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DEPARTMENT OF DEFENSE
OFFICE OF PUBLIC AFFAIRS
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NO. 701-60
OXford 75131

FACT SHEET

PROJECT TRANSIT IIA
LAUNCH VEHICLE

The vehicle to be used in the launch of the TRANSIT IIA satellite is an Air Force two-stage Thor-Able-Star missile. It stands over 79.3 feet tall and weighs more than 105,000 pounds at the time of lift-off.

This is the second time that the Air Force has used the Thor-Able-Star combination in the TRANSIT satellite series.

In the TRANSIT IIA Project, the Air Force is responsible for the launch vehicle, mating of the payload to the vehicle, the launch powered flight and orbital injection of the satellite; the Navy is responsible for the satellite, the conducting of the experiments contained therein, and the reduction of data obtained from the experiment.

Here is a breakdown of the Air Force Thor-Able-Star missile:

First Stage

Air Force Thor, intermediate range ballistic missile, minus guidance and modified to receive additional stages.

Weight -- Over 100,000 pounds
Thrust -- Approximately 150,000 pounds

The liquid-fueled Thor propels the vehicle for about 160 second after launch. During this period of time, the rocket is controlled by roll and pitch programmers.

Second Stage (Air Force Able-Star Orbital Vehicle)

Propulsion: Aerojet General Able-Star engine with a thrust of 7,890 pounds.

Weight -- Over 1,000 pounds
Length -- 14 feet 10 inches
Diameter -- 4 feet 7 inches
Fuel and Oxidizer -- Inhibited Red Fuming Nitric Acid, UDMH (Unsymetrical Dimethyl hydrazine)

MORE

Description: The Able-Star has a total burning time of approximately 300 seconds. The first 285 seconds of thrust will be used for initial orbital injection. The remaining burning time will be used, if needed, to inject payload into final orbit.

The Able-Star vehicle was developed from the original Air Force Able stage by ARPA. Able stages were used on Pioneer, Explorer, Tiros, Transit I and other space launches. Aerojet-General built the propulsion system for Able-Star. Space Technological Laboratories built the attitude control and guidance system.

Attitude control for Able-Star during non-power flight is accomplished through 8 small jet nozzles which control pitch, roll and yaw. This system uses a total of 14.8 pounds of pressurized nitrogen gas. The Able-Star system has a total operating life of about 10 minutes.

E N D

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NO. 709-60
OXford 7-6161

FACT SHEET: PROJECT TRANSIT II-A SATELLITE & EXPERIMENT

SATELLITE VEHICLE
36-inch sphere
223 lbs.

PAYLOAD
Two ultra-stable oscillators, in temperature resistant flasks, each capable of transmitting continuously on two frequencies.
Antenna: silver painted spiral band
Solar cells and storage batteries
Infrared scanner to measure satellite's rotation
Electronic clock as a time standard
Canadian receiver to measure galactic noise
Pickaback satellite for additional study of nature and effect of ionosphere

FREQUENCIES
54, 324, 162, 216, and 108 megacycles

ORBIT
Intended orbit near circular, altitude about 500 nautical miles, inclination about 67 1/2° with the equator providing an expected satellite life of more than 50 years. Faintly visible, weather permitting, in parts of U.S.

GROUND TRACKING STATIONS
Johns Hopkins University, Applied Physics Laboratory field station, Howard County, Maryland
University of Texas, Austin, Texas
University of Washington, Seattle, Washington
University of New Mexico, Las Cruces, New Mexico
U.S. Naval Air Station, Argentia, Newfoundland, Canada
Royal Aircraft Establishment, Lasham, Hants, England
San Jose' dos Campos, Brazil

RESPONSIBILITY ASSIGNMENT
Development of navigation satellite payload: Navy's Bureau of Naval Weapons
Launch into orbit: Ballistic Missile Division, U.S. Air Force

PRIME CONTRACTOR
Johns Hopkins University's Applied Physics Laboratory, Silver Spring, Maryland

NAVAL ACTIVITIES
U.S. Naval Ordnance Test Station, China Lake, California
U.S. Naval Weapons Laboratory, Dahlgren, Virginia

TRANSIT II-A is the second satellite launched in the Navy's program to develop an all-weather, global navigational system which would be used by all nations of the world.

The first satellite launched April 13, now circling the earth at heights of approximately 230 to 465 miles constantly provides new and important data on the ionosphere, its effect on satellite signals, as well as telemetered data to assist in improving subsequent TRANSIT vehicles. Orbiting of several satellites is contemplated before the TRANSIT system is operational.

