M-491-203-82-05

TO: A/Administrator September 22, 1982

FROM: M/Associate Administrator for Space Flight

SUBJECT: INTELSAT V-E (F-5) Launch

The fifth in a series of improved INTELSAT commercial communications satellites will be launched by an Atlas-Centaur (AC-60) from the Eastern Space and Missile Center (ESMC) no earlier than September 23, 1982. The INTELSAT V series has a capacity of 12,000 voice circuits plus two television channels. This flight will also carry for the first time a Maritime Communications Services (MCS) package for the Maritime Satellite Organization (INMARSAT) to provide ship/shore/ship communications.

The INTELSAT Global Satellite System comprises two elements: the space segment, consisting of satellites owned by INTELSAT positioned over the Atlantic, Indian, and Pacific Ocean regions; and the ground segment, consisting of Earth stations owned by telecommunications entities in the countries in which they are located.

INTELSAT awarded a contract for the development and manufacture of INTELSAT V satellites to Ford Aerospace and Communications Corporation as a prime contractor and an international team of manufacturers as subcontractors. A number of follow-on satellites with modified and expanded communications capabilities are being considered.

JAMES A. ABRAHAMSON
Lieutenant General, USAF
Associate Administrator for
Space Flight

(NASA-TM-84857) INTELSAT V-E (F-5) (National Aeronautics and Space Administration) 21 p HC A02/MF A01 CSCL 22B N82-33413

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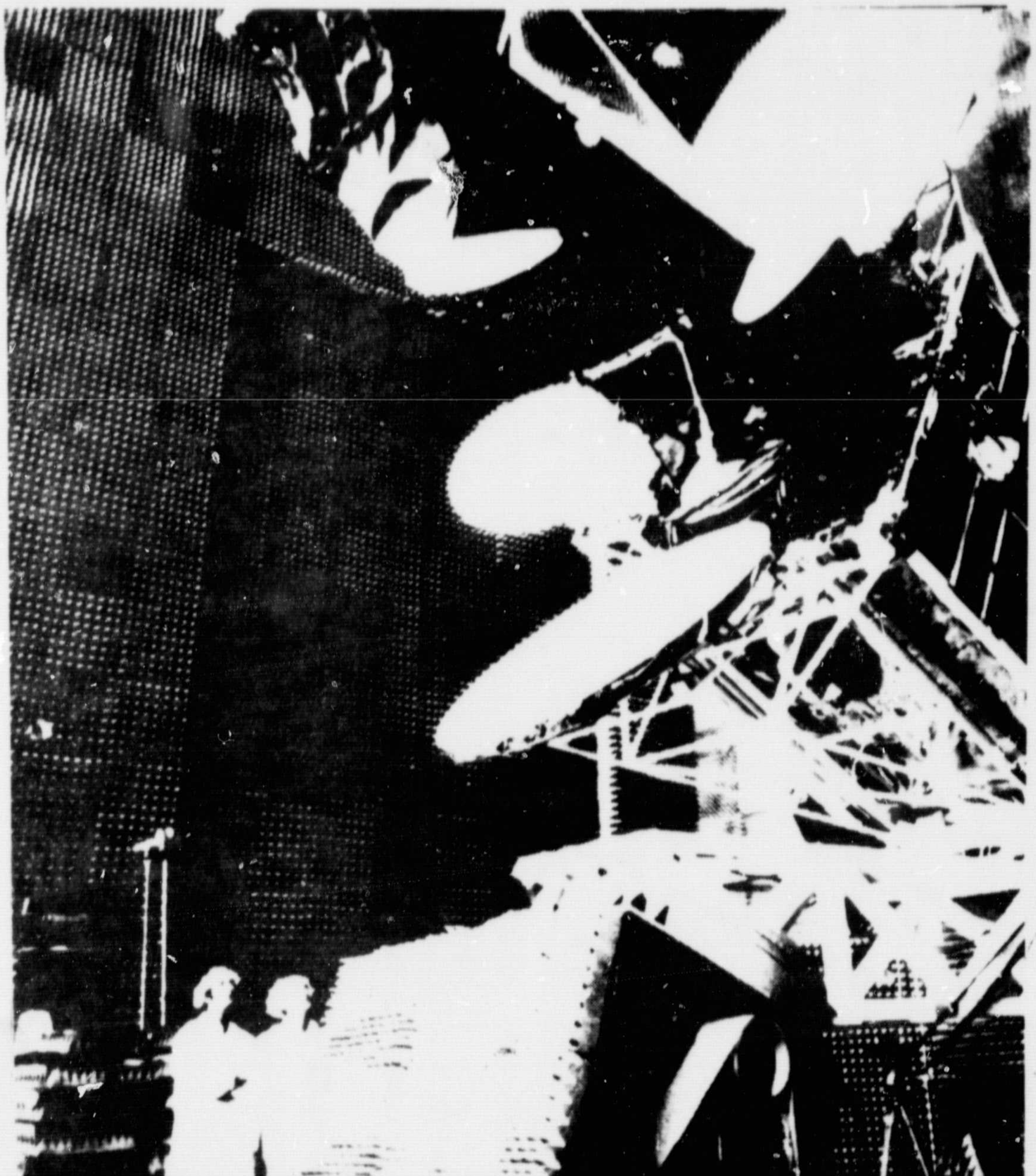
NASA
National Aeronautics and
Space Administration

