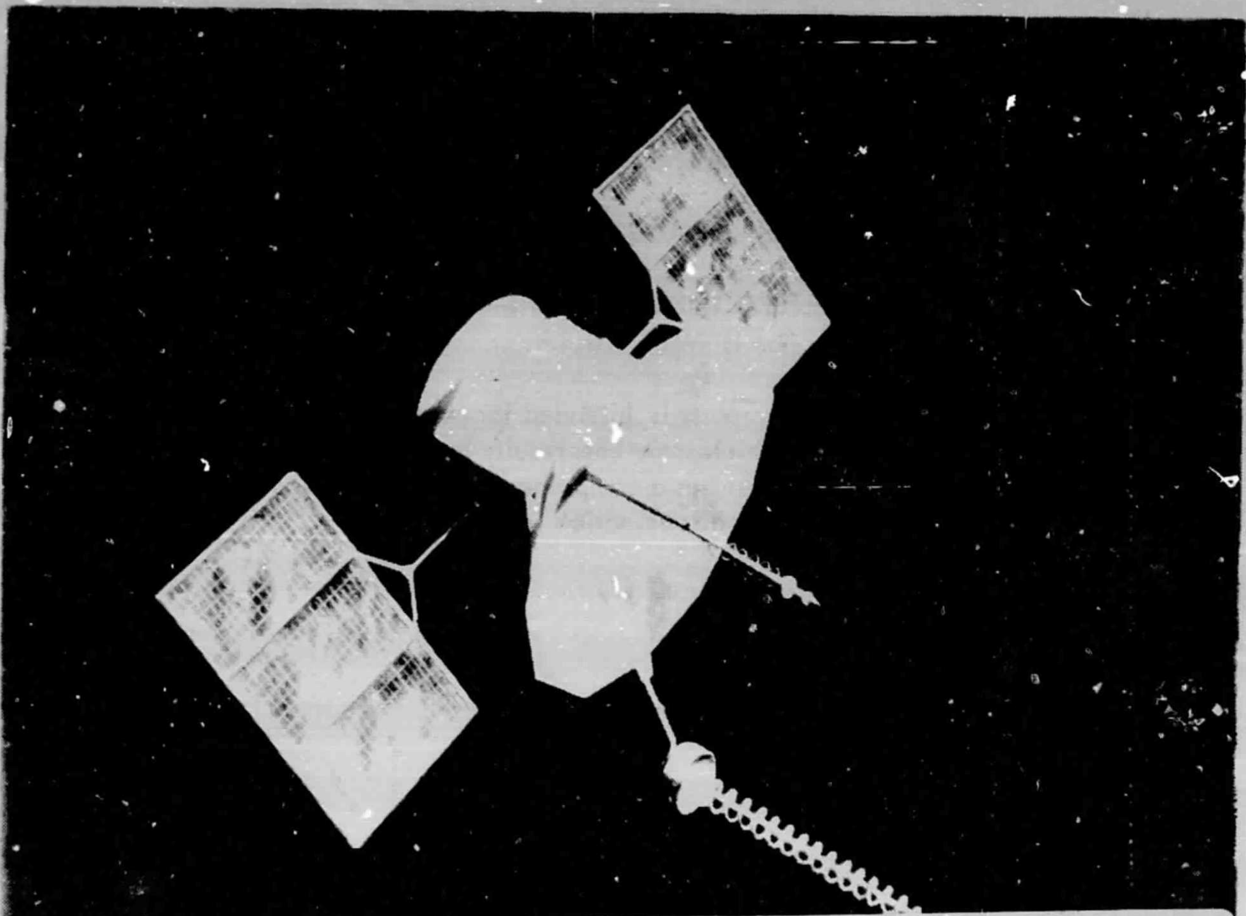
NASA
National Aeronautics and
Space Administration

Mission Operation Report

OFFICE OF SPACE TRANSPORTATION SYSTEMS   Report No. M-491-202-79-02



(NASA-TM-79941) FLTSATCOM-B LAUNCH (National Aeronautics and Space Administration) 22 p HC A02/MF A01 CSCL 22A
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FLTSATCOM-B

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 results in a highly technical orientation. The Office of Public Affairs publishes a comprehensive series of reports on NASA flight missions which are available for dissemination to the Press.

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BACKGROUND

FLTSATCOM is an advanced Earth satellite designed to provide extensive communication capability for the USAF and USN. The satellites are to be placed in synchronous, near equatorial orbits. The spacecraft provides 23 UHF and one SHF communication channels. Services provided are: Fleet broadcast, channel 1; Fleet relay, channels 2 through 10; Air Force narrowband, channels 11 through 22; a DOD wideband channel 23; and an additional Telemetry Tracking and Command (TT&C) S-band channel.

MISSION OBJECTIVES FOR FLTSATCOM

NASA OBJECTIVES

To launch the FLTSATCOM spacecraft into a transfer orbit which enables the spacecraft apogee motor to inject the spacecraft into a synchronous orbit.

SAMSO OBJECTIVES

To fire the apogee motor, position the satellite into its planned synchronous near equatorial orbit, and operate and manage the system for the USAF and USN.

Joseph B. Mahon
Joseph B. Mahon, Director
Expendable Launch Vehicle Programs
Office of Space Transportation Systems

Date: April 27, 1979

John F. Yardley
John F. Yardley
Associate Administrator for Space Transportation Systems

Date: 4/30/79

MISSION DESCRIPTION

ORBIT REQUIREMENTS

The FLTSATCOM mission requires injection of the satellites into synchronous, near equatorial orbits each with a circular altitude of 19,324 nmi (35,788 km) a 23,933 hour period, and a 2.4° inclination with respect to the equatorial plane. The Atlas Centaur injects the spacecraft into an inclined Hohmann transfer ellipse. An apogee motor on the FLTSATCOM is used to circularize the orbit and reduce the inclination. Final positioning of the spacecraft in synchronous orbit is provided by the use of a drifting orbit and multiple revolutions in the transfer orbit.

MISSION PROFILE

The Atlas booster and the first burn of the Centaur inject the vehicle into an 80 nmi (148.2 km) perigee by 196 nmi (363 km) apogee elliptical parking orbit. After an approximate 15 minute coast in the parking orbit, a second Centaur burn near the first equatorial crossing provides a plane change and injects the vehicle into the transfer ellipse. After second Main Engine Cutoff (MECO 2), The Centaur executes a turn to orient the FLTSATCOM spacecraft to its required attitude for the transfer orbit. This attitude places the spacecraft spin axis in the AKM firing attitude. During the transfer orbit operations, and through apogee motor burn, the spacecraft is spin stabilized. The Centaur is turned approximately 90 degrees after the spacecraft separation and a retromaneuver performed. The retromaneuver includes a propellant tank blowdown through the main engines to increase the separation distance from the spacecraft.