The new satellite is similar in appearance to its predecessor, both being 36 inches in diameter, and utilizing a band antenna which spirals the exterior. Both the I-B and II-A operate on the same four frequencies. The heart of each satellite consists of two ultrastable crystal oscillators, each of which generate two of the four transmitted signals.

Unlike I-B, the new sphere will be dependent completely upon solar cells to generate power for the transmitters. The first satellite carried an auxiliary chemical battery as a precaution. Also new is a digital clock or time standard based upon the ultrastable oscillators which may open the way to providing a world-wide time standard to replace the chronometers in ships.

The II-A will carry pickaback a 40-pound [redacted] satellite to measure solar radiation. It will be released from the TRANSIT satellite after orbital injection, and will operate independently.

A special antenna and receiver to detect cosmic noise beyond the ionosphere will also be a passenger. It was developed by the Defense Research Telecommunications Establishment of Canada. The new TRANSIT satellite will also include an improved telemetering system, a greater number of solar cells, and will be 42-pound lighter than its older sister. Like the I-B, the new satellite carries an infrared scanner which was developed by the Naval Ordnance Test Station, China Lake California, to measure the rotation of the sphere.

PURPOSE

Project TRANSIT is designed to develop and demonstrate equipment to provide a reliable means of fixing the position of surface craft, submarines, and aircraft anywhere in the world, and in all weather conditions, more precisely than has heretofore been possible, and to provide under any weather conditions more accurate means of maritime and aerial navigation than is now available.

TECHNIQUE

The launching of the second experimental TRANSIT satellite is another phase in the development of the navigational system. This test is based on the capacity of the ground stations and a computing center to extract positional information from the signals of the TRANSIT satellites.

As measured from a ground station, the signals from the ultrastable oscillators in a satellite change frequency as the satellite approaches and passes over the ground station. This phenomenon, known as the Doppler shift, is the key to the navigational system. By measurement of this shift, the future orbit of the satellite can be predicted perhaps several days ahead. This information, provided through another satellite signal, will permit ships at sea to mark their positions with a high degree of accuracy in any weather.

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TRANSIT II-A, like TRANSIT I-B, will transmit on four widely separated frequencies to provide broad experimental control. The change in frequency of the signal will be checked automatically by a ground station against a time and frequency standard. This information will be teletyped to a computing center where the satellite's position can be accurately computed. Since the Doppler shift is a direct measure of the rate of change of distance between the transmitter and the receiver at a known location of the ground, future positions of the satellite can be calculated as the satellite's orbit is governed by astronautical laws. Navigation is analogous to tracking and the reverse of the tracking procedure will be used. Since the satellite's positions at future times will be known, Doppler data received by a navigator at one of these future times may be used to determine his position on the surface of the earth.

The operational navigational system will consist of several satellites and a network of stations at altitudes and positions optimum for accurate tracking. In the operational system, however, a ground station will transmit to the satellite its orbital data for a minimum of one day in the future which will be recorded on magnetic tape. Thereafter, until new orbital data are transmitted, the satellite circles the earth transmitting on two stable, harmonically related frequencies. Thus navigators will need only special receiving equipment to obtain their positions from the satellite. There will be no need to trigger or interrogate the satellite.

Operational satellites will weigh 50 to 100 pounds, and will be designed to have an operational life of 5 years. They will contain a miniaturized digital memory for storing orbital information received from the ground station and a modulator for pulse-modulating this information on the transmitted frequencies for retransmittal to the navigating stations. The satellites will be completely transistorized and will use solar power.

TRANSIT II-A

The United States has orbited a second TRANSIT experimental satellite, TRANSIT II-A, in a program to establish an all-weather global navigational system, far more precise than any yet devised.

Launched from the Atlantic Missile Range, Cape Canaveral, Florida, the spiral-striped, 223-pound sphere was successfully launched into orbit by a two-stage Thor-Able-Star vehicle. The first TRANSIT experimental satellite successfully launched was the I-B. It was launched into orbit on April 13, 1960, by a two-stage Thor-Able-Star vehicle at Cape Canaveral. An earlier attempt to launch TRANSIT I-A into orbit on September 17, 1959, was unsuccessful due to failure of the Thor-Able second and third stages to separate properly.

The purpose of the experiment is to demonstrate the feasibility of a new navigational concept which would be a major scientific breakthrough and prove a boon to all nations of the world to whom it would be made available when operational.

The development of the specific system is carried out under the direction of the Bureau of Naval Weapons by the Applied Physics Laboratory of The Johns Hopkins University, Silver Spring, Maryland, who originated the concepts on which the specific system is based. Commander W.L. Clark, USN, has responsibility for the Bureau of Naval Weapons, while Dr. R. B. Kershner of the Applied Physics Laboratory directs the technical program.

