UNITED STATES DEPARTMENT OF

COMMERCE

John T. Connor, Secretary Washington, D.C.

Environmental Science Services Administration

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LAUNCH OF ESSA SPACECRAFT TO BEGIN OPERATIONAL WEATHER SATELLITE SYSTEM

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Launch is scheduled no earlier than Feb. 2, 1966

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546

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INITIAL TOS LAUNCHING SCHEDULED FEBRUARY 2

The first satellite in the TIROS Operational Satellite (TOS) system will be launched no earlier than February 2, the Environmental Science Services Administration (ESSA) of the Department of Commerce announced today.

The National Aeronautics and Space Administration will launch the weather-observing spacecraft for ESSA from Cape Kennedy.

If the launch is successful, the satellite will be named ESSA I (Environmental Survey Satellite).

Inaugurated by this launch, the TOS system will be the world's first operational weather satellite system and will provide forecasters with daily pictures of the cloud cover over the entire earth, except for those areas in polar darkness.

The system is a result of NASA's meteorological satellite research and development program and the second operational satellite system developed by NASA. The Communication Satellite Corporation's "Early Bird" communications satellite, launched April 6, 1965, by NASA was a direct result of NASA's R&D work with Syncom satellites.

- more -

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TOS is financed by ESSA and is managed and operated by ESSA's National Environmental Satellite Center. Information gathered by satellites in the TOS system will be used by the Weather Bureau (an agency of ESSA) to improve daily weather analyses and forecasts and also will be transmitted throughout the world to aid weathermen in other nations.

Since April 1, 1960, ten TIROS (Television Infrared Observation Satellite) satellites and one Nimbus spacecraft have been launched successfully by NASA. These were NASA research and development satellites, except for TIROS X which was bought by ESSA and launched during the 1965 hurricane season to keep watch on ocean areas.

The ESSA spacecraft is a cartwheel satellite of the TIROS type. As it rolls along in orbit like a wheel, each of the two cameras on its rim will point directly toward the earth once during every revolution. In its nearly polar, sun-synchronous orbit, the satellite will view weather all over the world once every day, photographing a given area at the same local time each day.

The satellite's two camera systems store photographs on magnetic tape for transmission to the Command and Data Acquisition (CDA) stations, which are located near Fairbanks, Alaska, and at NASA's Wallops Station, Virginia.

The TOS system will soon be expanded with the launching of a satellite carrying two Automatic Picture Transmission (APT) camera systems. APT camera systems photograph the clouds over areas beneath the satellite and immediately transmit the pictures automatically to relatively simple receiving stations on the ground.

The APT camera system was tested on TIROS VIII and Nimbus I and proved to be valuable because of its real-time feature in improving local weather forecasts, in briefing air crews on weather over oceans and intercontinental flying routes, and in warning ships of storms and rough seas.

When the TOS system is in full swing, two satellites--one with APT cameras and one with picture storage capability--will be in orbit at all times to provide both local and worldwide cloud cover pictures at least once a day.

(END OF PRESS RELEASE; BACKGROUND DATA FOLLOWS)

TECHNICAL DATA SUMMARY

Spacecraft	Cylindrical, 18-sided polygon, 22 inches high and 42 inches in diameter, weighing 305 pounds.
Mission Objectives	Initiate TIROS Operational Satellite System. Obtain complete daily coverage of weather systems over the earth.
Launch Information:	
Vehicle	Three-stage Delta developing 170,000 pounds of thrust at liftoff.
Launch Pad	Complex 17, Pad A, at the Eastern Test Range, Cape Kennedy, Fla.
Date	No earlier than February 2, 1966.
Orbital Elements:	
Inclination	Near polar and sun synchronous, 81 degrees retrograde to the Equator.
Period	100 minutes.
Orbit	Circular, 460 statute miles high.
Velocity	Approximately 17,000 miles per hour.
Cameras	Two $\frac{1}{2}$-inch vidicons which take more than 400 pictures daily with a resolution of about two miles at picture center.
Power System	9,100 solar cells (N on P) which convert sun energy to electrical energy to keep 63 nickel-cadmium batteries charged.
Tracking	Fifteen stations of the worldwide Space Tracking and Data Acquisition Network (STADAN) operated by the Goddard Space Flight Center.
Command and Data Acquisition Stations	Wallops Station, Va. Gilmore Creek, Alaska.

Program Management	National Environmental Satellite Center, Environmental Science Services Administration, Department of Commerce.
Spacecraft & Launch Vehicle Management	NASA Office of Space Science and Applications, Goddard Space Flight Center.
Launch Operations	Kennedy Space Center
Major Contractors:	
Delta Vehicle	Douglas Aircraft Company
TIROS Spacecraft	Radio Corp. of America

THE SPACECRAFT

The first ESSA satellite, like its TIROS predecessors, is a hatbox-shaped structure. The spacecraft is an 18-sided polygon which weighs 305 pounds, stands 22 inches high, and measures 42 inches in diameter.

