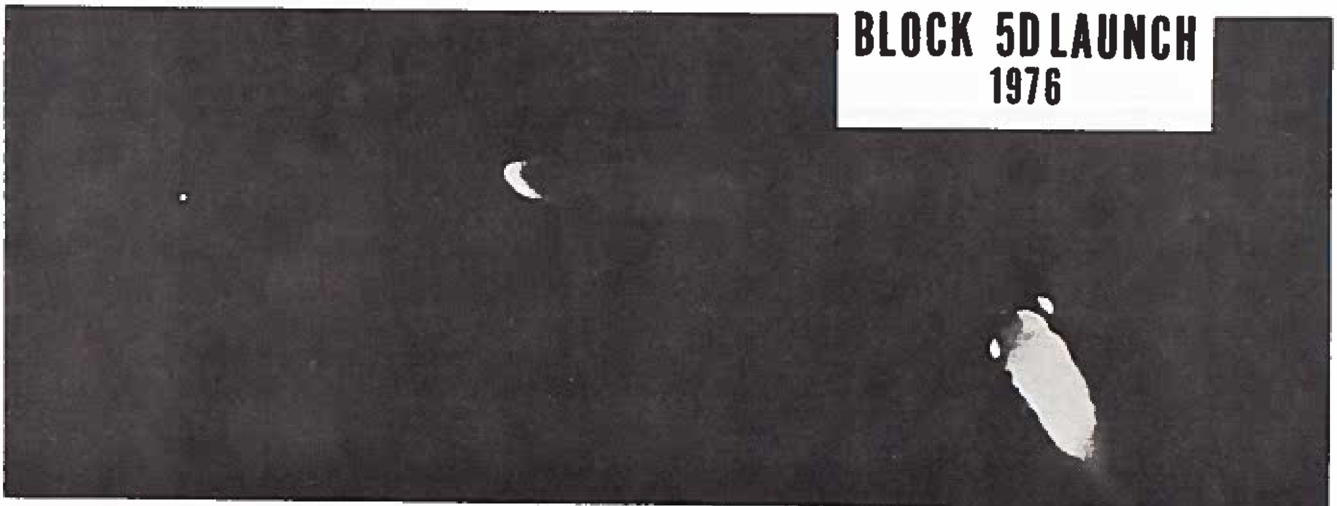
03 JUN 1980

DEFENSE METEOROLOGICAL SATELLITE PROGRAM

BLOCK 5D LAUNCH



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HEADQUARTERS
SPACE AND MISSILE SYSTEMS ORGANIZATION
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE

DEFENSE METEOROLOGICAL SATELLITE PROGRAM

The Defense Meteorological Satellite Program's Space Segment consists of two satellites in 450 nautical mile (nm) sun-synchronous polar orbits each carrying a payload of meteorological sensors. Primary cloud imaging sensors capable of globally viewing the earth in the visible (0.4 - 1.1 micrometers) and infrared (8 - 13 micrometers) spectrums are carried by every satellite. The ascending node of one satellite is in the early morning time period while the other is at mid-day. Each satellite collects data continuously scanning a crosstrack swath 1600 nm wide. The final data product is either in computer format or film product directly usable for imagery analysis.

The satellites are commanded and controlled from sites located at Loring AFB, Maine (Site 2) and Fairchild AFB, Washington (Site 1) which also receive stored data read from tape recorders on board the spacecraft. This data is relayed to the Air Force Global Weather Central at Offutt AFB, Nebraska (Site 3) over a communication satellite link.

Data is also directly transmitted as collected (in real time-not stored) from the DMSP satellite to Air Force and Navy ground terminals and Navy ground terminals and Navy carriers located throughout the world.

The Program has expanded to include sixteen Air Force and two Navy transportable terminals. These terminals can be deployed worldwide and made operational within 72 hours. Each is operated by a 2-man operator-maintenance crew. At the present time the U.S. Navy operates a data terminal on board the carrier USS Constellation and another on board the carrier USS JF Kennedy. Plans also call for outfitting additional carriers with this capability. These stations employ a 2-antenna concept -- one on each side of the flight deck.

DMSP has a payload test facility at Vandenberg AFB, California (Site 4) for system checkout at launch and on-orbit analysis.