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TRANSIT II-A DESCRIPTION

TRANSIT II-A is similar to the I-B in appearance and function. It is a 36-inch diameter sphere and weighs approximately 223 pounds. Structurally, it consists of a shell divided into two hemispheres, a central support tube, an instrument tray, and a cylindrical radiation shield. The shell is a lamination consisting of two pieces of Fiberglas with a honeycomb plastic filler. The tube, made of pressure-laminated Fiberglas, connects the hemisphers and supports the instrument tray. The tray and its outer lacing ring is tied to the cylindrical radiatio sheild. This shield, familiarly called "the bellyband", also serves as an attachment ring for the hemispheres and the solar panels.

The components on the tray include two transmitting systems, each containing an ultrastable oscillator and transmitting continuously on two frequencies. The frequencies are 54 mc and 324 mc, and 162 mc and 216 mc, respectively.

Also on the tray are two command receivers that change operational modes of the satellite in accordance with signals received from a ground station, a telemetry system that sends temperature and other data to the ground stations, a despin system that stops the spin of the satellite at a set time, a digital clock that acts as a time standard for the receiving stations, an infrared scanner that measures the rotation of the satellite before despin occurs, a Canadian receiver that measures galactic noise; and nickel-cadmium storage batteries that are paralleled to the solar panels.

A radiation and insulation shield is over the tray and one under the tray. Four metal rods of high magnetic permeability, part of the despin system, are mounted on each shield.

Two banks of solar cells and two despin weights are mounted on the "bellybanc Broadband antennas are painted on the shell in a spiral pattern.

TRANSIT II-A will carry in pickaback fashion a 40-pound satellite called [redacted] which will be used to measure solar radiation. After orbital injection, [redacted] will be released from TRANSIT and will operate independently.

DESPIN SYSTEM

It is necessary to spin the satellite about its axis during the launching operation. This spin causes an undesirable shift in the Doppler frequency transmitted by the satellite. Mechanical and magnetic devices have been installed in the satellite to stop its spin motion after it is in orbit.

The mechanical device consists of two weights attached to cables that are wrapped around the satellites equator. After seven days in orbit a preset timer causes these weights to fly out and separate from the satellite thereby causing a spin-stopping action.

The magnetic despin device consists of magnetic rods wrapped with a short-circuited coil of wire. As the satellite spins in the earth's magnetic field it causes the rods to be magnetized first one way and then the other. To magnetize the rods in this manner requires energy which is supplied by the spin of the satellite. The satellite twists against the earth's magnetic field with a dragging action similar to a ball spinning in a sticky liquid. This action causes the satellite's spinning motion to stop completely within several days after the mechanical weights are deployed.

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TEST OBJECTIVES

TRANSIT II-A, like TRANSIT I-B, will supply the tracking stations with data from which the following objectives are expected to be realized:

1. A basis for navigation trials and demonstrations in elementary form.

2. An improved understanding of the effects of ionospheric refraction of radio waves at higher latitudes.

3. Increased accuracy in geodetic measurement such as a better knowledge of the earth's shape and the distances between land masses and of the earth's gravitational field.

4. Improved orbital tracking.

TRANSIT II-A will also provide an accurate time standard for TRANSIT tracking stations.

An infrared scanner is a passenger in the II-A satellite, as in the I-B, to attempt to measure the rotation of the satellite. It was designed and built by the Naval Ordnance Test Station, China Lake, California.

The galactic receiver with its antenna is also a passenger in TRANSIT II-A. This equipment will measure the cosmic radio noise levels above the ionosphere. It was designed by the Defense Research Telecommunications Establishment, Ottawa, Canada. This experiment in the TRANSIT satellite is in preparation for the launching of the top side ionosphere sounding satellite being conducted by DRTE.

END

CANADIAN RECEIVER

A Canadian Receiver with its antenna is a passenger in TRANSIT II-A. This equipment will measure the cosmic radio noise above the ionosphere. It was designed by the Defense Research Telecommunications Establishment, Ottawa, Canada. This receiver and its antenna will detect cosmic noise at a frequency of 3.8 mc. The information of the noise levels measured will be telemetered to the ground stations where it will be decoded.

After one week the Canadian equipment will be shut off, and the satellite will continue its normal functions. At this time the satellite spin will be stopped by releasing the despin weights that also serve as the DRTE antenna. The antenna will be cut loose when the satellite stops spinning.

This experiment in the TRANSIT satellite is in preparation for the launching of the top side ionosphere sounding satellite being conducted by DRTE. The receiver in the TRANSIT satellite is similar to the equipment that will form part of the top side sounder.