9,100 solar cells are mounted on the top and sides of the satellite structure. Protruding from the top of the spacecraft is an 18-inch receiving antenna which receives commands from the data acquisition stations. Four 22-inch transmitting whip antennas, which extend from the bottom or baseplate of the satellite, transmit television pictures, as well as telemetry information on the spacecraft temperature, pressure, battery charge levels, spin rate, and other "housekeeping" data.

TELEVISION CAMERAS

The camera subsystems are two identical $\frac{1}{2}$-inch vidicon cameras, similar to those carried on previous TIROS missions. They have a resolution of about two miles at picture center. Each camera has a wide-angle (104-degree) lens.

The cameras, mounted 180 degrees apart on the side of the spacecraft so they can view the earth once every revolution (every six seconds), are canted 26.5 degrees to each side of the plane of the satellite's rotation. An onboard camera-triggering system programs the cameras to take pictures only when looking at the earth.

The camera system can send pictures directly to a command and data acquisition station or store the photos on its associated tape recorder for readout when the satellite passes within a 1,500-mile radius of a ground station.

DATA ACQUISITION AND ANALYSIS

Picture Reception

Cloud pictures, as well as spacecraft performance data, will be received at two ground stations called Command and Data Acquisition (CDA) stations. These stations are at Wallops Island, Virginia, and Gilmore Creek (near Fairbanks), Alaska.

Transmission time for a full orbit of pictures is about three minutes and begins when the satellite receives a radio command from the ground.

Television pictures are transmitted from the spacecraft as signals which are recorded on magnetic tape at the command and data acquisition stations. These signals are immediately transmitted to the National Environmental Satellite Center, near Washington, D. C., where they are "played back" on special kinescopes and photographed by 35-mm. cameras.

Each of the spacecraft's two tape recorders has sufficient tape to store 48 frames for later transmission. The tapes are erased immediately after playback and again just before recording.

Data Analysis

The picture signals received at the command and data acquisition stations are retransmitted immediately to the Data Processing and Analysis Facility of ESSA's National Environmental Satellite Center.

The signals are projected on special TV screens and photographed by 35-mm. cameras. To locate the pictures geographically, latitude and longitude grids prepared by computer are electronically combined with the picture signals.

Meteorologists use the gridded photographs to produce cloud-cover maps, called nephanalyses. The Weather Bureau's National Meteorological Center then integrates the cloud maps with worldwide weather data obtained by conventional means for use in daily weather analysis and forecasting. The satellite analyses also are relayed to field stations in the United States and to other countries throughout the world.

THE ORBIT

The combination of the cartwheel configuration and the near-polar, sun-synchronous orbit permits complete coverage of the earth's weather.

In a sun-synchronous orbit, the precession (eastward drift) of the satellite is about one degree daily, at the same rate and direction as the earth moves around the sun, so the satellite photographs each area of the earth at the same local sun time every day.

THE FLIGHT PLAN

The launch vehicle for this mission is the NASA-developed three-stage Delta. If successful, it will be the 33rd Delta-launched spacecraft orbited out of 36 attempts. This will be the third polar orbit attempt from Cape Kennedy by a Delta. The two previous successful TIROS launches were on January 22 and July 1, 1965.

For this mission, NASA will use the DSV-3C Delta.

The launch window for Delta 36 is about 30 minutes with lift-off from Complex 17, Pad-A, scheduled for 2:53 A.M. EST.

It must perform three precise "dogleg" maneuvers before it reaches its orbital injection point some 2000 miles southwest of Cape Kennedy over the Pacific Ocean. All commands during the dogleg maneuvers will be initiated from the airborne autopilot system.

During the first-stage burning time, from T plus 90 to T plus 111 seconds, commands from the autopilot will turn the vehicle to the right, changing the trajectory.

When the second stage burns out and the seven-minute coast period begins, Delta will perform its final maneuver. During this period, the vehicle will be pitched down 47 degrees and the nose will be turned left eight degrees so the vehicle is in the proper attitude and trajectory for third-stage ignition and injection into orbit.

The ESSA spacecraft is scheduled to be injected into a sun-synchronous orbit about 300 miles west of Quito, Ecuador (84 degrees west longitude and 0 degrees latitude).

During the first orbit, the satellite will operate in much the same manner as earlier (non-cartwheel) TIROS spacecraft. It will be spin stabilized at about 10 revolutions per minute with the spin axis in the plane of the orbit.