The FLTSATCOM mission trajectory profile is depicted in Figure 1. The Earth projection of the flight is shown in Figure 2 and telemetry coverage is presented in Figure 3.

PARKING ORBIT

The launch mode shall be parking orbit ascent with Centaur second burn in the vicinity of the first equatorial crossing. Elements of the parking orbit shall not be constrained by ground based tracking stations for telemetry data. The required parking orbit altitudes are:

Apogee altitude	196 NM (363 km)
Perigee altitude	80 NM (148.2 km)

TRANSFER ORBIT

The transfer orbit is defined as the spacecraft orbit following separation from the launch vehicle. All orbit parameters except apogee altitude are specified at the time of spacecraft separation. Apogee altitude is specified at first apogee. The final orbit is to be synchronous, circular, and nominally inclined to the equator by 2.4°. The required transfer orbit parameters and the acceptable targeting tolerances on the nominal values are:

FLTSATCOM MISSION TRAJECTORY PROFILE

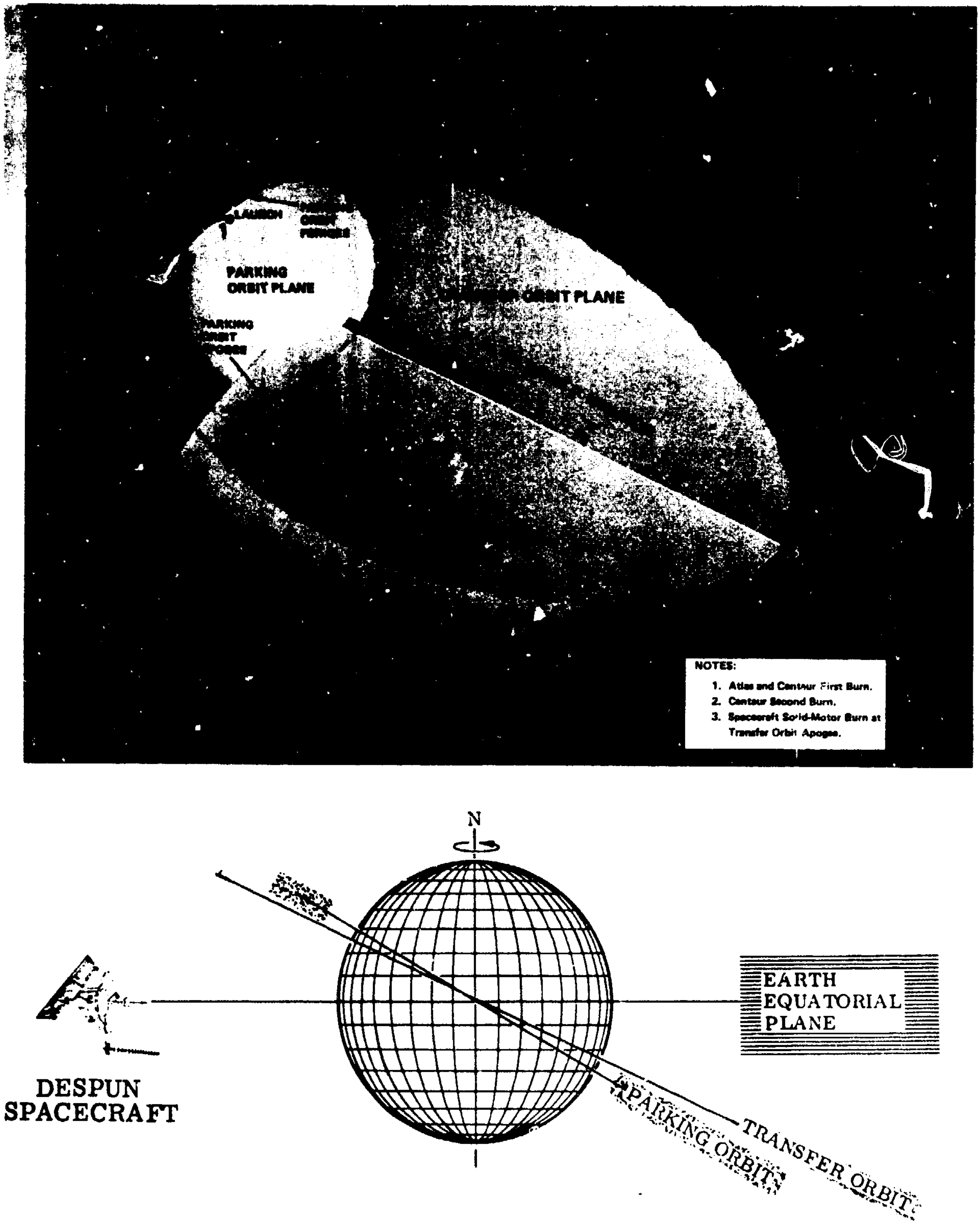


Fig. 1

TRAJECTORY EARTH TRACK
(Launch Through First Apogee)