BACKGROUND

The TRANSIT navigation system is based upon the ability to extract extremely accurate positional information from the measured Doppler shift of a satellite's transmitter during a single passage of the satellite over a tracking station or ship's receiver.

The Doppler shift is the measurement of the change in frequency of a radio signal continuously transmitted from a satellite. This change, or shift, is caused by the satellit's motion relative to a receiving or tracking station.

This phenomenon was first stated by Christian Doppler, an Austrian physicist, in 1842, but its application to precision tracking of an artifical satellite was discovered by two Applied Physics Laboratory scientists, Dr. William H. Guier and Dr. George Weiffenbach.

It was Dr. F. T. McClure, head of the Research Center of the Applied Physics Laboratory, who recognized that the Doppler shift phenomenon could also be used to locate accurately a receiving station and recommended to Dr. R. E. Gibson, Director of the Laboratory, the study of the Doppler shift as a basis of a new method of navigation. Dr. McClure is thus credited as the originator of the TRANSIT navigational system.

GROUND STATIONS

TRANSIT II-A is being tracked in its orbit by seven ground stations which are recording the signals broadcast on four frequencies of 54, 324, 162 and 216 megacycles. The headquarters station to which is being flashed the recording of the signals from the satellite picked up by the other stations, is located in the Howar County, Maryland, Applied Physics Laboratory.

Other stations are located at the Defense Research Laboratory of the University of Texas, Austin, Texas; the New Mexico State University, Las Cruces, New Mexico; the University of Washington, Seattle, Washington, and the U.S. Naval Air Station, Argentia, Newfoundland, Canada. The last two are van-mounted. A sixth station has been provided with the cooperation of the British Government at the Royal Aircraft Establishment, Lasham, Hants, England. A new seventh station has been provided with the cooperation of the Brazilian Government at San Jose' dos Compos, Brazil.

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NAVY NAVIGATIONAL SATELLITE
TRANSIT II-A LAUNCHED TODAY

The Navy's second navigational satellite, TRANSIT II-A, was launched into orbit June 22 on the nose of an Air Force Thor-Able-Star missile from the Atlantic Missile Range, Cape Canaveral, Florida.

It marked another major step in the Navy's program to provide a world-wide, all-weather, navigational system which could be used by all nations on earth. Several satellites will be placed into orbit before the navigational system is operational.

TRANSIT II-A is 36 inches in diameter, weighs 223 pounds, and was launched to achieve a near circular orbit at an altitude of about 500 nautical miles and at an inclination of 67 and-a-half degrees to the equator. The sphere is expected to have a life of more than 50 years, and may be faintly visible in parts of the United States.

Object of the high orbital latitude is to expose the satellite to the more intense disturbances of the ionosphere. The intended orbit will also carry the II-A over areas of the earth not covered by its older sister, the I-B, first navigational satellite placed in orbit on April 13. The new satellite in a higher orbit than that of I-B will be affected differently by the bulges of the earth which it will survey. Contrary to popular opinion, the earth is not a perfect sphere, but bulges at the middle. This is an important consideration in determination of the geodetic information which the TRANSIT system is expected to relate.

The TRANSIT program is being developed by the Applied Physics Laboratory of the John Hopkins University for the Astronautics Group of the Bureau of Naval Weapons. Sponsorship of the program was recently transferred to the Navy from the Advanced Research Projects Agency.

Similar in appearance and function to the I-B, the new sphere will transmit the same four frequencies of 54, 324, 162, and 216 megacycles, and utilize the same spiral band antenna, painted around the outside of the satellite. It also contains, as did I-B, an infrared scanner developed by the Naval Ordnance Test Station for measuring the rotation of the satellite.

New in the II-A is the digital clock or time standard which could lead to a new global time system, itself a significant change in the pattern of navigation. The satellite will be completely solar powered, and include twice as many solar panels as its predecessor. A nickel-cadmium battery will store power for use by the satellite when it is not in the sunlight. The I-B utilized a separate transmitting system powered by chemical batteries as a precaution.

MORE

The heart of the satellite consists of two ultrastable oscillators, each of which generates two of the four frequencies. The signals are picked up by seven ground stations which relay them to the Applied Physics Laboratory where they are interpreted.

Riding pickaback on the TRANSIT II-A is a 20-inch solar radiation measurement satellite designed to detect and analyze solar radiation and provide new information on the ionosphere. Bound to the TRANSIT by a metal ring, the 40-pound unit is hurled from the TRANSIT by a spring, after orbital injection from the second stage rocket. This satellite which was designed and developed by the Naval Research Laboratory, is programmed to travel in the same orbit as the II-A TRANSIT but a short distance ahead of it. The NRL satellite will have an operational life of one year, the life of its chemical batteries, although it may remain aloft as long as 50 years.