As the satellite starts its second orbit, a gradual orientation maneuver, controlled from the ground, will begin to turn the satellite on its side into the cartwheel position. On command from the ground, electrical currents will pass through a magnetic attitude coil inside the spacecraft which turns the satellite at a rate of about 10 degrees per orbit.

When the satellite is about halfway on its side (spin axis 45 degrees out of the plane of the orbit), the current will be reduced to about half, so that the spacecraft will turn five degrees per orbit.

About 14 to 18 orbits, about 24 hours after launch, the satellite should be on its side, in the cartwheel attitude. After about 36 hours, project engineers will turn on the two television cameras to photograph the earth.

Normal orbital elements are an apogee and perigee of 460 miles, a period of 100 minutes, and an inclination to the Equator of 81.7 degrees (retrograde).

STABILIZATION AND CONTROL SUBSYSTEMS

Two dynamic control (DYCON) units in TOS control the satellite's spin rate, camera timing, and the magnetic attitude coil currents which steer the satellite to the cartwheel attitude and maintain it in that position.

Shortly before the burned-out second stage of Delta separates from the third stage, the entire vehicle spins up to approximately 125 r.p.m. to maintain control of the third stage.

To reduce the satellite's spin rate to the desired 10 r.p.m., a timer triggers two weights attached to cables wrapped around the outside of the satellite. As the weights uncoil, they reduce the spin to the proper rate and then automatically drop away from the spacecraft.

The interaction between the earth's magnetic field and magnetic material in the spacecraft causes a drag effect which reduces the spin rate, making the satellite unstable. To prevent this, the satellite has two types of spin control systems--a magnetic coil inside the spacecraft and small, solid-propellant rockets for backup.

The magnetic coil, made of aluminum, is 30 inches long and is tightly wrapped inside a rectangular spool in the spacecraft. The satellite's spin rate can be kept nearly constant by sending small charges of electric current through the coil.

As a backup method of maintaining the spin rate, five pairs of small solid-propellant rockets mounted on the rim of the spacecraft can be fired upon command from a ground station. Each rocket motor develops an impulse of approximately 1.4 pounds per second. When fired in pairs, these rockets can increase the spin rate by about three r.p.m.

Attitude Sensors

Two infrared horizon sensors arranged in a V configuration determine the satellite's attitude in space. The plane of the V contains the spin axis, and the bisector of the angle between the optical axes is normal to the spin vector.

If the spin axis of the satellite is normal to an earth radius, the outputs of the sensors are identical. If a yaw error exists at one point in orbit, there will be an equal roll error 90 degrees later in orbit because of the inertial rigidity of the spin vector. Roll error is detectable as an inequality in the pulse durations of the two sensors. Because accuracy is determined by the resolution and reliability of each of the data points, at least 10 minutes of roll error data will be required in a given pass. The roll error data will be used by the satellite control center to correct attitude and spin rate errors.

Power Supply

The power supply delivers up to 2.2 amperes and consists of solar cells, storage batteries, voltage regulators, and protective circuits.

Solar energy is converted to electricity by 9,100 N on P solar cells, 1 cm. by 2 cm., attached to the top and sides of the spacecraft cover assembly. The cells are arranged in shingles of five series-connected cells. Each cell has a bonded coat of fused silica to improve thermal emissivity, a vacuum-deposited antireflective coating, and a 6-mm. shield to prevent radiation damage.

During the daylight orbits, power from the solar array is fed directly to spacecraft subsystems. Current not used immediately charges 63 nickel-cadmium storage batteries which have a capacity of 295 watt-hours. The batteries, connected in three parallel strings of 21 cells, supply spacecraft power during the nighttime.

Diodes in the solar cells prevent the storage batteries from discharging into the solar cells during orbital night.

Camera Triggering Subsystem

The camera triggering system is designed to assure that pictures are taken only when the cameras are looking vertically at earth.

Each camera has two independent triggering systems--a self-computing trigger system and a spin-synchronized trigger system. A command from the ground selects the system to be used.

The self-computing trigger system is controlled by an onboard computer which predicts horizon crossings in advance to ready the cameras and tape recorders for an upcoming picture sequence.

The spin-synchronized trigger system can operate only when the spacecraft is spinning precisely at 9.8 r.p.m. Horizon scanners determine the satellite's spin rate so the triggering system will turn on the cameras and tape recorders when the earth is directly below.

DELTA LAUNCH VEHICLE

Delta is a launch vehicle program of NASA's Office of Space Science and Applications. Project management is the responsibility of the Goddard Space Flight Center. Launch agency for Goddard is the Kennedy Space Center's Unmanned Launch Operations. Prime contractor is the Douglas Aircraft Co.