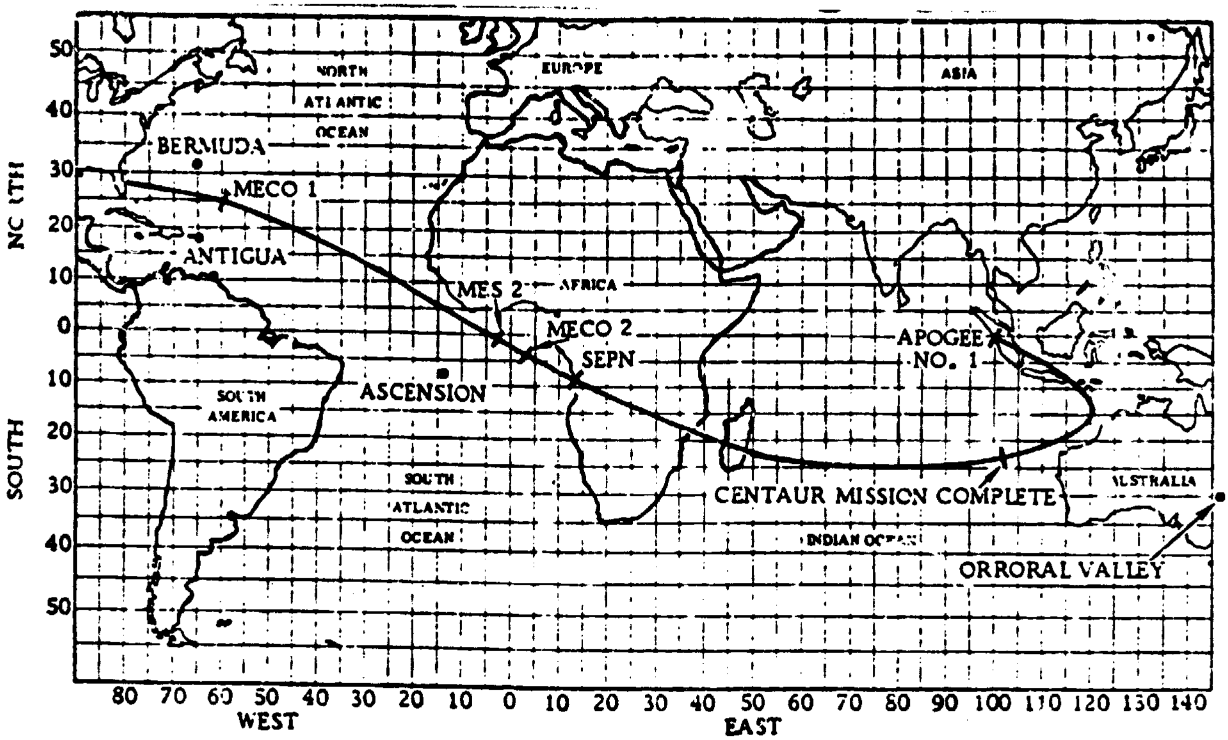


Fig. 2

ORIGINAL PAGE IS OF POOR QUALITY

RADAR AND TELEMETRY COVERAGE

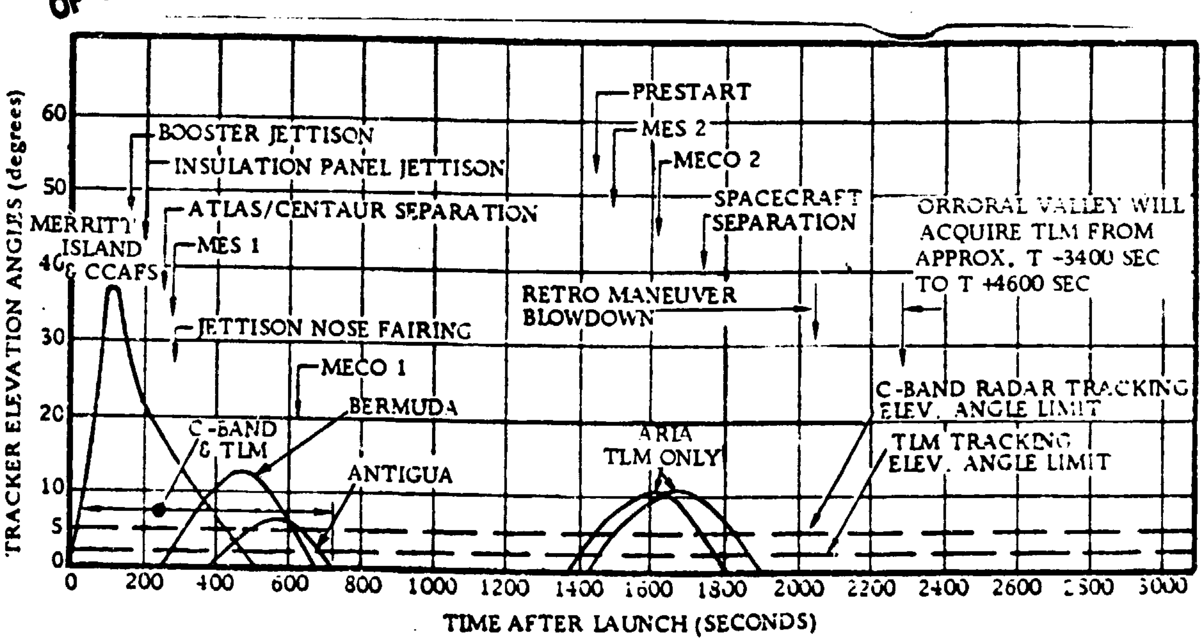


Fig. 3

Perigee altitude	90 NM (166.7 km) NOM
Apogee altitude	19,324±7 NM (34,788±13 km)
Inclination	As necessary to maximize payload capability
Argument of perigee	181.±0.05°

For reference purposes, this transfer orbit is based upon the following spacecraft characteristics:

Spacecraft separated weight	4,136 lbs (1876 kg)
Spinup and reorientation propellants	7 lbs (3.2 kg)
Spacecraft weight at apogee motor ignition	4,102 lbs (1872.9 kg)
Apogee motor expendables	1,914 lbs (868.2 kg)
Spacecraft weight at apogee motor burnout	2,188 lbs (1004.7 kg)
Apogee motor effective specific impulse	285.5 sec

For reference purposes, the final orbit is to be synchronous, circular, and near equatorial.

SPACECRAFT SEPARATION ATTITUDE

The launch vehicle shall be oriented at the time of spacecraft separation so that the spacecraft will be in the AKM firing attitude.

SPACECRAFT DESCRIPTION

The FLTSATCOM spacecraft consists of two major hexagonal elements, a payload module and a spacecraft module. A majority of the electronic equipment is mounted on 12 panels that enclose the payload and spacecraft modules. An exploded view of FLTSATCOM is shown in Figure 4.

The payload module, which is fastened to the six corners of the spacecraft module, contains the UHF and X-band communications equipment and antennas. The UHF transmit antenna is made of ribs and mesh that opens like an umbrella, and the receive antenna is a separate, deployable helix. The spacecraft provides 23 UHF and one SHF communications channels including: Fleet broadcast, channel 1; Fleet relay, channels 2 through 10; Air Force narrowband, channels 11 through 22; and a DOD wideband, channel 23.

The spacecraft module contains the Earth sensors, apogee kick motor, attitude and velocity control, telemetry tracking and command (TT&C), electrical power distribution, and the solar array.

