When over the Galapagos, ATS 6 can cover the Eastern Seaboard and the North Atlantic aviation and maritime routes some two-thirds of the way out from the United States. PLACE is conducted in this area.

PLACE tests a number of communications and position-location techniques using ATS 5 or 6 as a relay between ground terminals and airborne planes or ships at sea. Ground terminals are in the United States and Canada. Four jet aircraft and five ships for PLACE have been provided by the United States, Canada, and European Space Agency. Special communications and ranging instruments are installed in the ships and airplanes.



The major objective of PLACE is to contribute data from which requirements for future operational communications and position-location systems may be derived. Such systems would provide uninterrupted aeronautical and maritime communications, aid air and sea traffic control, and speed rescues to ships in distress. They could be operating within a few years.

Satellite Relay Point

A related experiment involves spacecraft rather than aircraft. The Tracking and DATA Relay Experiment (TDRE) calls for ATS 6 to track and relay data from NASA's experimental Nimbus meteorological and GEOS geodetic satellites in lower orbits.

Today, an extensive network of ground stations gathers data from satellites. Usually, a single station is in contact with a 320-kilometer (200-mile) high satellite for only about 10 percent of the satellite's orbit. Despite a global network of ground tracking and data acquisition stations, there are periods when satellites are out of range of all stations and must record data for later transmission. Two satellites in properly located stationary geosynchronous orbits could keep in constant touch with lower altitude satellites and relay all data to as few as two ground stations.

Weather Experiments

In a terminated experiment, ATS 6 used an advanced high resolution camera to acquire day and night photographs of the Earth and its cloud cover. ATS-6 also gathers other weather data. The information derived from these observations is not only used in day-to-day operational weather forecasts and climatological studies but also contributes to improvement in the Synchronous Meteorogical Satellite (SMS) system. ATS 1 and 3 previously have provided much useful information in planning SMS.

Keeping Satellites on Station

Another experiment is aimed at keeping synchronous stationary satellites from drifting. East/west drift of a satellite is due to the fact that the cross-section of the Earth at its equator is elliptical rather than circular. North/south drift is due to the gravitational attractions of the Sun, Moon, and even Jupiter on the satellite. The ability to counter these forces is called station keeping.

In this experiment, NASA tests use of advanced ion engines for long term station keeping. Ion engines produce tiny amounts of thrust by ionizing (stripping electrons from atoms) and accelerating a propellant such as cesium. Also called electric rockets, they have such attributes as longevity, variable thrust, no moving parts, and easy turn-on and turn-off, such as is possible with a light switch. Less advanced ion engines were tested on ATS 4 and 5.