The program's Command and Control Center (CCC) is at Offutt AFB, Nebraska (Site 5). The 4000th Aerospace Application Group (SAC) is responsible for the on-orbit commanding through Sites 1 and 2 and the orbital telemetry analysis performed at the CCC.

THE 5D SPACECRAFT

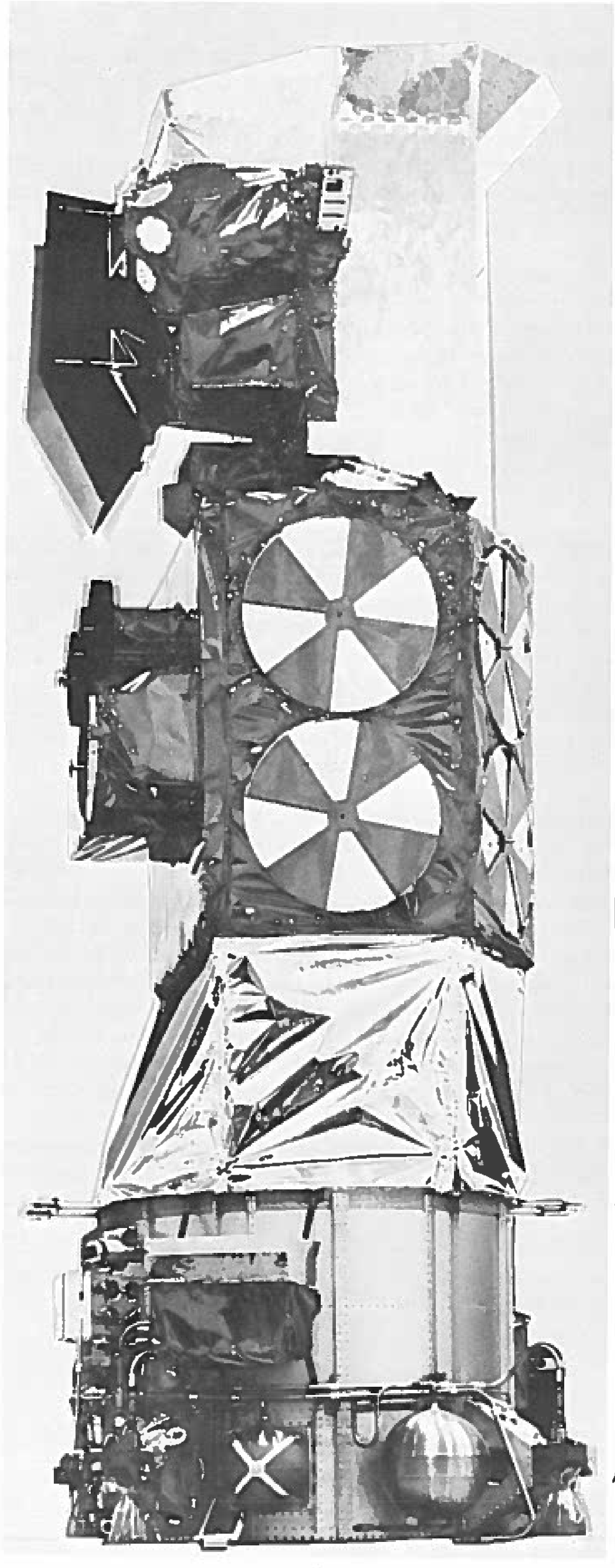
The Block 5D spacecraft is an "integrated spacecraft" in that specific functions of a launch vehicle upper stage have been integrated into the satellite. In particular, the Block 5D spacecraft provides ascent phase guidance for the launch vehicle from lift-off through orbital insertion as well as upper stage electrical power, telemetry, and attitude control. The spent third stage propulsion and reaction control systems are carried into orbit. This configuration affords considerable weight savings over the conventional booster/spacecraft configuration. This savings has been reallocated to provide selective redundancy of life limiting components of the spacecraft. The integrated spacecraft was also designed with an expanded power subsystem to meet payload requirements.

