Science in the News

U.S. Meteorological Satellite Cameras Photograph Cloud Cover

The U.S. meteorological satellite TIROS I (for television and infrared observation satellite) was launched at 6:40 A.M. on Friday, 1 April 1960, from the Atlantic Missile Station at Cape Canaveral, Fla. The 270-pound satellite is by far the heaviest yet launched by the United States and has achieved an orbit remarkably close to that desired in both height and inclination. The intended orbit was to have been circular at about 400 nautical miles above the earth's surface; the actual orbit, according to preliminary calculations, is 378.7 nautical miles at perigee and 407.2 at apogee, or 435.5 and 468.28 statute miles, respectively.

The north inclination to the equator of the orbit is 48.327°, which is within 0.0003° of the angle desired. Consequently, the orbit will extend from about 48° north to 48° south latitude, as shown in Fig. 1. The orbital time is 99.15 minutes.

The satellite, shown in Fig. 2, looks like a large hatbox, 42 inches in diameter and 19 inches high. Its top and sides are almost completely covered by banks of solar cells—some 9200 in all. Extending beneath the payload are four transmitting antennas. A single receiving antenna is located on the top.

Primary Mission of TIROS

The primary mission of TIROS is to send back pictures of the cloud cover. Its two television cameras will be able to take pictures every 30 seconds for 32 exposures. The 500-line pictures will be stored on magnetic tape and read off on demand from ground control stations at Fort Monmouth, N.J., and Kaena Point, Hawaii.

In addition to its TV cameras and associated equipment, the satellite contains beacon transmitters, attitude sensors, and telemetry circuits. Power is supplied by nickel-cadmium batteries charged by solar cells. Power output is expected to average about 19 watts.

The two TV cameras differ in coverage and resolution. The side-angle camera is designed to cover, at 400 miles' altitude, an area of cloud cover roughly 800 miles on a side. The narrow-angle camera will photograph a smaller area located within the wide-angle camera's view.

Identical except for lens equipment, each of the cameras is the size of a water glass and has a ½-inch Vidicon tube especially designed for use in satellites. Each camera consists of two parts: a Vidicon and a focal-plane shutter which permits still pictures to be stored on the tube screen. The two TV systems and their associated equipment operate independently of one another.

At the ground stations, pictures will be displayed on Kinescopes for immediate viewing and photographing. Photographic data will also be sent to the U.S. Naval Photographic Interpretation Center for developing and processing.

Around the payload are nine solar sensing cells. They measure the position of the satellite with respect to the sun. This information is transmitted to the ground stations with the TV transmission, where it is processed by a computer to show which direction is north in each picture.

Two beacon transmitters, operating on 108.00 and 108.03 megacycles per second, respectively, each with a power output of 30 milliwatts, will be used for tracking purposes. They can be modulated to provide information on satellite attitude, environmental conditions, and satellite-equipment operation. For back-up purposes, both frequencies carry the same data. Each of the photographic data acquisition stations is equipped with tracking antennas.

When the payload separated from the third stage of the Thor-Able rocket, it was spinning at about 136 revolutions per minute. Pictures taken from a vehicle with this rate of spin would be blurred. About 10 minutes after payload separation a mechanism to slow the revolutions to 12 per minute (within operating limits for the camera) went into operation. The mechanism consisted of two weights attached to cables wound around the satellite. As the weights unwound they slowed the rate of spin and then dropped off automatically.

The satellite is expected to remain stable in its orbit as long as it maintains a minimum spin rate of 9 rev/min. When spin slows to the minimum, ground-activated control rockets will speed the satellite's rotation up to 12 rev/min. There are three pairs of these jets located around the baseplate of the TIROS. Each set can be used once. It is estimated that spin-up will be necessary only every 20 days.

An infrared detector within the payload senses the crossing of the earth's horizon. This information is transmitted to the ground stations for processing to determine the attitude in space of the satellite's spin axis; it also can be used as a basis for computing spin rate.

Since TIROS is spin-stabilized, it will not be "looking" at the earth at all times. On the basis of tracking information, Fort Monmouth and Kaena Point will program the cameras to take photographs only at times when the satellite is viewing the earth and when the area to be photographed is in sunlight. This is done by setting a timer. Program commands can be given as much as 5 hours in advance. Pictures taken while TIROS is out of range of the ground stations will be stored on tape for later relay. In the remote mode, the timer starts the camera, power, and transmitter functions. Each read-out wipes the tape clean. It immediately rewinds for its next recording.

When the satellite is within range of a station, ground command can turn on the cameras directly, and photographs taken above the station will immediately be relayed to earth, bypassing the magnetic tape.

The equipment is expected to operate for about 3 months, but the satellite will stay in orbit for many years.

The first stage of the launching was

an improved Thor intermediate-range ballistic missile with a weight of more than 100,000 pounds and a thrust of about 150,000 pounds. The liquid-fueled Thor propelled the vehicle for about 160 seconds after launching. During this time, the rocket was controlled by roll-and-pitch programmers. During the latter part of the second-stage boost, a plastic nose-fairing covering the third stage and satellite was jettisoned.

The second stage was powered by a liquid-fueled engine which was adapted and modified from earlier Vanguard and Thor-Able rocket vehicles. At the top were six small rockets to spin the third stage. The second stage, which fired immediately after first-stage separation, weighed more than 4000 pounds and had a thrust of about 7500 pounds. It contained a radio-guidance system developed by Bell Telephone Laboratories and Western Electric Company, which is the same as that used in the Titan ICBM. This stage propelled the vehicle for about 100 seconds. At burn-out the spin rockets ignited, causing the third stage and the payload to rotate at 136 rev/min. The spin stabilizes the trajectory of the third stage and payload. About 1½ seconds after the spin rockets fired, the second stage was separated by a retro-rocket.