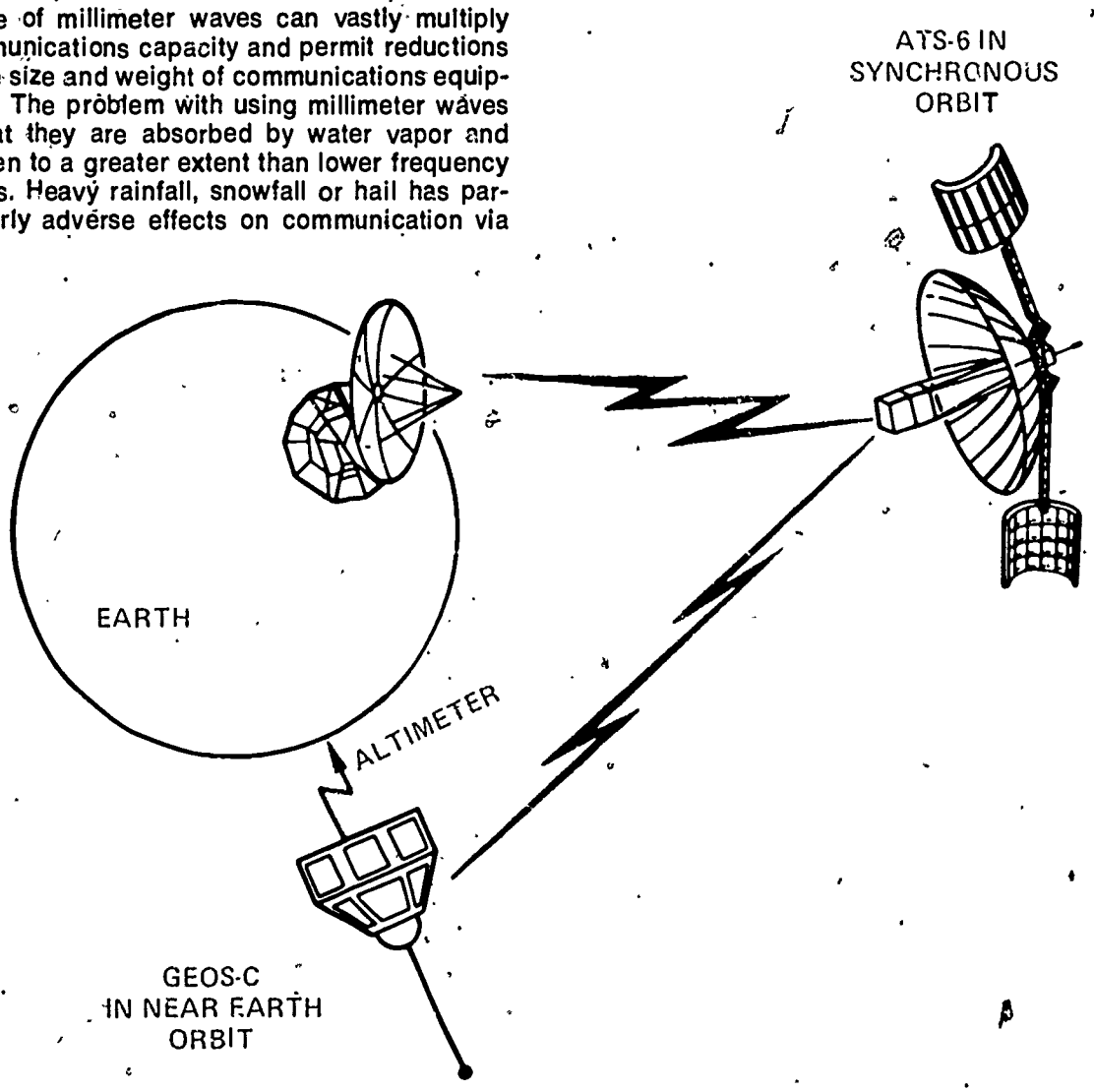
Communications Technology

Another ATS 6 experiment tests so-called frequency band windows in millimeter wave radio frequencies (above 10GHz or 10 billion Hz range). For comparison, the typical TV frequency band, including VHF and UHF, ranges from about 50 to 900 MHz (50 million to 900 million Hz).

Use of millimeter waves can vastly multiply communications capacity and permit reductions in the size and weight of communications equipment. The problem with using millimeter waves is that they are absorbed by water vapor and oxygen to a greater extent than lower frequency waves. Heavy rainfall, snowfall or hail has particularly adverse effects on communication via these waves. However, there are some frequency band windows where water vapor and oxygen absorption submillimeter waves is low.

In the ATS 6 experiments, millimeter waves in selected frequencies are beamed to special ground stations in the United States and Canada. Weather conditions and their effects upon the waves will be monitored at each station.

Another communications test, called RFI (Radio Frequency Interference), is expected to provide information that will permit more effective use and regulation of radio transmissions by identifying the nature of interference with satellite communications by ground communication systems. The data obtained will also contribute to improvement in design of future communications satellites.