Mission Operation Report

OFFICE OF SPACE FLIGHT

Report No. M-491-203-82-05



INTELSAT V-E (F-5)

FOREWORD

MISSION OPERATION REPORTS are published expressly for the use of NASA Senior Management, as required by the Administrator in NASA Management Instruction HQMI 8610.1A, effective October 1, 1974. The purpose of these reports is to provide NASA Senior Management with timely, complete, and definitive information on flight mission plans, and to establish official Mission Objectives which provide the basis for assessment of mission accomplishment.

Prelaunch reports are prepared and issued for each flight project just prior to launch. Following launch, updating (Post Launch) reports for each mission are issued to keep General Management currently informed of definitive mission results as provided in NASA Management Instruction HQMI 8610.1A.

Primary distribution of these reports is intended for personnel having program/project management responsibilities which sometimes result in a highly technical orientation. The Office of Public Affairs publishes a comprehensive series of reports on NASA flight mission which are available for dissemination to the Press.

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NASA HEADQUARTERS

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GENERAL

The International Telecommunications Satellite Organization (INTELSAT) headquartered in Washington, DC, was created on August 20, 1964, through the adoption of interim agreements signed by 11 countries, for the establishment of a global commercial communications satellite system.

Since February 12, 1973, INTELSAT has operated under definitive agreements with an organizational structure consisting of: (a) an Assembly of Parties (governments that are Parties to the INTELSAT Agreement); (b) a Meeting of Signatories (governments or their designated telecommunications entities that have signed the Operating Agreement); (c) a Board of Governors; and (d) an Executive Organ headed by a Director General, Mr. Santiago Astrain.

The Board of Governors, which has overall responsibility for the decisions relating to the design, development, construction, establishment, operation, and maintenance of the INTELSAT space segment, is currently composed of 26 Governors.

The INTELSAT global satellite system comprises two essential elements: the space segment, consisting of satellites owned by INTELSAT, and the ground segment, consisting of Earth stations owned by telecommunications entities in the countries in which they are located.

At present, the space segment consists of 16 satellites in synchronous orbit at an altitude of approximately 35,780 km (22,240 miles). Global service is provided through a combination of INTELSAT IV-A, INTELSAT IV, and INTELSAT V satellites over the Atlantic, Indian, and Pacific Ocean regions.

The INTELSAT IV-A has a capacity of 6,000 voice circuits and two television channels, while the INTELSAT IV has a capacity of 4,000 voice circuits plus two television channels. The INTELSAT V has a capacity of 12,000 voice circuits plus two television channels.

The ground segment of the global system consists of 424 communications antennas at 334 Earth station sites in 134 countries and territories.

The combined system of satellites and Earth stations provides more than 800 Earth station-to-Earth station communications pathways.

In addition to the international voice circuits in full-time use (now about 27,820), INTELSAT provides a wide variety of telecommunications services, including telegraph, telex, data, and television to over 150 countries, territories, and possessions (Table 1).

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TABLE 1

INTELSAT MEMBER COUNTRIES

Afghanistan
Algeria
Angola
Argentina
Australia
Austria
Bangladesh
Barbados
Belgium
Bolivia
Brazil
Cameroon
Canada
Central African Republic
Chad
Chile
China, People's Republic of
Colombia
Congo
Costa Rica
Cyprus
Denmark
Dominican Republic
Ecuador
Egypt
El Salvador
Ethiopia
Fiji
Finland
France
Gabon
Germany, Federal Republic of
Ghana
Greece
Guatemala
Guinea, People's Revolutionary Republic of
Haiti
Honduras
Iceland
India
Indonesia
Iran, Islamic Republic of
Iraq
Ireland
Israel
Italy
Ivory Coast
Jamaica
Japan
Jordan
Kenya
Korea, Republic of
Kuwait
Lebanon
Libya
Liechtenstein
Luxembourg
Madagascar
Malaysia
Mali
Mauritania
Mexico
Monaco
Morocco
Netherlands
New Zealand
Nicaragua
Niger
Nigeria
Norway
Oman
Pakistan
Panama
Paraguay
Peru
Philippines
Portugal
Qatar
Saudi Arabia
Senegal
Singapore
South Africa
Spain
Sri Lanka
Sudan
Sweden
Switzerland
Syria
Tanzania
Thailand
Trinidad and Tobago
Tunisia
Turkey
Uganda
United Arab Emirates
United Kingdom
United States
Upper Volta
Vatican City State
Venezuela
Viet Nam
Yemen Arab Republic
Yugoslavia
Zaire
Zambia