The solar array is folded around the spacecraft module prior to its final position in orbit where it is deployed by spring loaded hinges. It is exposed to sunlight in both the deployed and folded positions.

During the transfer orbit operations and through apogee kick motor burn, the spacecraft is spin stabilized. After apogee kick motor burn, the spacecraft is despun, solar arrays and the UHF antenna are deployed, and the Sun and Earth are acquired. In normal on orbit operations, the spacecraft is pointed at the center of the Earth by Earth sensors, roll/yaw jets, and a reaction wheel. The solar array is usually normal to the orbit plane and is rotated at a uniform rate to point at the Sun. Rotation is achieved by a clocked drive with command correction available.

A redundant monopropellant hydrazine thruster system is provided for spacecraft control and velocity maneuvers. A solid propellant apogee kick motor is provided to inject the spacecraft into a circular, near-synchronous orbit.

Solar arrays and batteries interface with a command electrical power bus which distributes primary power to the subsystem equipment converters. Overload protection is provided in the power distribution subsystems.

Spacecraft TT&C is compatible with the SGLS ground system and can receive in either a clear or secure mode.

EXPLODED VIEW OF FLTSATCOM SPACECRAFT

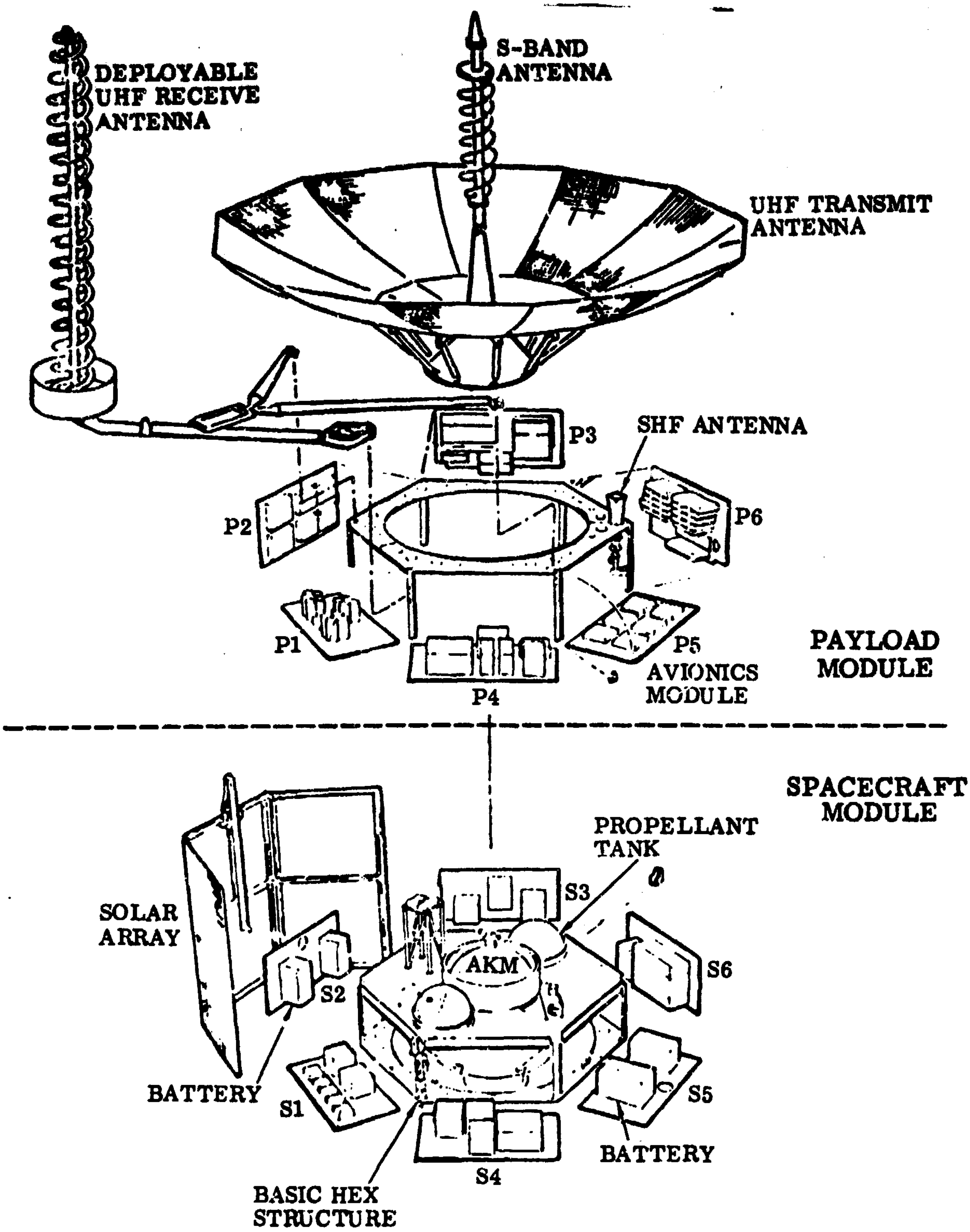


Fig. 4

LAUNCH VEHICLE CONFIGURATION

The Atlas SLV-3D/Centaur D-1A launch vehicle will be used for the FLTSATCOM mission. A summary of all airborne RF systems carried aboard the Atlas Centaur FLTSATCOM vehicle is presented below. The major GDC End Item Description (EID) assemblies is shown in Figure 5.

ATLAS CENTAUR/FLTSATCOM RF SYSTEMS SUMMARY

Vehicle Stage	Vehicleborne System	Subsystem or Link	Nominal RF Carrier Freq. (MHz)
Atlas	Telemetry	To be transmitted on Centaur TLM No. 1	
	Range Safety Command	Command Receivers (2)	416.5
Centaur	Telemetry	TLM No. 1, PCM/FM	2202.5
	Tracking	C-Band Transponder	Receive on 5690 Transmit on 5765
	Range Safety Command	Command Receivers (2)	416.5
FLTSATCOM Ref. 7b	Telemetry Tracking & Command	Uplink (S-Band) FSK/PM Downlink (S-Band) PCM/PSK/PM	1803.760 or 1811.768 2252.5 or 2262.5
	Communications	UHF Repeaters 23 channels (FSK) SHF Repeater 1 channel (X-Band) (PM)	250-400 7260-7995