The II-A also carries an experimental receiver and antenna for measurement of the cosmic noise above the ionosphere. It is a guest in the TRANSIT and was designed by the Defense Research Telecommunications Establishment, Ottawa, Canada, to detect cosmic noise at a frequency of 3.8 mc. The information of the noise levels measured in the satellite is telemetered to the TRANSIT ground stations where it is decoded. After a week, the Canadian equipment will be shut off and the satellite will continue its normal functions. The DRTE antenna is connected to the II-A despin weights. After seven days, these weights are released to fly out and separate from both sides of the sphere. This will have the effect of bringing the TRANSIT satellite to a near-stop, and the weights will then be cut loose. Magnetic bars within the satellite, acting against the earth's magnetic field, will remove any residual spin.

Telemetered data from the I-B satellite revealed a reduction in the spin from 2.815 to 0.004 revolutions per second with the operation of its despin devices.

The TRANSIT ground stations, including one in Newfoundland and one in England, have been able to track the I-B with precision from time to launch. From this tracking information excellent orbits have been determined and the relative positions of several TRANSIT receiving stations have been determined to within a few hundred feet of the surveyed positions. Results to date clearly indicate the feasibility of using the TRANSIT system to perform navigation with the precision that may be required for any military application.

E N D

The final operational system will consist of a family of satellites and stations at altitudes and positions optimum for tracking. The type of signals providing Doppler data will remain as in the TRANSIT I-B and II-A, except that in the operational system an injection station will transmit back to the satellite its orbital parameters for a minimum of one day in the future. Thereafter, until new orbital data are injected, the satellite orbits around the earth transmitting on two very stable, harmonically related frequencies. Thus, navigators need only use special receiving equipment to obtain from the satellite their positions. The navigational fix can be made in any weather, and there is no need for the ship or station to interrogate the satellite.

Operational satellites would weigh 50 to 100 pounds, have a useful life of several years, and contain a stable oscillator. They will also contain a miniaturized digital memory for storing orbital information received from the injection station plus a modulator for pulse-modulating this information on the transmitted frequencies for re-transmittal to the navigating stations. The satellites will be completely transistorized and will use solar power.

ANTENNA

An unusual and highly versatile antenna, painted as a silver spiral band around the surface of each TRANSIT satellite is part of the vital communications link between the sphere and the stations and ships which it will serve.

Instead of providing a separate antenna for each frequency being transmitted, the broad band antenna in the form of a logarithmic spiral is used to transmit all four frequencies. The silver spiral pattern is painted onto the outside of the fiberglass radomes and is coated on the inside with a gold film to deflect the heat coming from the sun.

The radiating fields are confined to the edges of the conducting surface of the silver paint. Over-all, the logarithmic spiral design of the antenna around the sphere resembles that on a barber's pole.

In order to determine some of the navigational errors, four frequencies will at first be utilized. Once the most desirable frequencies have been determined, only two frequencies will be required.

The frequencies are controlled by two stable oscillators which are housed in Dewar flasks (temperature resistant jugs) because thermal changes would alter the frequencies of the oscillators. The chemical batteries and banks of solar cells (on the outside of the sphere) power the four transmitters. TRANSIT I-B has an auxiliary chemical battery as a safety factor. The II-A relies completely upon solar power.

Contained also in the satellite are two receivers, two telemetering gathering and sending devices and an infra-red scanning system.

The antenna for the Canadian receiver is an integral part of TRANSIT II-A's despin weights. The antenna and weights are released when despin of the satellite occurs.

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BACKGROUND INFORMATION ON TRANSIT

HOW IT WORKS

The feasibility test of a new navigational system launched by the orbiting of TRANSIT I-B experimental satellite and continued by the orbiting of the TRANSIT II-A experimental satellite is based upon the capacity of seven ground receiving stations and a computing center to extract positional information from the signals of an orbiting sphere.

The signals as measured on the ground, although originating in an ultra-stable oscillator, nevertheless change their frequency as they approach and pass over the ground station. This change caused by the movement of the satellite is called the Doppler shift. It is the key to the entire TRANSIT system.

Measurement of this Doppler shift permits scientists of the Applied Physics Laboratory to predict the future orbit of the satellite, perhaps days ahead. These data, when later provided to ships through another satellite signal will permit them in any weather to mark their positions to a high degree of accuracy. Also, the TRANSIT system will permit man finally to measure the sizes of land masses and the distances between points on them.

If orbit is achieved, the TRANSIT II-A will become the second pioneer satellite of the system which is expected to be operational in 1962.