INTELSAT NON-SIGNATORY USERS

Bahrain
Botswana
Brunei
Burma
Cook Islands
Czechoslovakia
Cuba
Djibouti
Gambia
Guyana
Hungary
Kiribati
Liberia
Malawi
Maldives
Mauritius
Mozambique
Nauru, Republic of
New Guinea
Papua
Poland
Romania
Seychelles
Sierra Leone
Solomon Islands
Somalia
Surinam
Togo
Tonga
U.S.S.R.
Western Samoa

OTHER TERRITORY USERS

American Samoa
Ascension Island
Azores
Belize
Bermuda
Cayman Islands
French Guiana
French Polynesia
French West Indies
Gibraltar
Guam
Hong Kong
Netherlands Antilles
New Caledonia
Van Uatu

Fifteen countries also lease satellite capacity from INTELSAT for their own domestic communications. These are: Algeria, Australia, Brazil, Chile, Colombia, France, India, Nigeria, Norway, Oman, Peru, Saudi Arabia, Spain, Sudan, and Zaire.

INTELSAT currently authorizes two standards for Earth stations that operate international services through its satellites: Standard A, with 30-meter (100 ft.), or larger, dish antenna, 10 stories tall, which can be rotated one degree per second and which can track to within a fraction of a degree a satellite stationed in synchronous orbit; and a smaller Standard B of 10 meters (33 ft.).

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MISSION OBJECTIVES FOR INTELSAT V-D (F-4)

NASA OBJECTIVE

To launch the INTELSAT V-E (F-5) satellite into a transfer orbit which enables the spacecraft apogee motor to inject the spacecraft into a synchronous orbit.

COMSAT OBJECTIVES

To fire the apogee motor, position the satellite into its planned geostationary position, and operate and manage the system for INTELSAT.

Joseph B. Mahon
Joseph B. Mahon
Acting Director
Special Programs

Date: September 17, 1982

J. Abrahamson
JAMES A. ABRAHAMSON
Lieutenant General, USAF
Associate Administrator for
Space Flight

Date: 22 Sept 82

SPACECRAFT DESCRIPTION

Figures collected as a result of INTELSAT-sponsored Global Telecommunications Traffic Conference indicated that an INTELSAT IV-A satellite would have insufficient capacity to cope with the traffic and load on the Atlantic Ocean primary satellite and on the Indian Ocean satellite by the early 1980s.

While one solution could have been simply to orbit another INTELSAT IV-A Atlantic Ocean and Indian Ocean satellite, subsequent planning proceeded toward the development of a high-capacity INTELSAT V satellite (Figure 1). After an international bidding process, the INTELSAT Board of Governors, at its meeting in September 1976, decided to award a contract for the development and manufacture of seven INTELSAT V satellites to Ford Aerospace and Communications Corporation as prime contractor and an international team of manufacturers as subcontractors. Since that time, the Board has decided to order two additional INTELSAT V satellites. A decision has also been made to order six higher-capacity INTELSAT V-A spacecraft for launch in 1984 and beyond.

AN INTERNATIONAL EFFORT

Contributions have been made to the design, development, and manufacture of INTELSAT V by aerospace manufacturers around the world under the prime contractor Ford Aerospace and Communications Corporation (FACC) of the United States.

Members of this international manufacturing team include:

- Aerospatiale (France)
- GEC-Marconi (United Kingdom)
- Messerschmitt-Bolkow-Blohm (Federal Republic of Germany)
- Mitsubishi Electric Corporation (Japan)
- Selenia (Italy)
- Thomson-CSF (France)

Each manufacturer has concentrated on specific areas of the INTELSAT program.

- Aerospatiale (France) - Aerospatiale initiated the structural design that forms the main member of the spacecraft modular design construction. It supplies the main body structure thermal analysis and control.

- GEC-Marconi (United Kingdom) - Marconi produces the 11 GHz beacon transmitters used for Earth station antenna tracking.