ATLAS CENTAUR/FLTSATCOM SPACE VEHICLE MAJOR ASSEMBLIES IDENTIFICATION

- ATLAS/CENTAUR/FLTSATCOM SPACE VEHICLE ASSEMBLY
  - LAUNCH VEHICLE ASSY (GDC) EID NO. 55-0531 DWG. NO. 55-00531
    - ATLAS VEHICLE (FIRST STAGE) (GDC) EID NO. 69-0050 DWG. NO. 69-00070
    - ATLAS INTEGRATED ELECTRONIC PACKAGE (GDC) EID NO. 55-1400 DWG. NO. 55-00555
    - CENTAUR AIRBORNE SOFTWARE (GDC) EID NO. 55-0003 DWG. NO. 55-931XX
    - CENTAUR VEHICLE COMPOSITE ASSEMBLY (GDC) EID NO. 55-0532 DWG. NO. 55-00532
      - CENTAUR ASSEMBLY SECOND STAGE EID NO. 55-0533 DWG. NO. 55-00533
        - CENTAUR EQUIPMENT MODULE EID NO. 55-0592 DWG. NO. 55-00592
        - CENTAUR TANK EID NO. 55-0591 DWG. NO. 55-00591
      - ATLAS - CENTAUR INTERSTAGE ADAPTER EID NO. 55-0518 DWG. NO. 55-00078
      - PAYLOAD ADAPTER EID NO. 55-0608 DWG. NO. 55-00608
      - JETTISONABLE PANEL INSULATION EID NO. 55-0560 DWG. NO. 55-74045
      - PAYLOAD FAIRING ASSY. EID NO. 55-0527 DWG. NO. 55-79206
      - MISSION PECULIAR KIT FLTSATCOM EID NO. 55-0701 DWG. NO. 55-00701
      - SPACECRAFT PAYLOAD ADAPTER (GFP)
  - FLTSATCOM SPACECRAFT (TRW)
  - GENERAL ARRANGEMENT NASA/LeRC CR 600455; MECHANICAL DETAILS NASA/LeRC CR 600456; ELECTRICAL DETAILS NASA/LeRC CR 600457

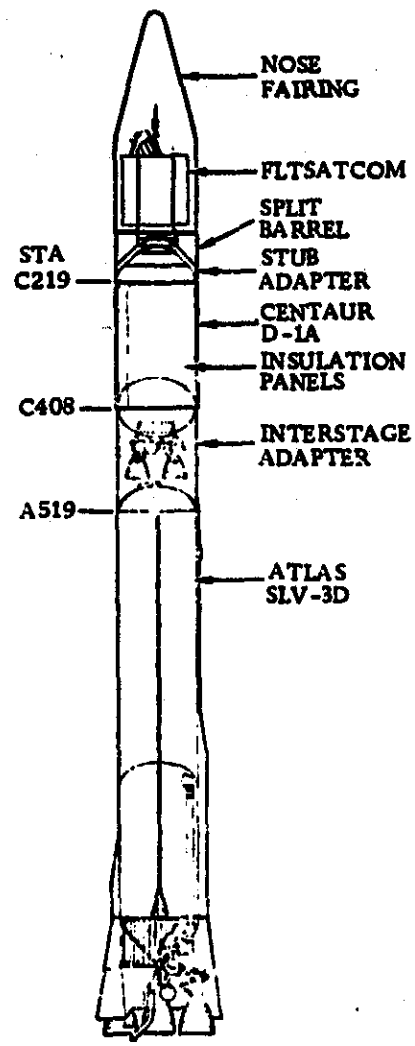


Fig. 5

ATLAS SLV-3D (First ;e) VEHICLE

The general arrangement of the Atlas SLV-3D first stage vehicle configuration to be used for FLTSATCOM is shown in Figure 6. A brief summary follows.

The SLV-3D basic vehicle consists of the basic first stage tank and thrust structures, propulsion, hydraulics, pneumatics, propellant depletion, range safety, retrorockets, vehicle battery, electrical power distribution, and pyrotechnic control systems. The SLV-3D propulsion system is a Rockwell International/Rocketdyne MA-5 engine system which burns RP-1 and LO_2. The MA-5 engine systems are each composed of a 370,000-pound (1.646 mN) thrust booster engine (with two thrust chambers), a 60,000-pound (266.9 kN) thrust sustainer engine with Mod II turbine, and a two 675-pound (3003 N) thrust vernier engines (nominal sea-level rating).

An SLV-3D Atlas Integrated Electronics Kit provides the electronics which integrate directly with each Centaur D-1A. This kit consists of a first stage servo inverter unit (SIU), a PCM telemetry remote multiplexer unit (RMU), a telemetry signal conditioning unit (all mounted in the Atlas equipment pod), and a rate gyro unit (RGU) mounted forward in the Atlas tank wiring tunnel at Station 535.

An SLV-3D interstage adapter mates each Atlas to its respective Centaur D1A. Each Centaur is separated in flight by detonating shaped charge assemblies attached to the perimeter of its adapter just below the Centaur tank attachment point. Eight 700-pound (3114 N) vacuum thrust retrorockets located aft on the cylindrical portion of each Atlas fuel tank are then fired to provide the required separation thrust.

The only RF system carried on each first stage is a range safety command (RSC) system consisting of two CEC Model CR-104B receivers, a power control unit, an Atlas destruct unit, two batteries, and associated antennas and hybrid junction.

CENTAUR D-1AR (Second Stage) VEHICLE

The general arrangement of the Centaur D-1AR second stage vehicle configuration to be used for FLTSATCOM is shown in Figure 7. A brief summary follows.

The D-1AR Centaur basic tank structure and mechanical systems are similar to those used on D-1AR Centaurs except that various changes, which were instituted on D-1T Centaurs, have been incorporated. The main propulsion system consists of two Pratt and Whitney RL10A3-3 LO_2/LH_2 liquid propellant engines, which provide an effective nominal combined thrust of 29,500 pounds (131.2 kN). The H_2O_2 system supplies H_2O_2 to the LO_2 and LH_2 boost pumps and to the twelve reaction control engines, which are mounted in four clusters on the aft bulkhead. Each cluster includes one pitch/roll engine (P1-P4) and one yaw/roll engine (Y1Y4). Two additional clusters contain two settling engines (S2A/S2B or S4A/S4B). The four 6-pound thrust settling engines provide 12 (53.4 N) or 24 pounds (106.8N) of axial thrust for propellant settling and retention and to affect small changes in vehicle axial velocity, and are not used for attitude control. The eight 6-pound (27 N) lateral thrust attitude control engines provide all coast phase pitch, yaw, and roll control even in the event of one engine failures-to-fire