Delta Statistics

The three-stage Delta for the ESSA A mission has the following characteristics:

Height:	90 feet
Maximum diameter:	8 feet
Lift-off weight:	about 75 tons

First Stage: Modified Air Force Thor, produced by Douglas Aircraft Co., engines produced by Rocketdyne Division of North American Aviation.

Diameter:	8 feet
Height:	51 feet
Propellants:	Rp-1 kerosene is used as the fuel and liquid oxygen (LOX) is utilized as the oxidizer.
Thrust:	172,000 pounds
Burning time:	2 min. 26 sec.
Weight:	more than 50 tons

Second Stage: Produced by the Douglas Aircraft Co., utilizing the Aerojet General Corporation AJ 10-118 propulsion system; major contractors for the autopilot are Minneapolis-Honeywell, Inc., Texas Instrument, Inc., and Electrosolids Corp.

Propellants: Liquid-Unsymmetrical Dimethyl Hydrazine (UDMH) for the fuel and Inhibited Red Fuming Nitric Acid for the oxidizer.

Diameter:	2.7 feet
Height:	20.6 feet
Weight:	$2\frac{1}{2}$ tons
Thrust:	about 7,500 pounds

Burning Time: 2 min. 47 sec.

Guidance: Western Electric Co.

<u>Third Stage</u>: Allegany Ballistics Laboratory X-258 motor.

Propellants: Solid

Height: 3 feet

Diameter: 1½ feet

Weight: 570 pounds

Thrust: 5,760 pounds

Burning time: 22 sec.

PROJECT MANAGEMENT

ENVIRONMENTAL SCIENCE SERVICES ADMINISTRATION

Dr. Robert M. White, Administrator

NATIONAL ENVIRONMENTAL SATELLITE CENTER, ESSA

David S. Johnson, Director
A. W. Johnson, Director of Operations
J. G. Vaeth, Director of System Engineering
J. C. Glover, Chief, Satellite Operations Division
E. G. Albert, Chief, Goddard Space Flight Center Project Office

NASA, OFFICE OF SPACE SCIENCE AND APPLICATIONS

Dr. Homer E. Newell, Associate Administrator for Space Science and Applications
Dr. Morris Tepper, Director of Meteorological Programs
Michael L. Garbacz, TIROS/TOS Program Manager
Vincent L. Johnson, Director of Launch Vehicles and Propulsion Programs
T. B. Norris, Delta Program Manager

NASA, GODDARD SPACE FLIGHT CENTER (TOS and Delta Project management)

Dr. John F. Clark, Acting Director
Herbert I. Butler, Chief, Operational Satellites Office
Robert M. Rados, TIROS Project Manager
William Jones, TOS Project Manager
William R. Schindler, Delta Project Manager

NASA, KENNEDY SPACE CENTER (Launch; initial tracking, guidance, and control)

Dr. Kurt H. Debus, Director
Robert H. Gray, Assistant Director of Unmanned Launch Operations

RADIO CORPORATION OF AMERICA, Astro-Electronics Division, Hightstown, N. J. (Spacecraft contractor)

Abraham Schnapf, TOS Project Manager

DOUGLAS AIRCRAFT COMPANY, Santa Monica, Calif. (Launch vehicle contractor)

Jack Kline, Director, Delta Programs
Marcus F. Cooper, Director, Florida Test Center

WEATHER SATELLITE RECORD

Satellite	Launch Date	Lifetime	Inclination	Meteorologically Useable Pictures
TIROS I	Apr. 1, 1960	$2\frac{1}{2}$ mos.	48 degrees	19,389
TIROS II	Nov. 23, 1960	10 mos.	48 degrees	25,574
TIROS III	July 12, 1961	$4\frac{1}{2}$ mos.	48 degrees	24,000
TIROS IV	Feb. 8, 1962	$4\frac{1}{2}$ mos.	48 degrees	23,370
TIROS V	June 19, 1962	$10\frac{1}{2}$ mos	58 degrees	48,547
TIROS VI	Sept. 18, 1962	13 mos.	58 degrees	59,830
TIROS VII	June 19, 1963	Still operating	58 degrees	110,983 *
TIROS VIII	Dec. 21, 1963	Still operating	58 degrees	88,604 *
NIMBUS I	Aug. 28, 1964	26 days	near polar 82 degrees	27,000
TIROS IX	Jan. 22, 1965	Still operating	near polar 83 degrees	63,306 *
TIROS X	July 2, 1965	Still operating	near polar 81 degrees	51,150 *
			Total Pictures:	541,753 *

*
As of January 17, 1966

These satellites have tracked almost every tropical storm and hurricane since 1960, enabling the Weather Bureau to issue more than 2,500 storm bulletins. The thousands of pictures have been used to construct more than 20,000 of the nephanalyses (cloud maps) used daily for analysis of world weather maps.