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INTELSAT V SPACECRAFT

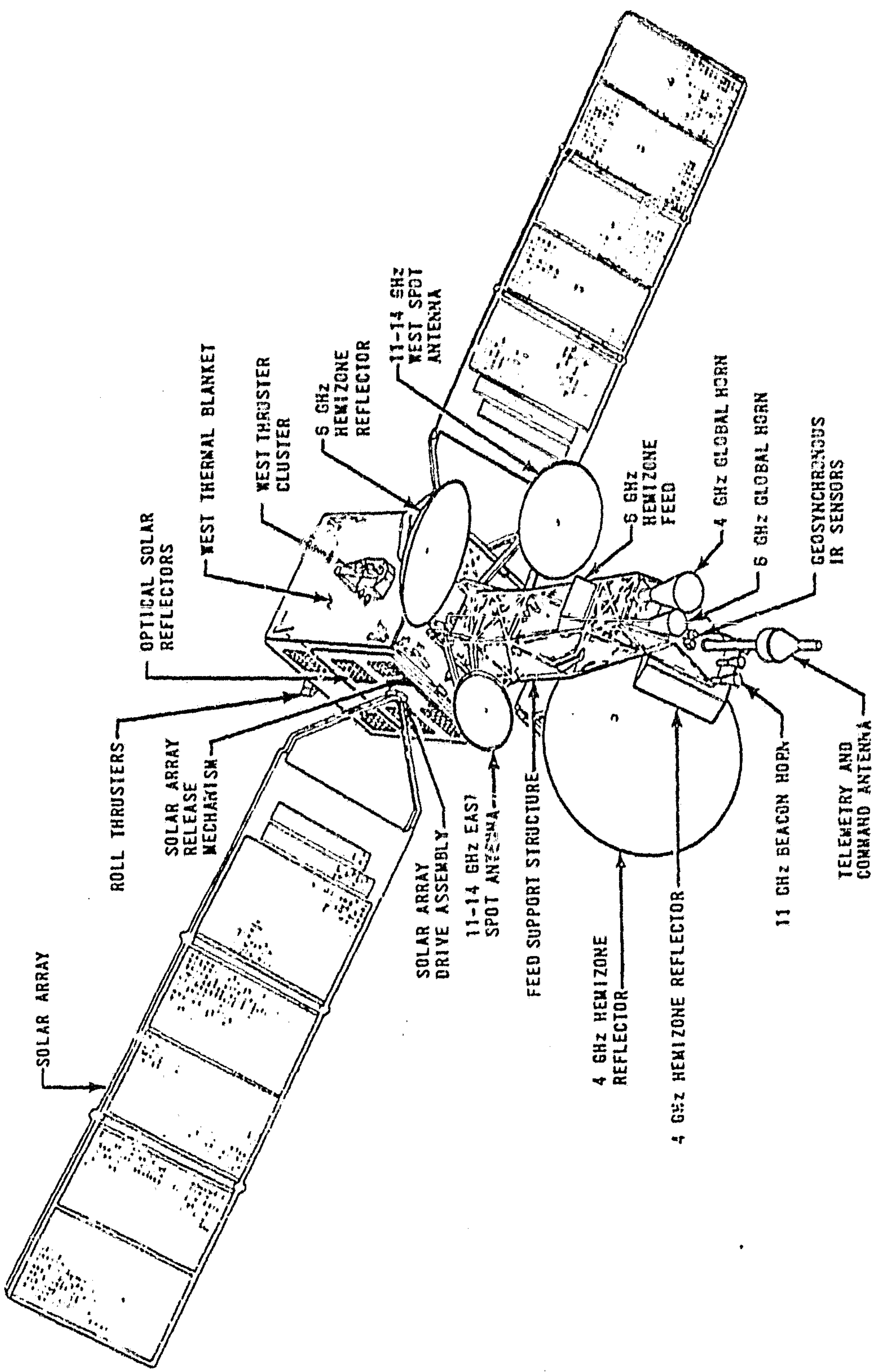

Fig. 1

- Messerschmitt-Bölkow-Blohm (Federal Republic of Germany) - MBB designed and produces the satellite's control subsystem and the solar array.

- Mitsubishi Electric Corporation (Japan) - Mitsubishi is responsible for both the 6 GHz and the 4 GHz Earth coverage antennas. It also manufactures the power control electronics and, from an FACC design, the telemetry and command digital units.

- Selenia (Italy) - Selenia designed and built the six telemetry, command, and ranging antennas, two 11 GHz beacon antennas and two 14/11 GHz spot beam antennas. It also built the command receiver and telemetry transmitter which combine to form a ranging transponder for determination of the spacecraft position in transfer orbit.

- Thomson-CSF (France) - Thomson built the 10 w, 11 GHz taveling wave tubes of which there are 10 per spacecraft.

All this is brought together by FACC through its Western Development Labs Division in Palo Alto, California. Ford is also responsible for the development of the satellite's communications package and for the development of the maritime communications subsystem (MCS) to be integrated into the fifth, sixth, seventh, eighth, and ninth INTELSAT V satellites. An INTELSAT V Mission Summary is shown on Figure 2.

FACTS, STATISTICS, AND SPECIAL FEATURES

Dimensions

. Solar Array (end to end)	: 15.6 meters (51.1 feet)
. Main Body "Box"	: 1.66 x 2.01 x 1.77 meters (5.4 x 6.6 x 5.8 feet)
. Height	: 6.4 meters (21.0 feet)
. Width (fully deployed)	: 6.8 meters (22.25 feet)
. Weight (at launch, without MCS)	: 1,928 kilos (4,251 pounds)

General Characteristics

- Three-axis body stabilized with Sun and Earth sensors and momentum wheel.