The satellite is designed to transmit on four widely varied frequencies to provide room for experimentation. Each signal is controlled by the ultrastable oscillator in the satellite. The received signal is speeded up or slowed down (frequency change) as a result of satellite (transmitter) motion. This change in the frequency of the signal is picked up by the receiver in the ground station. It is checked automatically against a time and frequency standard and reveals at the station the change in the signal frequency. This change is the Doppler shift.

Doppler shift data are teletyped to the computer center at the Applied Physics Laboratory in Howard County, Maryland. Here, APL scientists use the Univac 1103--a high-speed digital computer--to calculate satellite positions. These calculations are possible since the Doppler shift is a direct measure of the rate of change of the distance between the transmitter in the satellite and a receiver on the ground. If the position of the ground receiver is known, the position of the satellite transmitter can be calculated. Future positions of the satellite can be calculated since satellite rotation around the earth is governed by strict astronomical laws. Navigation occurs analogously to satellite tracking. Actually, the reverse of the tracking procedure is used. Now that the satellite's position is known at future times, Doppler data received by a navigator at one of these future times may be used to calculate his position.

While TRANSIT II-A, as well as TRANSIT I-B, is aimed at determining the feasibility of the Doppler navigation system, it will also initiate geodetic measurement and analysis, and provide data for a better understanding of the effects of ionosphere refraction of radio waves. Eventually, the composition of the ionosphere in terms of electron densities will be determined.

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TRACKING STATIONS

Seven ground receiving stations stretching from England to Newfoundland to the northwest and southwest United States to Brazil are the scientific ears of the Applied Physics Laboratory of The Johns Hopkins University which plots and predicts the orbits of TRANSIT I-B and II-A satellites.

They will receive Doppler data from the TRANSIT I-B and II-A satellites launched from Cape Canaveral, Florida. The string of stations will be the vital receiving posts which will furnish man a new navigational technique and permit scientists for the first time to mark the exact locations of land masses.

The TRANSIT stations are situated at the Howard County site of the Applied Physics Laboratory; at the University of Texas, in Austin, Texas; the University of Washington, at Seattle, Washington; at the New Mexico State University, Las Cruces, New Mexico; the U.S. Naval Air Station, Argentia, Newfoundland; the Royal Aircraft Establishment at Lasham, England, and San Jose' Dos Compos, Brazil.

In the heart of each satellite, APL engineers have installed two stable oscillators. The frequencies are generated from each oscillator. At the ground receiving station, engineers measure the Doppler shift. This measurement is made by determining the amount of time required to receive a preset number of Doppler cycles.

This Doppler shift information is recorded in the ground receiving station and special equipment reduces it to data suitable for the transmission on teletape to the APL computing center at Howard County, Maryland. The next station completes an identical recording and processing function until the total of the information is prepared and transmitted by all of the stations to the big Univac 1103-A at the Applied Physics Laboratory.

With the stations and the computing center, APL scientists will be able not only to mark the parameters of the satellite but also predict its orbital paths for several days ahead.

Once the satellite's future positions are calculated, they can be used by navigators as stable reference points with which to obtain an accurate navigational fix. This is possible since the size of the Doppler shift depends on the rate of change in the position of the satellite and the position of the navigator.

Present techniques have been inadequate to give exact positions on land masses. This means the exact distance, for example, between the top of the Empire State Building in New York City, and the top of the Eiffel Tower in Paris is not known precisely. As a by-product of satellite navigational development, important contributions are expected to be made to the science of geodetics.

A future navigational pattern might well include an injection terminal which would transmit the predicted satellite parameters to the sphere itself. Held in a storage device which could be erased from time to time, the information could be relayed continually to ships and aircraft navigators. Knowing the path or parameters of the sphere, navigators would be able to mark their own positions within a few minutes, under any conditions of visibility anywhere in the world.

Equipment in the station includes a non-directional antenna, stable frequency reference, receiving equipment and facilities for both precisely measuring the Doppler shift and for reducing data to form suitable for transmission.

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THE MANAGEMENT OF PROJECT TRANSIT

The success of Project TRANSIT is due to the cooperation and teamwork of the United States Navy and Air Force.

The Air Force Ballistic Missile Division (ARDC) has responsibility for launc sequence, and the Department of the Navy, Bureau of Naval Weapons, for the over-all payload experiment.

A Thor-Able three-stage missile combination was chosen as the launch vehicle for the first attempt to place a TRANSIT satellite into orbit. The third stage was redesigned and modified to accommodate the Navy's satellite. Air Force and Space Technology Laboratory engineers started working on the complete system to insure proper functioning of the thousands of parts that comprise a complicated space vehicle.