The major structural sections of the spacecraft are: (1) a precision mounting platform (PMP) for mounting sensors and other equipment requiring precise alignment, (2) an equipment support module (ESM) which encloses the bulk of the electronics, (3) a reaction control equipment (RCE) support structure (RSS) which contains the spent third stage rocket motor and supports the reaction control equipment, and (4) a sun tracking solar cell array. The design of a precision mounting platform in combination with an equipment support module allows for an increase in spacecraft capacity for redundant equipment, thereby improving system reliability. The spacecraft is capable of supporting 300 lbs of sensor payload on orbit, of which 95 lbs is available for special sensors. The nominal on-orbit spacecraft weight is 1032 lbs.

A highly accurate attitude determination and control subsystem (ADACS) permits precise pointing of the primary imaging sensor (The OLS - Operational Linescan System). The subsystem includes three orthogonal gyroscopes which measure short-term changes in attitude while a star sensor provides long-term update to bound effects of gyro drift. The desired attitude is computed based upon star catalogs and ephemeris tables uplinked to the spacecraft central processor unit on a periodic basis.

A separate backup attitude determination subsystem on the Block 5D spacecraft provides attitude control about one tenth the accuracy of the primary system. This subsystem consists of a solid state earth sensor assembly which provides pitch and roll information to the central processor, and a sun sensor which in conjunction with the gyro package provides yaw information. The software programs for both primary and backup attitude determination are resident in each of two fully redundant central processor units.

S/C -Y VIEW



PMP
PRECISION MOUNTING PLATFORM

ESM
EQUIPMENT SUPPORT MODULE

RSS
REACTION CONTROL EQUIPMENT SUPPORT STRUCTURE

Three-axis attitude control is maintained in the orbital configuration by automatic momentum exchange between three momentum wheels. On-board magnetic coils provide controlled interaction with the earth's magnetic field to prevent the accumulation of wheel secular momentum. Operation of these coils is under the control of the closed-loop spacecraft attitude control system. Both the momentum wheels and gyros are backed up by a fourth skewed unit for redundancy.

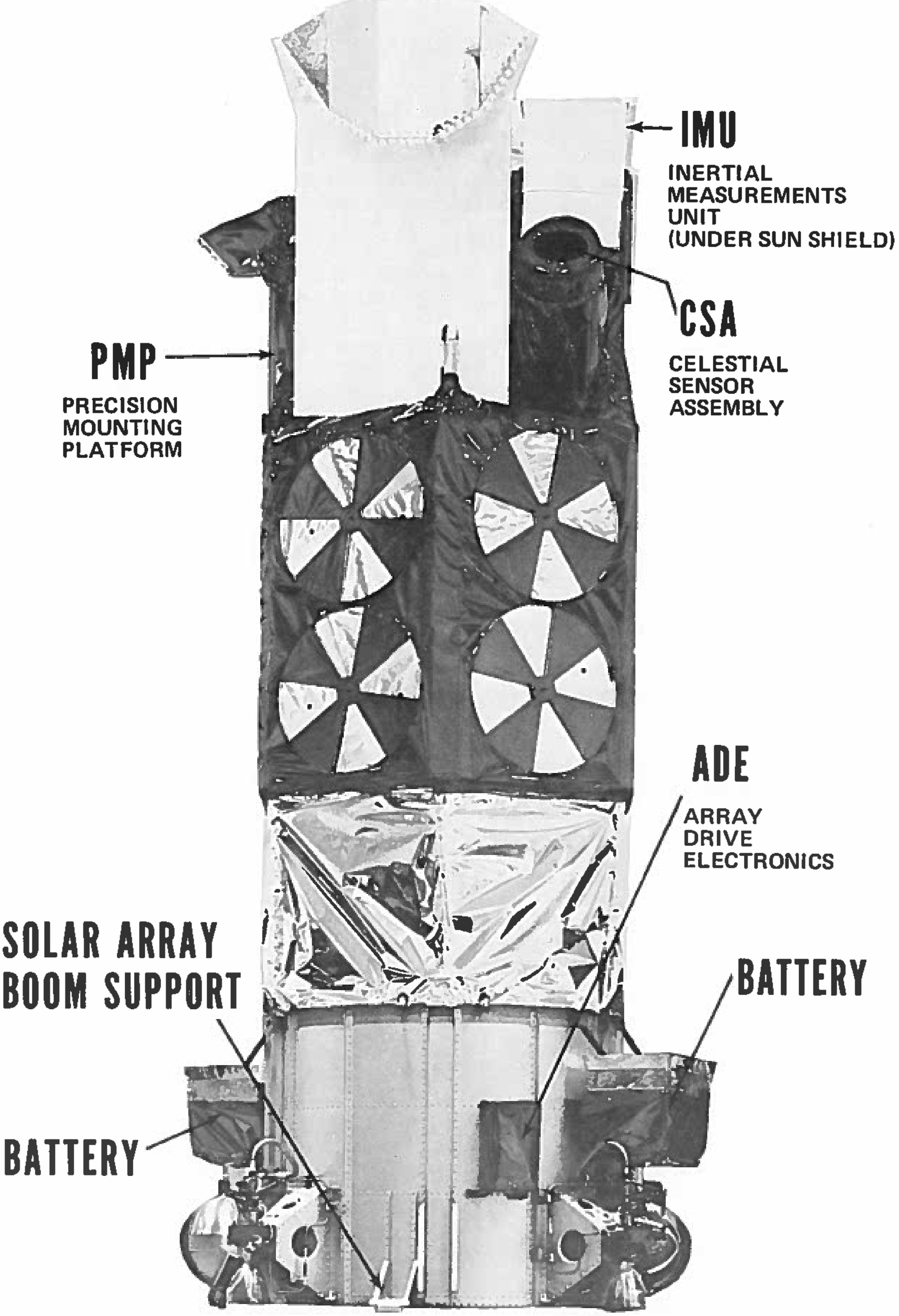
A closed-loop on-board digital system provides ascent phase guidance. Ascent phase attitude is determined by three orthogonal accelerometers and the same three orthogonal strapped-down gyros used for orbital attitude determination. Outputs from these inertial measurement devices are processed by one of the on-board central processors to determine inertial position, attitude and time derivatives. The guidance portion of the on-board ascent phase software computes a new trajectory each 20 milliseconds based upon computed position and velocity errors, and a description of the desired final orbit and issues appropriate steering commands.