- Wing-like, Sun-oriented solar array panels producing a total of 1,241 watts of electrical power after 7 years in orbit.

- Modular construction.

- Seven-year expected life in orbit.

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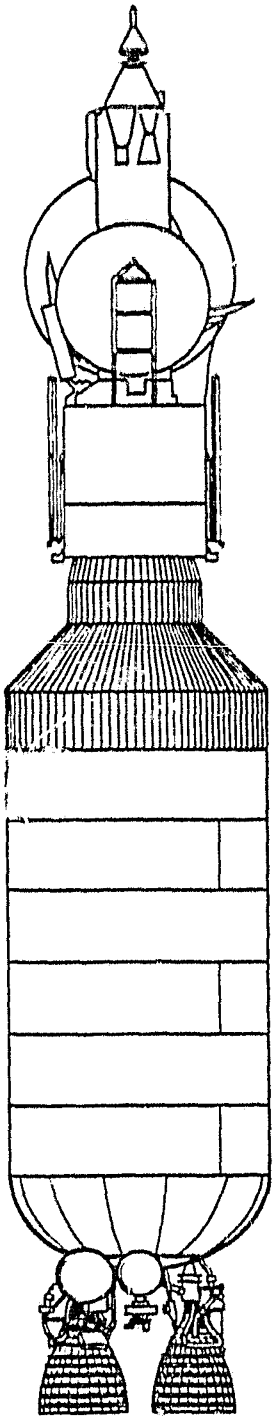
MISSION SUMMARY



MISSION PARAMETERS	
Mission Designation	INTELSAT V Series
Mission Objective	Placement of commercial communications satellites into Earth stationary orbit.
Mission Final Orbit	Stationary in Earth equatorial plane.
Final Stationary Position	To be selected by INTELSAT (desired positioning achieved by combined use of multiple revolutions in launch transfer orbit plus post-apogee drift orbit).
LAUNCH PHASE PARAMETERS	
Launch Mode	Parking Orbit Ascent (Two Burn)
Launch Azimuth	97.6 degrees
Ascent Yaw Maneuver	Small left yaw (to reduce P.O. inclination)
CENTAUR PARKING ORBIT	
Perigee/Apogee Altitude	80/193 nautical miles
Orbit Inclination	28.3 degrees
Coast Time in Orbit	14.2 minutes
CENTAUR SECOND BURN	
Location of Burn	First equatorial crossing
Burnout Altitude (MECO2)	95.2 nautical miles
SPACECRAFT TRANSFER ORBIT	
Perigee/Apogee Altitude	90/19,324 nautical miles
Orbit Inclination	24.1 degrees (for 4206 lb S/C)
Coast Time to 1st Apogee	5.20 hours (from S/C separation)
Orbit Period	633.8 minutes (at 1st apogee)
SPACECRAFT APOGEE BURN	
Location of Burn and Burnout Longitude	INTELSAT will command S/C apogee burn via RF link at one of the transfer orbit apogee occurrences (yet to be selected).
SPACECRAFT FINAL ORBIT	
Perigee/Apogee Altitude	19,324/19,324 nautical miles*
Orbit Inclination	0 degrees*
Orbit Period	23.935 hours

* Nominal parameters for Earth stationary orbit. Actual INTELSAT V spacecraft final orbits may have slight variations in altitude and/or inclination angles.

Fig. 2

Communications Characteristics

- Capacity average in 12,000 simultaneous two-way telephone circuits and two television channels.
- Utilizes both 14/11 GHz frequency band and 6/4 GHz frequency band.
- The 6/4 GHz frequency band is used four times on the hemi-zone beams through spatial isolation and dual polarization.
- The 14/11 GHz frequency band is used twice through east and west spot beams.
- Six communications antennas--two global coverage horns, two hemispherical/zone offset-fed reflectors, and two offset-fed spot beam reflectors.

SPACECRAFT

- Aluminum main body structure.
- Graphite epoxy antenna tower.
- Catalytical and electro-thermal hydrazine thrusters.

INTELSAT FIRSTS

INTELSAT V is the first INTELSAT satellite to have the following features:

- Frequency reuse through both spatial isolation and dual polarization isolation.
- Multi-band communications--both 14/11 GHz and 6/4 GHz.
- Three-axis stabilization.
- A contiguous band output multiplexer.
- Maritime communications subsystem (MCS).
- Use of nickel hydrogen batteries in later spacecraft.

COMMUNICATIONS CAPACITY

In designing INTELSAT V, engineers had to work within a number of limiting factors to achieve the communications capacity required.

Typical of these were:

- limitations on the available frequency bands;
- the maximum mass which could be placed in orbit by the then (1973+) only available launch vehicle - Atlas Centaur.