Late in December, 1958, the first of a series of regularly scheduled Technical Direction meetings was held at Air Force Ballistic Missile Division-Space Technology Laboratory. In attendance were representatives of all agencies, both governmental and civilian involved in the project to review, evaluate, criticize correct, modify and discuss what had already been done, and what was proposed to be done.

Through such meetings, progress was made. Problems were encountered and solved. The end result of this teamwork, of these meetings, of this coordination, was an initial launch attempt on September 17, 1959, of TRANSIT I-A which, while unsuccessful in orbiting, provided data to confirm the system concepts. Intensive efforts since September, 1959, resulted in the launching of a second satellite — TRANSIT I-B on April 13, 1960. This improved satellite was injectec into orbit by a completely new two-stage booster vehicle — the Thor-Able-Star. The Thor-Able-Star was also used to launch another improved satellite, TRANSIT II-A, on June 22, 1960. Complete coordination was essential to successful integration of satellite and launch vehicle, and the resulting successful orbiting of both TRANSIT I-B and TRANSIT II-A.

SUMMARY OF TRANSIT I-A OPERATION

Data from the short-lived flight of the TRANSIT I-A navigational satellite from Cape Canaveral, Florida, on September 17, 1959, classed as a failure, has furnished scientists with a complete test of the space vehicle's internal complex and a preliminary confirmation of its feasibility as the basis of a new, more accurate system of world-wide navigation.

TRANSIT I-A was launched by a Thor-Able rocket and the first two stages operated as planned. The third stage was not ignited and the satellite apparently burned up when it entered the atmosphere several hundred miles west of Ireland. The flight lasted twenty-five minutes. Despite this failure the satellite reached an altitude of 400 miles, exactly the altitude planned for the test, and information was received on all four of its frequencies from the moment of lift-off at Cape Canaveral to its destruction. The portable station located at the U.S. Naval Air Station at Argentia, Newfoundland, recorded the same information it would have received on two frequencies, 162 and 216 megacycles, if the satellite had been in orbit.

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In short, although the satellite did not get into orbit it did provide the mechanism for determining in a preliminary way the feasibility of making refraction corrections and determining the orbit by means of the Doppler signals.

By comparing the Doppler signal of the two frequencies received at Argentia, the refraction of the ionosphere has been preliminarily calculated. When this correction was applied to the signal originally received, it yielded a Doppler curve unaffected by ionospheric refraction. The TRANSIT I-A trajectory determined by the Doppler curve was in close agreement with track data obtained by other means.

The flight also exposed TRANSIT I-A to the punishment of launching, accelerated thrust, and later the hard vacuum environment of 400 miles altitude. Continual telemetering recorded all components as operating. Solar cells provided electrical energy utilized by the transmitters. The frequency of the transmitters was off only one cycle per second out of 100 million cycles from pre-launch tests under ideal conditions on the ground.

Although only a partial pass of the satellite was obtained, acquired data indicate that major objectives of the flight were accomplished.

SUMMARY OF TRANSIT I-B OPERATION

TRANSIT I-B was launched into orbit around the earth by a Thor-Able-Star vehciel fired from Cape Canaveral, Florida, April 13, 1960.

At the designated time of injection into orbit, the satellite separated satisfactorily from the second stage of the Thor-Able-Star vehicle and was transmitting on all four Doppler channels. Signals were received at all tracking stations at the expected time of launch. Although some noise was experienced on two frequencies radiated by the satellite, an excellent orbital determination was made a few hours after launch.

Since TRANSIT I-B satellite was injected into orbit it has met several test objectives and notable progress has been made on others. The pickaback satellite separation technique, subsequently used in the TRANSIT II-A to release GREB, was successfully demonstrated, and despin of the satellite occurred.

Telemetered data from the satellite indicate that the temperatures are within design limits and that the solar cell power supply is functioning as designed.

From the tracking data excellent orbits are being determined, and the relative positions of several TRANSIT receiving stations have been determined, and to within a few hundred feet of the surveyed positions.

The use of two frequencies in making corrections for the refraction effect of the ionosphere has proved effective. Investigation of the earth's gravitational field and the geodetic surface of the earth has been started.

The reduction and analysis of the tracking data and experiments on position determinations are continuing, but the results to date clearly indicate the feasibility of using the TRANSIT system to perform navigation with the precision that may be required for any military application.

END

NEWS RELEASE
PLEASE NOTE DATE

DEPARTMENT OF DEFENSE
OFFICE OF PUBLIC AFFAIRS
Washington 25, D. C.