The third stage was a solid-propellant rocket, adapted from the Vanguard and Able I rocket vehicles. It propelled the payload to orbital velocity (about 18,000 miles per hour), weighed more than 500 pounds, and had a thrust of about 3000 pounds.

The third stage coasted for about 6½ minutes before ignition. It then went into orbit still attached to the payload. Separation occurred about 25 minutes after third-stage burnout when a set of springs forced the third stage and payload apart. Burned out, the empty third-stage casing weighs about 50 pounds.

Responsible Agencies

Over-all responsibility for the project rested with the National Aeronautics and Space Administration, but several government agencies and industrial organizations cooperated in various phases of the assembly and launching.

Meteorologists in the Meteorological Satellite Section of the Weather Bureau will be responsible for analyzing and interpretating the cloud-cover data. Assisting NASA and the Weather Bureau in weather-data analysis will be the Air Force Cambridge Research Center, Allied Research Associates, Air Weather Service, Navy Research Weather Facility, and the Army Signal Corps. The U.S. Naval Photographic Interpretation Center will develop and process photographs before they are distributed for research purposes.

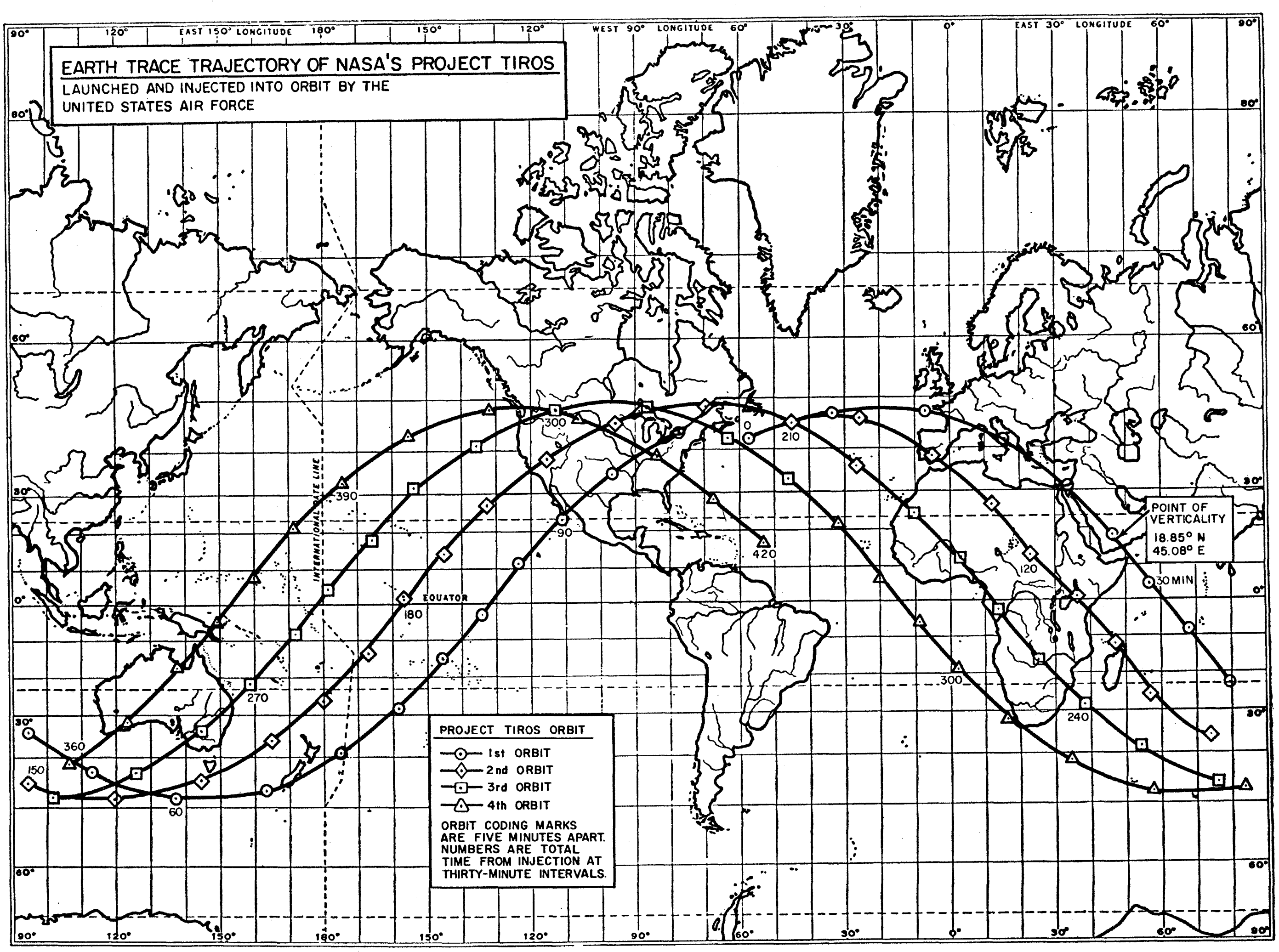

Fig. 1. The orbital path for TIROS I, closely approximated by the actual path. In the next 3 months the satellite will sweep over every point in the belt from 48°N to 48°S. The time after launching given for the fourth orbit near the Greenwich meridian was 330 minutes, not 300.