These limitations have been overcome with the result that each INTELSAT V will have twice the capacity of its predecessors. The extra capacity was derived by reusing the available frequency bandwidth--up to four times--and by utilizing another range of frequencies.

INTELSAT IV-A makes limited use of zonal beam antennas to increase its capacity by reusing frequencies twice. Of the 500 MHz bandwidth available to INTELSAT IV-A a portion is allocated to global coverage transmissions and the remaining bandwidth is used twice in two hemispherical beams which are concentrated over heavy traffic areas. As these beams do not overlap, except with the global coverage beam, there is no possibility of signals in one beam interfering with signals in the other even though they are on the same frequencies.

With INTELSAT V, frequency reuse techniques have been taken even further with the introduction of polarized transmissions. Overlaid on INTELSAT V's global beam transmissions are two circularly polarized transmissions beamed into separate hemispheres. Overlaid upon each of these, using the same frequencies but polarized in the opposite directions (orthogonal to the hemisphere transmissions), are two zonal beam transmissions. All of these beams operate using and reusing the frequencies in the 6/4 GHz band. In addition, there are concentrated spot beam transmissions using, for the first time for INTELSAT, frequencies in the 14/11 GHz (Ku) band.

MARITIME COMMUNICATIONS SUBSYSTEM (MCS)

For the first time, INTELSAT will build facilities for maritime communications services into several of its INTELSAT V satellites. The INTELSAT Board of Governors at its meeting in January 1979 decided to go ahead with plans to install equipment designed to provide maritime communications services on board the fifth, sixth, seventh, eighth, and ninth in its series of INTELSAT V international communications satellites. The satellites carrying the MCS are to be placed in orbit commencing during 1982. It is planned that the maritime-equipped INTELSAT Vs will become part of a global system operated by the newly formed International Maritime Satellite Organization (INMARSAT). In this system, the INTELSAT Vs, as well as performing their normal international communications roles, would provide ship/shore/ship communications and other services. The maritime packages for the INTELSAT Vs, are being developed and built by the Ford Aerospace and Communications Corporation, prime contractor for the INTELSAT V series satellites. INTELSAT has offered to lease the maritime communications facilities to INMARSAT over a 7 year lifetime. The INMARSAT system is expected to become the successor to the MARISAT system currently being operated by the U.S. corporation, COMSAT General.

SPACECRAFT SUBSYSTEMS

Communications Repeater

The communications subsystem receives and amplies signals from Earth, routes the signals between antenna beams, and retransmits the signals back to Earth. The equipment involved includes 15 receivers, 43 traveling wave tube amplifiers, and more than 140 microwave switches. The repeater provides 27 separate transponders which may be connected in nearly 600 different combinations of coverage areas and frequency bands. Solid state receivers, graphite epoxy filters, and contiguous channel output multiplexers are among the technical innovations introduced in this subsystem.

Communication Antennas

The antennas employ such advanced design features as dual-polarized low-axial ratio feed elements and extremely lightweight feed distribution networks. These items, as well as the antenna tower and reflectors, are made of graphite epoxy for extremely low weight and high temperature stability.

COMMUNICATIONS PAYLOAD

Quantity	Component	Remarks
	Communications Antennas	
2	Offset fed, shaped beam frequency reuse antennas	Freq: 6/4 GHz Size: 2.44 and 1/6 m dia.
2	Offset fed, mechanically steered spot antennas	Freq: 14/11 GHz Size: 0.96 and 1.12 m dia.
2	Earth coverage horns	Freq: 6/4 GHz
1	Beacon antenna	Freq: 11 GHz
	Receivers	All solid-state
4	14 GHz	2 active, 2 redundant
11	6 GHz	5 active, 6 redundant
	Traveling Wave Tubes	
10	11 GHz, 10 w dual collectors	6 active, 4 redundant
33	4 GHz, 4.5 w and 8.5w	21 active, 12 redundant
	Upconverters	
10	4/11 GHz	6 active, 4 redundant
	Transmitters	
2	Beacon	Freq: 11.196 and 11.454 GHz

Telemetry, Tracking, and Command

The telemetry, tracking, and command subsystem is used to control the spacecraft during transfer orbit and on-station operations. The major elements of the subsystem include antennas, telemetry and command units, and a transponder.

Antennas are packaged in a single assembly except for the two telemetry Earth coverage horns. Two command antennas receive signals from Earth, and three transmit antennas telemeter spacecraft data back to Earth.

The command subsystem provides for remote control from Earth of many spacecraft functions through a microwave link consisting of two ring slot antennas, two command receivers, and two command units. Diagnostic data and subsystem status are transmitted to the ground via two independent and redundant telemetry channels.