GENERAL ARRANGEMENT OF ATLAS SLV-3D VEHICLE

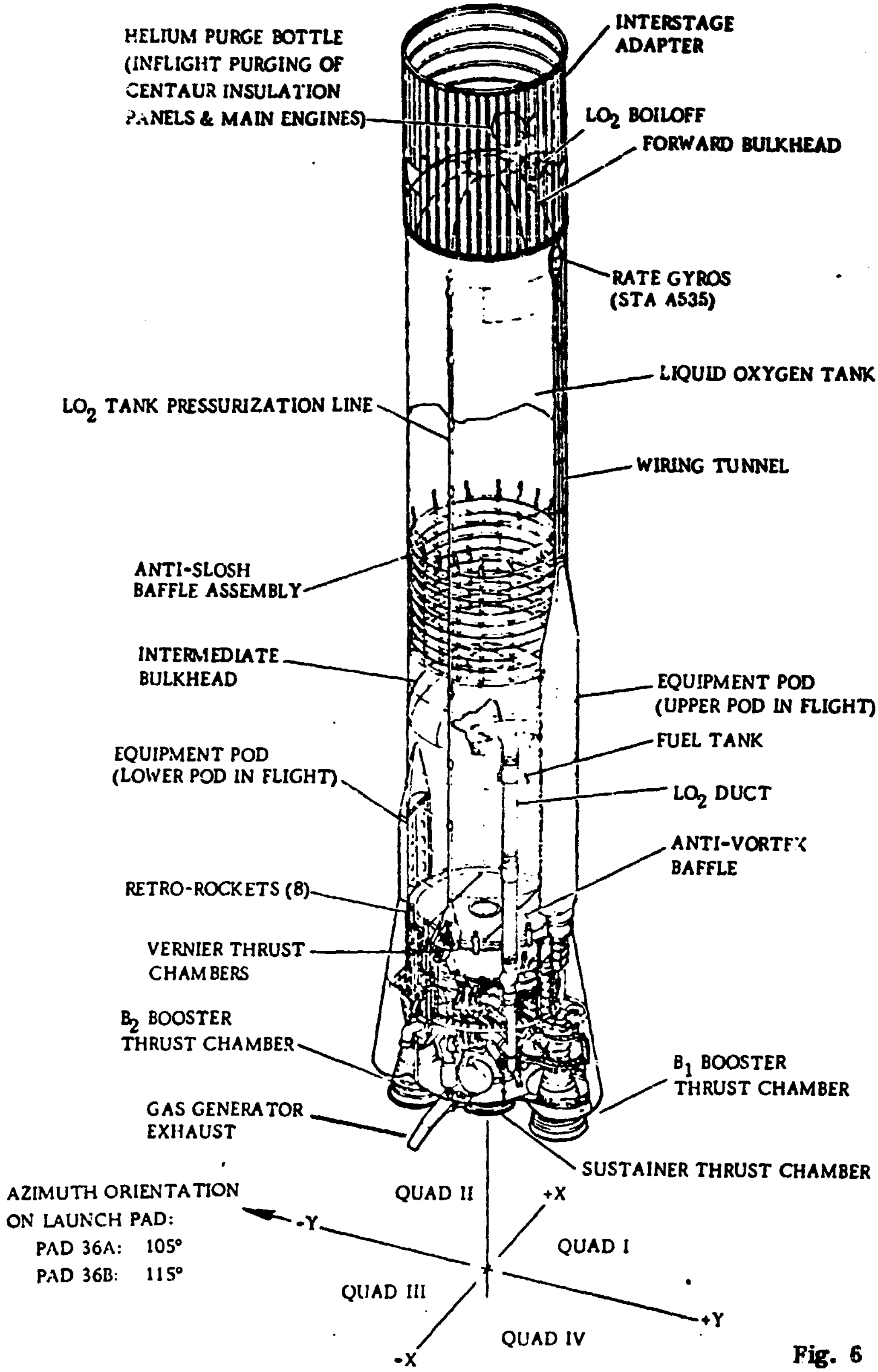


Fig. 6

GENERAL ARRANGEMENT OF CENTAUR D-1AR VEHICLE

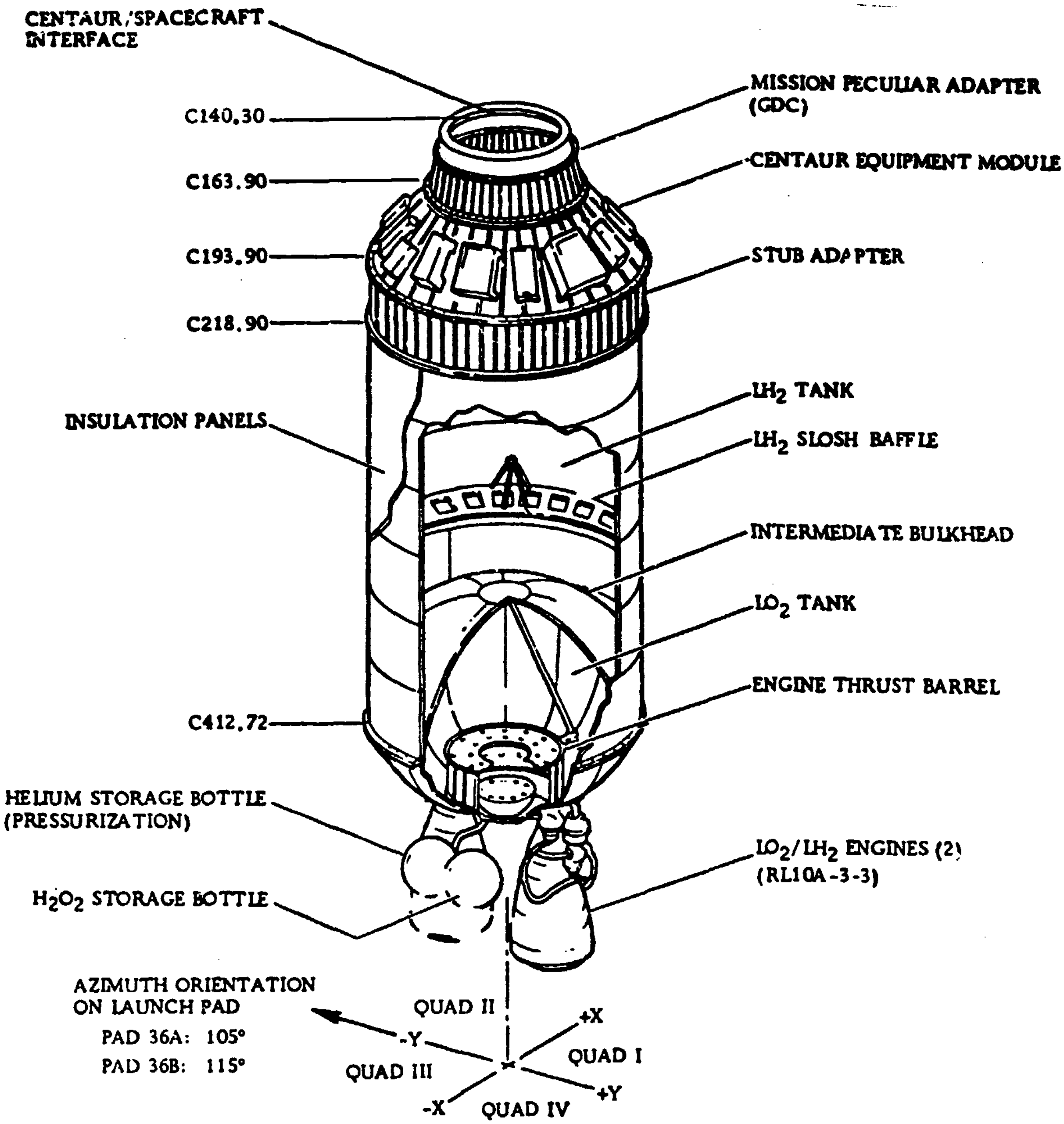


Fig. 7

and without failure detection. On D-1AR Centaurs, as on D-1T Centaurs, the Computer Controlled Vent and Pressurization System (CCVAPS) provides propellant tank pressure control throughout pre-MES and post-MECO tank pressurization periods and during the parking orbit coast period. CCVAPS provides failure detection and performs corrective action necessary to overcome redundant transducer and pressurization valve failures.

On D-1AR Centaur as on D-1A Centaurs, electronic packages are mounted on a conical equipment module structure instead of directly on the forward tank as on previous Centaurs. Attached to the forward apex of this equipment module is the GDC-provided FLTSATCOM mission peculiar adapter, which serves as the mounting structure for the TRW-provided FLTSATCOM payload adapter and spacecraft.

Centaur electronic systems (called astrionics) provide an integrated flight control system using airborne computer software to perform navigation, guidance, autopilot, attitude control, venting, pressurization, sequencing, telemetry, and data management