Technology Experiments

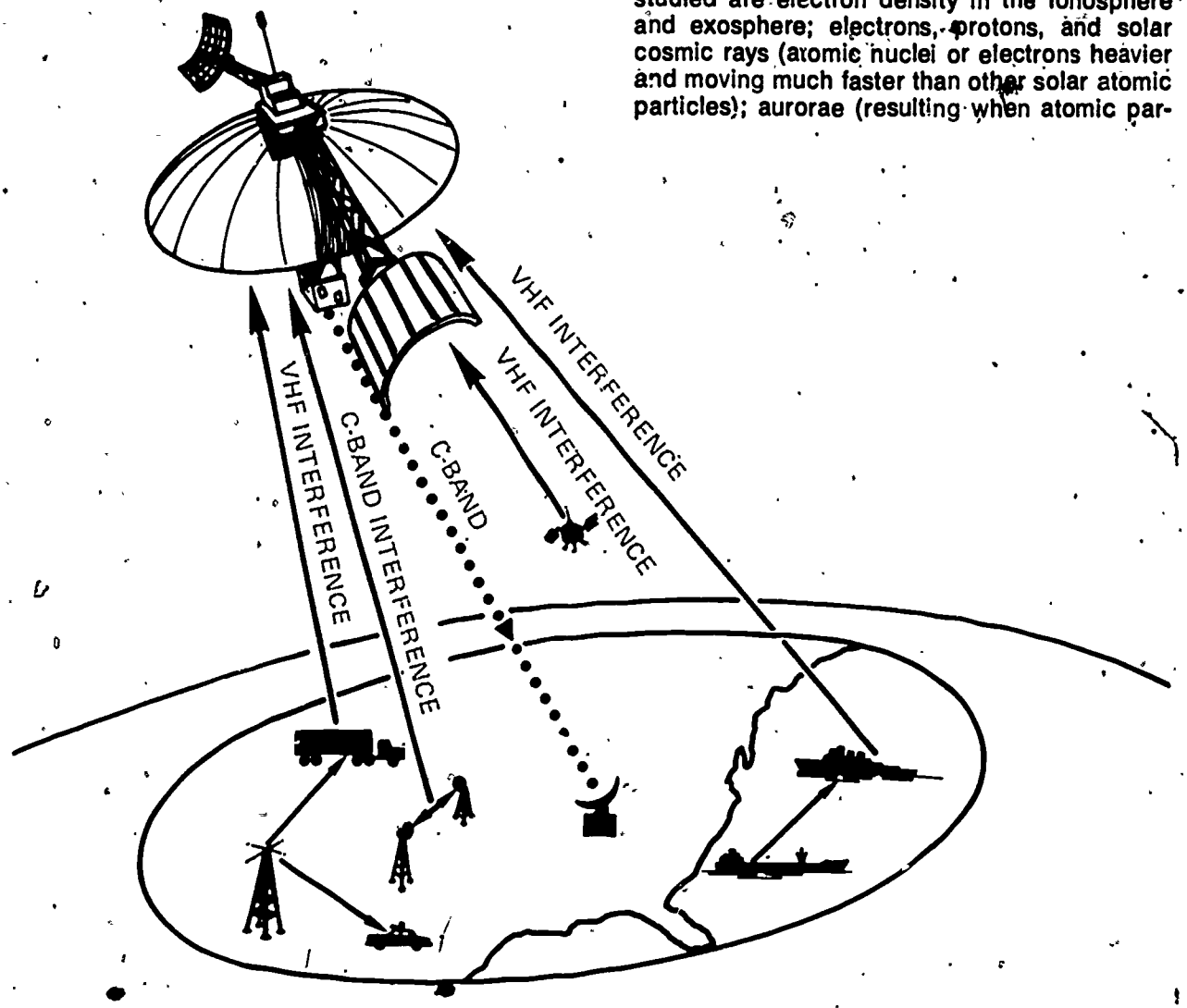
An idea that would transfer spacecraft control from space to computers on the ground is being tested in the Spacecraft Attitude Precision Pointing and Slewing Adaptive Control (SAPP-SAC) Experiment. The chief advantages of such control would be reductions in weight and size of the spacecraft and increase of reliability as complex systems that might need repair would be on the ground rather than in space. For this experiment, a ground-based computer is programmed to reorient ATS 6 several times.

The Advanced Thermal Control Flight Experiment (ATFE) is aimed at testing advanced temperature control systems and comparing their effectiveness in stabilizing temperatures of spacecraft components. The new devices would keep temperature variations within 3 degrees.

Other ATS 6 experiments include testing the most precise Earth-pointing orientation system yet flown on a spacecraft (to about one-tenth of a degree, as noted earlier) and evaluating the damage of radiation in space on different makes of solar cells. (Solar cells turn sunlight to electricity for powering a spacecraft.)

Space Environment Data

ATS 6 will also conduct a set of scientific experiments called EME, for Environmental Measurements Experiments. These will provide data on the space environment at synchronous altitude (35,680 km). Among phenomena to be studied are electron density in the ionosphere and exosphere; electrons, protons, and solar cosmic rays (atomic nuclei or electrons heavier and moving much faster than other solar atomic particles); aurorae (resulting when atomic par-



ticles from space interact with atmospheric atoms and molecules); Earth's magnetic field; and acceleration of atomic particles from space by Earth's magnetic field. Experimenters will also determine effects of these particles and fields on radio communications and communications equipment.