Attitude Control

The attitude control subsystem provides active stabilization of the spacecraft. In transfer orbit, the spacecraft is spin-stabilized. Its attitude is derived from Earth sensor and Sun sensor data and processed by the attitude determination and control electronics.

After injection into synchronous orbit, the spacecraft is despun and the solar arrays and antenna reflectors deployed. In a series of maneuvers, it is then locked onto the correct attitude in relation to the Earth. In the normal on-station mode, pitch control is maintained by a spinning momentum wheel. Roll and yaw control is accomplished by firing small hydrazine thrusters. Three geostationary infrared sensors provide Earth reference data.

Propulsion

The propulsion subsystem, excluding the apogee motor, is based on conventional catalytic hydrazine thrusters for transfer orbit and normal geostationary operations. North-south stationkeeping is accomplished by electrothermal hydrazine thrusters which are more efficient than catalytic thrusters. As a result, approximately 30 kg (66 lb.) less hydrazine fuel is required for the mission. The electrothermal units are backed up by conventional catalytic thrusters.

Electric Power

Electric power for the spacecraft is derived from two wing-like structures that fold out from the main body. These wings are covered on one side with silicon solar cells which convert sunlight into electrical energy. Once extended the arrays rotate to face the Sun and will thereafter track the Sun providing 1564 watts at the beginning of life. This output will gradually degrade to 1288 watts at the end of several years in orbit. Twice per year the spacecraft will experience a series of passes through the Earth's shadow. At these times the power subsystem is supported by two rechargeable batteries. Early spacecraft will carry nickel cadmium batteries as have all previous INTELSAT satellites. However, starting with the fifth flight, newly developed nickel hydrogen batteries with enhanced life characteristics will be flown.

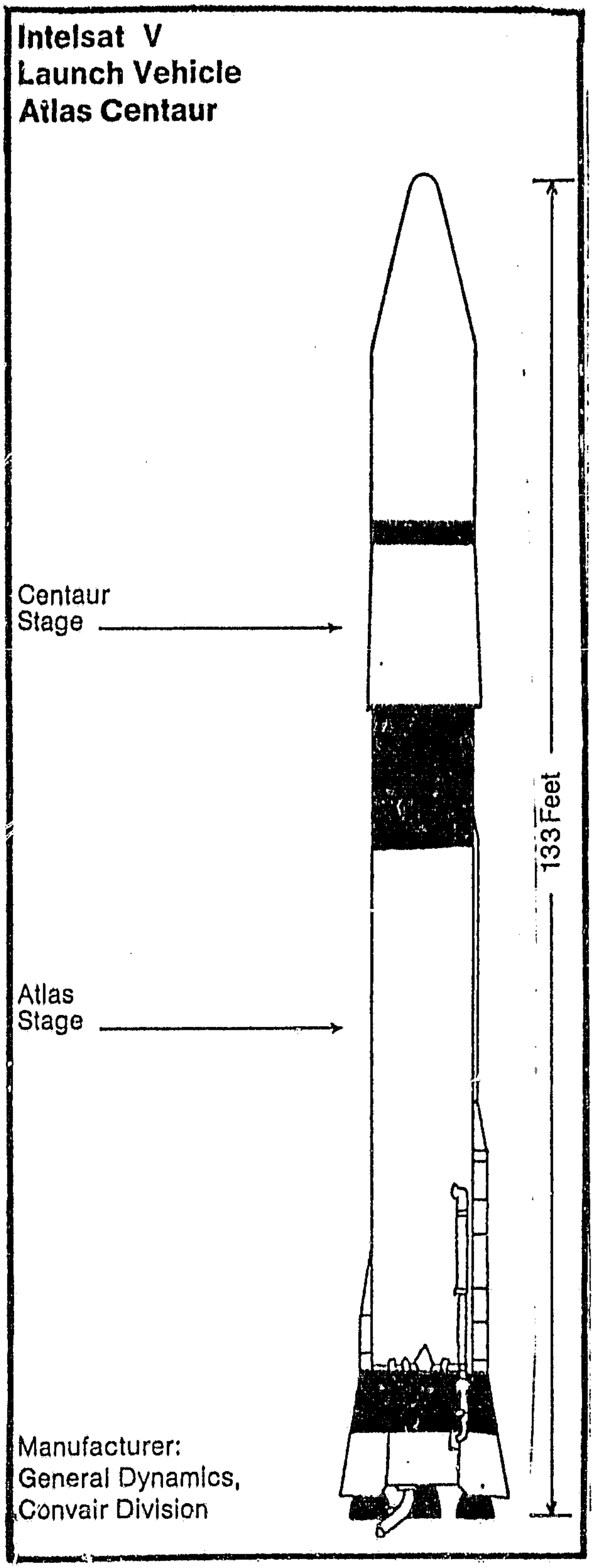


Fig. 3

LAUNCH VEHICLE DESCRIPTION

The Intelsat V-B (F-5) will be launched into a transfer orbit by an Atlas-Centaur launch vehicle (Figure 3).