functions for both Atlas and Centaur stages. At the heart of the system is a Teledyne digital computer unit (DCU) consisting of an advanced, high speed computer with a 16,384-work random-access memory. From the DCU, discretes are provided to a sequence control unit (SCU) for control of sequenced events on both stages. During powered phases, the DCU provides steering commands to the Atlas and Centaur servo inverter units (SIUs); during in-orbit maneuvering phases, it provides H_2O_2 engine firing commands to the Centaur SCU. Inertial sensing and inertial vector-to-vehicle coordinate transformations are performed by a Honeywell four-gimbal, all-attitude stable platform called the inertial reference unit (IRU). A system electronic unit (SEU) provides conditioned power and control functions for the IUR. The combination of the IRU and the SEU forms the inertial measurement group (IMG).

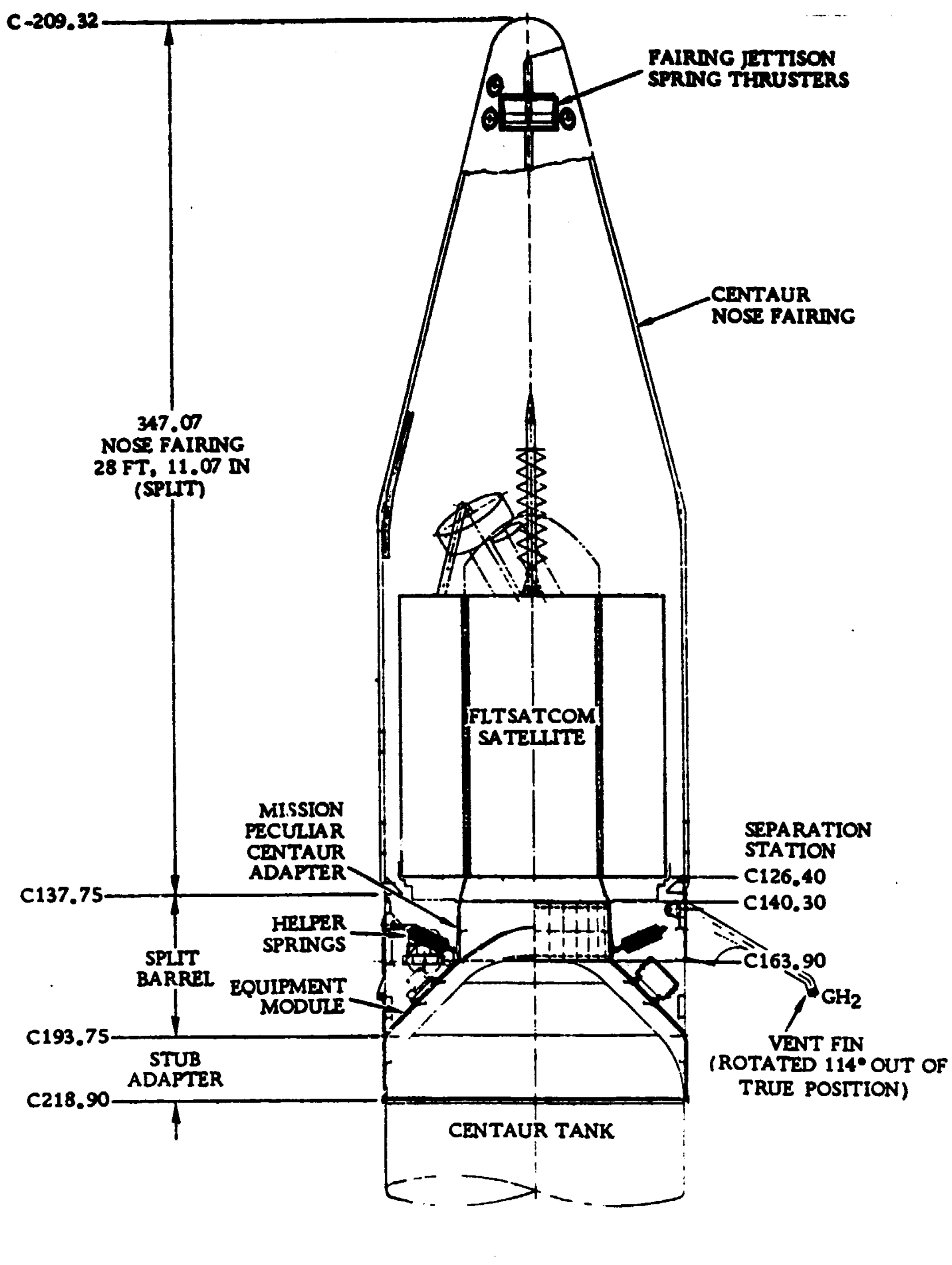
All telemetry data from both the Atlas and Centaur stages are transmitted by an S-band PCM transmitter on the D-1AR. The central controller unit (CCU) for the PCM system is housed in the DCU. The CCU serves two remote multiplexer units (RMUs) on the Centaur stage and one on the Atlas stage. PCM bit rate is 267,500 bits per second.