HOLD FOR RELEASE
UNTIL LAUNCH

NO. 711-60
OXford 7-6161

NRL RADIATION MEASUREMENT SATELLITE
PLACED INTO ORBIT WITH TRANSIT II-A

Placed into orbit with the TRANSIT II-A satellite was a 20-inch solar radiation measurement satellite developed by the Naval Research Laboratory, Washington, D. C. The two spheres were clamped together in the nose cone of the rocket and were separated at orbital altitude and injected into orbit separately by a spring.

The NRL device measures solar emissions.

The accuracy of the Doppler measurement by stations tracking TRANSIT satellites is affected by the ionosphere, the multi-layered and electrified belt of thin air that extends from 35 to hundreds of miles above the earth. This layer refracts radio signals sent from the satellite to stations on the ground. Since the intensity of the ionosphere is a function of solar activity, measurements of solar emissions made by the NRL radiation measurement satellite should provide a better understanding of the ionosphere. This, in turn, would be an important step toward perfecting Doppler-navigation.

Since observations of the ionosphere from the earth's surface are limited by the atmosphere and the variability of rocket observations, the NRL satellite constitutes the first above-atmosphere, long-term study of solar radiation. This type of study is vital in that the solar radiation environment in which the earth moves determines almost completely its status as an inhabitable planet.

One of the principal problems with which upper air physics have been concerned is that of the formation of the ionosphere. The latter is strongly solar dependent, with much greater ionization being present during the day than during the night. The nocturnal ionosphere is thought to be the uncombined high altitude remnant of the intense ionization produced during the day. In addition, the ionosphere is electrically denser during the period of sun spot maximum than during sun spot minimum. Furthermore, specific solar events, particularly large solar flares, are followed by an immediate increase in the lowest level of the ionosphere with resulting disappearance of short wave ionospheric reflection.

Since 1950, the solar radiations producing the ionosphere have been measured intermittently from rockets. The measurements have indicated a considerable variability in the short wave X-ray region of the sun's emission. At wavelengths below 20 Angstroms, more intensity has been observed during the recent sun spot maximum than was observed during the low activity period 1953-55. Rocket measurements during solar flares (short-lived brightening of the solar surface in the neighborhood of a sun spot) have given further evidences of this relation between X-ray emission and solar activity. Measurements showed that the larger flares produced greatly increased quantities of penetrating solar X-rays, 2 to 8 Angstroms in wavelength. (MORE)

The Command Receiver - This unit is similar to the Vanguard command receiver providing a sensitivity of -90 dbm (power level in decibels with reference to power of one milliwatt). For security, the detector is followed by a tuned audio amplifier. The detected audio signal operates the command relay. The receiver only responds to the proper carrier frequency when it is modulated more than 60% by the proper audio tone. The command receiver will turn off the transmitter at the end of the useful life of the experiment.

The Antenna System - The sphere has four rigid tube antennas protuding from the equator of the satellite at right angles to each other. Arranged in a plane perpendicular to the spin axis, they provide a signal which will not vary at the spin rate. The system serves for both transmission and reception. The antennas, hinged for folding during the launch, extend by independent spring action as the nose cone falls away.

The Power Supply - The satellite's entire system is powered by a nine-cell, 12-volt storage battery charged by 936 silicon solar cells. These solar cells, which provide two watts of charging power to the chemical storage batteries, are distributed equally among the six circular solar patches symetrically located on the surface of the sphere. Fused silica windows, one-sixteenth of an inch thick, protect the patches from meteoric erosion.

E N D

NEWS RELEASE
PLEASE NOTE DATE

DEPARTMENT OF DEFENSE
OFFICE OF PUBLIC AFFAIRS
Washington 25, D. C.

FOR THE PRESS: JUNE 22, 1960 NO. 720 60
OXford 7-6161

As a result of a joint Navy-Air Force effort, the United States made a major advancement in the realm of space satellites early today by launching two satellites at once.

The Navy's TRANSIT II-A navigation satellite and a radiation measurement satellite developed by the Naval Research Laboratory were launched together by a Thor-Able-Star Rocket from Cape Canaveral at 1:54 A.M.(EDT). At 3:30 A.M.(EDT) the satellites passed over Seattle, Washington confirming their being in orbit. Telemetering data is still being analyzed by the Applied Physics Laboratory of JohnsHopkins University to determine the exact orbit, although preliminary indications are that it is in a much better orbit than TRANSIT I-B which was launched on April 13.

The TRANSIT II-A is a 36-inch sphere weighing 223 pounds. Attached to it by a metal band was the 20-inch solar radiation measuring satellite.

After the second stage of the rocket cut back in to give the necessary speed for orbit, the two satellites seperated from the rocket shell, then a spring seperated the two satellites. Both satellites are broadcasting loud and clear.

END

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