The rocket combination, standing approximately 41 meters (133 ft) high, consists of an Atlas SLV-3D booster and Centaur D-1A second stage.

The Atlas booster develops 1913 kilonewtons (430,000 lb) of thrust at liftoff using two 828,088 newton (184,841 lb) thrust booster engines, one 267,000 newton (60,000 lb) thrust sustainer engine, and two vernier engines developing 3006 newton (676 lb) thrust each. Its propellants are RP-1 (a kerosene type fuel) and liquid oxygen (LOX).

Centaur was the nation's first high energy, liquid hydrogen-liquid oxygen propelled launch vehicle. Developed and launched under the direction of NASA, Lewis Research Center, Cleveland, Ohio, it became operational in 1966 with the launch of Surveyor 1, the first U.S. spacecraft to soft land on the Moon's surface.

The Centaur stage is being used in combination with the Atlas booster, and has been used in combination with the Titan III booster. The Titan Centaur combination has successfully launched four heavier payloads into interplanetary trajectories. These were two Helios spacecraft toward the Sun and the two Viking spacecraft toward the planet Mars. In addition, it launched two Voyager planetary spacecraft to Jupiter/Saturn flybys.

The Centaur stage for the Atlas booster was modernized over 7 years ago and designated D-1A. This modernization consisted primarily of the integrated electronic system controlled by a digital computer. This flight proven "astrionics" system checks itself and all other systems prior to and during the launch phase; during flight, it has the prime role of controlling all events after the liftoff. This system is located on the equipment module located on the forward end of the Centaur stage.

The launch vehicle characteristics are contained in Table 2.

TABLE 2
LAUNCH VEHICLE CHARACTERISTICS

Liftoff weight including spacecraft	147,871 kg (326,000 lb)
Liftoff Height	40.5 meters (133 ft)
Launch Complex	36 B
Launch Azimuth	97.6 degrees

	Atlas Booster	Centaur Stage
Weight	128,934 kg (284,248 lb)	17,676 kg (38,970 lb)
Height	21.3 meters (70 ft)	18.6 meters (61 ft) (with payload fairing)
Thrust	1931 kilonewtons (431,000 lb) (sea level)	1334.4 kilonewtons (30,000 lb) (vacuum)
Propellants	Liquid Oxygen and RP-1	Liquid Oxygen and Liquid Hydrogen
Propulsion	MA-5 system: 2 - 828,088 newton (184,841 lb) thrust engines; 1 - 267,000 newton (60,000 lb) sustainer engine; and 2 - 2982 newton (670 lb) thrust vernier engines	2 - 67,000 newton (15,000 lb) thrust RL-10 engines. 14 small hydrogen peroxide thrusters.
Guidance	Preprogrammed profile through BECO. Switch to inertial guidance for sustainer phase.	Inertial guidance

The 16,000 word-capacity computer, which is the heart of the system, replaces the original 4800-word capacity computer and enables it to take over many of the functions previously handled by separate mechanical and electrical systems. The new Centaur system handles navigation, guidance tasks, control pressurization, propellant management, telemetry formats and transmission, and initiation of vehicle events.

Many of the command and control functions previously performed by Atlas systems are now being handled by the Centaur equipment also. Systems which are totally integrated include guidance, flight control, telemetry, and event sequence initiation.

One of the major advantages of the new Centaur D-1A system is the increased flexibility in planning new missions. In the past, hardware frequently had to be modified for each mission. Now most operational needs can be met by changing the computer software.

INTELSAT TEAM

INTELSAT

Andrea Caruso	Deputy Director General - Administration
Francis Latapie	Acting Deputy Director General - Administration
Allan McCaskill	Manager, Launch Vehicle Program Office

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J.B. Mahon	Acting Director, Special Programs
F.R. Schmidt	Atlas-Centaur Manager

LEWIS RESEARCH CENTER

James E. Patterson	Director, Launch Vehicles
Richard E. Orzechowski	Mission Project Engineer

KENNEDY SPACE CENTER

Charles D. Gay	Director, Expendable Vehicles Operations
James L. Womack	Chief, Centaur Operations Division
Donald G. Sheppard	Chief, Automated Payloads Division
Larry F. Kruse	INTELSAT Spacecraft Coordinator

PRIME CONTRACTORS	RESPONSIBILITY
Ford Aerospace & Communications Corporation Palo Alto, CA	INTELSAT V Spacecraft
General Dynamics/Convair San Diego, CA	Atlas-Centar Vehicle
Honeywell, Aerospace Division St. Petersburg, FL	Centaur Guidance Inertial Measurement Group
Pratt & Whitney West Palm Beach, FL	Centaur RL-10 Engines
Teledyne Systems Co. Northridge, CA	Digital Computer Unit/ PCM Telemetry