Other RF systems carried on the second stage consist of a C-band beacon and an RSC system. The C-band beacon, consisting of a transponder, two antennas, and a power divider, operates in conjunction with the range radars to provide vehicle tracking information. The RSC system consists of two receivers, two batteries, a Centaur destruct initiator, a mild detonating fuse train, a destruct charge, a power control unit, two antennas, and a hybrid junction.

CENTAUR D-1A/FLTSATCOM INTERFACE CONFIGURATION

The general arrangement of the Centaur D-1A/FLTSATCOM spacecraft interface configuration and the Centaur D-1A payload fairing assembly is shown in Figure 8.

GENERAL ARRANGEMENT OF CENTAUR/FLTSATCOM/PAYLOAD FAIRING INTERFACE



C - CENTAUR STATIONS SHOWN

Fig. 8

Major assemblies include the FLTSATCOM Payload Adapter (provided by TRW), the Centaur FLTSATCOM Mission Peculiar Adapter (MPA) (provided by GDC), and the Payload Fairing Assembly consisting of a fiberglass nose fairing forward section and an aluminum split barrel aft section (provided by GDC).

The Centaur/FLTSATCOM mechanical interface is the mating plane between the two payload adapter sections (Sta. 140.30). The field joint between the Centaur and the encapsulated spacecraft assembly, however, occurs at the base of the MPA (Sta. 163.90). The MPA serves as the support structure for the spacecraft during encapsulation and transport to the pad. Centaur/FLTSATCOM inflight separation occurs at the forward end of the TRW adapter (Sta. 126.40). Electrically, interfaces occur between the payload adapter sections for instrumentation and the spacecraft separation firing pulse provided from Centaur to the FLTSATCOM separation pyrotechnics.

ORGANIZATION AND RESPONSIBILITIES

The Atlas Centaur prelaunch and launch operations at ETR will be performed by Convair Division of General Dynamics (GDC) under contractual direction from the NASA Lewis Research Center (LeRC). The FLTSATCOM spacecraft prelaunch and launch operations will be performed by the Thompson Ramo Woolridge, Inc. (TRW) under contractual direction from the Space and Missile Systems Organization/Deputy for Space Communications (SAMSO/SK) Project Manager.

Operational and technical direction over prelaunch operations of the launch vehicle and launch countdown operations of the launch vehicle/spacecraft combination will be administered by the Kennedy Space Center/Expendable Vehicle Directorate (KSC/EVD). The GDC Test Conductor, responsible to the designated KSC/EVD Launch Director, will conduct the overall launch countdown of the total vehicle, including the spacecraft. The GDC Centaur Launch Operations Group, headed by the GDC Complex 36 Site Manager, will be responsible for preparation and checkout of the Atlas and Centaur stages, associated GSE, launch complex, and participation in the launch countdown.

At FLTSATCOM spacecraft separation from the Centaur vehicle, all primary control of the spacecraft flight operations becomes the responsibility of SAMSO/SK.

ORGANIZATIONAL ELEMENT	RESPONSIBILITIES
FLTSATCOM System Program Director Deputy for Space Communication Systems; Space & Missile Systems Organization	F. S. McCartney, Brigadier General, USAF: accomplishment of the program, integrating program systems, identifying program requirements, maintaining program control.
Program Office	NASA Office of Space Transportation Systems (STS) is responsible for direction of the program and assignment of responsibility of other NASA agencies.
Program Manager Associate Administrator	J. Yardley, NASA/OSTS (Code M); management direction, evaluation of program progress, budgetary management.
Field Center	NASA Lewis Research Center; field management of the project.
Chief, Vehicle Engineering Div.	L. J. Ross, NASA/LeRC; technical design, launch vehicle integration, development, fabrication, testing, operation of the NASA Atlas-Centaur vehicle.

Tracking & Data Systems Manager	K. McDonald, NASA/GSFC; responsible for all tracking and data systems requirements for the GSFC Space Flight Tracking & Data Network (STDN).
Range Coordination Manager	R. E. Orzechowski, NASA/LeRC; planning and coordination of range, launch vehicle tracking, and data support requirements.
Project Engineer	K. Adams, NASA/LeRC; monitoring and coordinating the launch vehicle-space craft interface.
Launch Director	G. F. Page, NASA/KSC/EVD; preparation and launch of space vehicle.
GD Convair Program Director Launch Vehicle Programs	C. E. Wilson - Director of Launch Programs for GDC.
GD Convair Program Office	R. Benzwi, Manager of FLTSATCOM launch vehicles for GDC.
	D. J. Sarokon - Management of GDC/ETR Base Activities

Prelaunch
Mission Operation Report
No. M-491-202-79-02

MAY 1 1979

TO: A/Administrator

FROM: M/Associate Administrator for Space Transportation Systems

SUBJECT: FLTSATCOM-B Launch

The 2nd in a series of Fleet Satellite Communications System (FLTSATCOM) spacecraft will be launched by an Atlas Centaur (AC-47) from Cape Canaveral, Florida, by NASA, no earlier than May 3, 1979. The spacecraft will provide communication capability for the United States Air Force (USAF) with narrowband and wideband channels and the United States Navy (USN) for fleet relay and fleet broadcast channels.

John F. Yardley

John F. Yardley