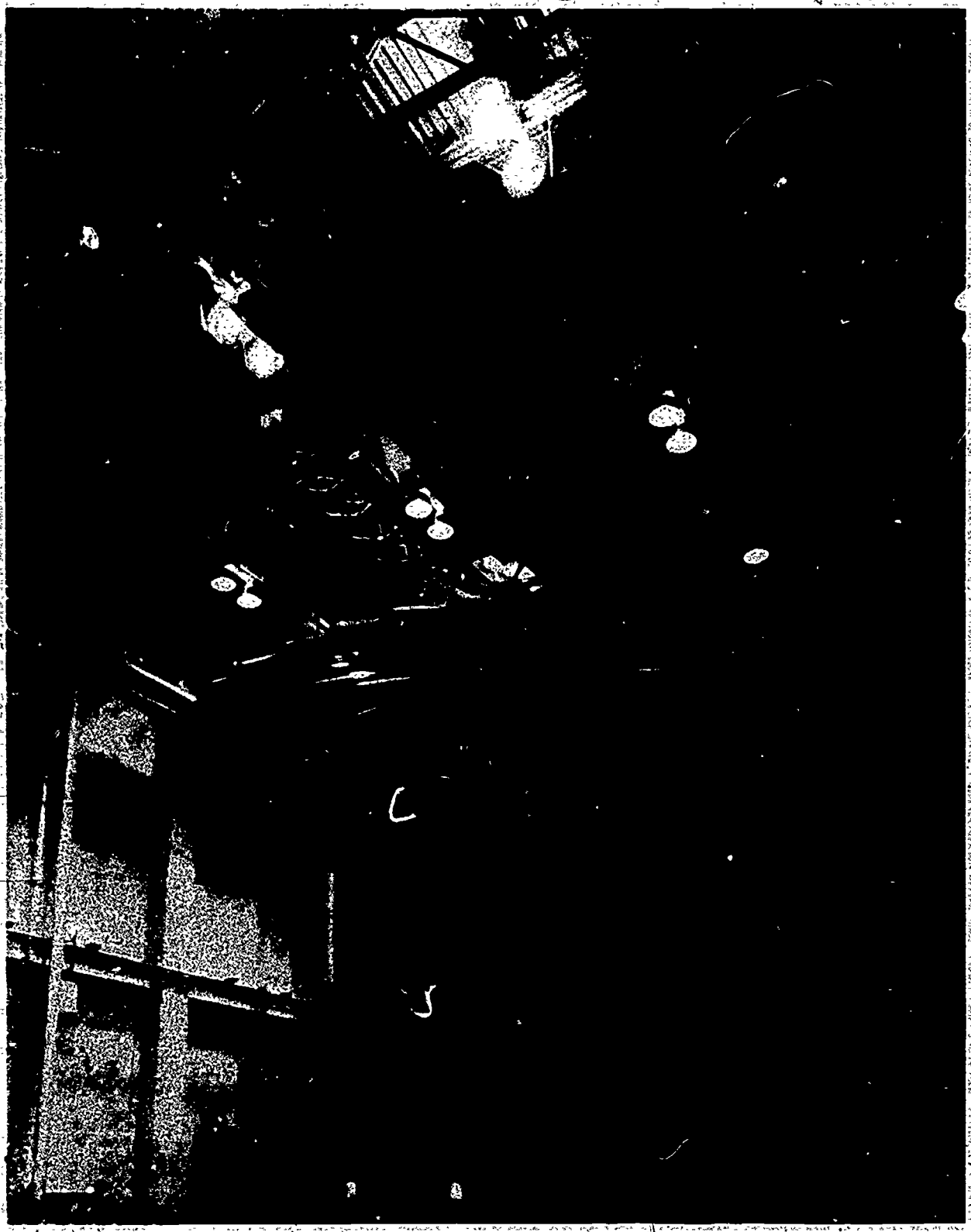
Prior ATS Experience

Five Applications Technology Satellites preceded ATS 6. Their launch dates and launch vehicles and brief summaries of results are presented below.

- ATS 1, launched December 7, 1966. It not only conducted experiments but also provided operational communications and meteorological services. The satellite is still in use. HEW has employed ATS 1 since 1971 in an experiment to improve the health care of native Alaskans by making possible reliable voice communication between Public Health Service physicians and health aides in remote Alaskan villages. ATS 1 is augmenting voice links in HET.
- ATS 2, launched April 6, 1967, was lost because of launch vehicle failure.
- ATS 3, launched November 5, 1967, like ATS 1, supported communications and meteorological operations while performing numerous advanced experiments in these fields. One of its significant firsts was its experimental relay on November 21, 1967, of conversations between the communication engineer of a Pan American Airways airliner over the Atlantic and officials in the United States. ATS 3 is augmenting voice communication in HET.
- ATS 4, launched August 10, 1968, did not reach proper orbit because of launch vehicle malfunction. It burned up during entry into Earth's atmosphere on October 17, 1968.
- ATS 5, launched August 12, 1969, performed a wide variety of scientific and technical experiments relating to tracking objects on the ground, on water, and in the air and a number of advanced communication experiments even though an uncorrectible stabilization failure precluded payoffs from 6 of its 13 experiments. The satellite is being used in PLACE.
- ATS 1 through 5 weighed 700-800 kilograms (1500-1700 pounds) at launch. ATS 1 through 3 were launched by Atlas-Agena rooket vehicles; ATS 4 and 5, by Atlas-Centaur.

The ATS program is concluded with ATS 6. But its experiments will have paved the way for benefits to mankind for years to come.

ATS-6 goes on its way as Air Force Titan III-C lifts off from Complex 40 at Cape Canaveral, May 30, 1974.



Spacecraft gets final systems test and checkout at contractor's Maryland plant before shipment to Florida for launch.

☆ U.S. GOVERNMENT PRINTING OFFICE : 1975 O—571-839

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402
Price 45 cents Stock Number 033-000-00600-4