Ascent phase attitude control is accomplished through a combination hot and cold gas reaction thruster array. The hot gas system uses hydrazine as a monopropellant. Each of the four pitch/yaw hydrazine thrusters produces 155 lbs of vacuum thrust and can be reduced, on command, to 65 lbs thrust. The high thrust mode is used for first stage separation thrusting and attitude control during second stage burn. The low thrust mode is used for second stage separation, attitude control during third stage burn, and the final velocity trim maneuver. A cold gas nitrogen system provides low level thrusting for attitude control during coast phases.

The primary functions of the command and control subsystem are to process the uplinked spacecraft and sensor commands, to monitor/control the operating configuration of the various spacecraft equipments, and to provide clock signals for all spacecraft functions. The heart of the subsystem consists of two fully redundant high speed, digital central processing units. Although these units are part of the command and control subsystem, they perform the additional functional requirements of boost guidance support, primary orbital attitude determination and control, back-up orbital attitude determination and control, and solar array orientation control. The central processor programs are loaded in the spacecraft memory and can be changed by uplinked commands, if necessary, during orbital operations.

The spacecraft command and control subsystem accepts sensor commands as well as spacecraft commands and routes valid sensor commands to the primary sensor for further processing within its central processing unit.

S/C -X VIEW


IMU
INERTIAL MEASUREMENTS UNIT (UNDER SUN SHIELD)
CSA
CELESTIAL SENSOR ASSEMBLY
PMP
PRECISION MOUNTING PLATFORM
ADE
ARRAY DRIVE ELECTRONICS
SOLAR ARRAY BOOM SUPPORT
BATTERY
BATTERY

The power subsystem is a direct energy transfer system. The Block 5D solar cell array is a planar array that is rotated about one axis to track the sun. Power from the solar cell array is either conditioned for direct use by the spacecraft components, stored in a nickel-cadmium battery or shunted through resistive power dissipators on the array. The sun attitude is computed from ephemeris data in the central processor. The solar array is deployed and erected following spacecraft orbital injection. The direct energy system is capable of supporting loads requiring 290 watts of orbit average power.

The communication subsystem consists of two functional groups: the data transmission group, and the telemetry/receiver group.

The data transmission group consists of three S-band transmitters and three earth-oriented antennas, two of which are cross-strapped for redundancy. The data rates for real time data are 1.024 megabits per second (mbs) and for stored data 1.3312 or 2.6624 mbs.

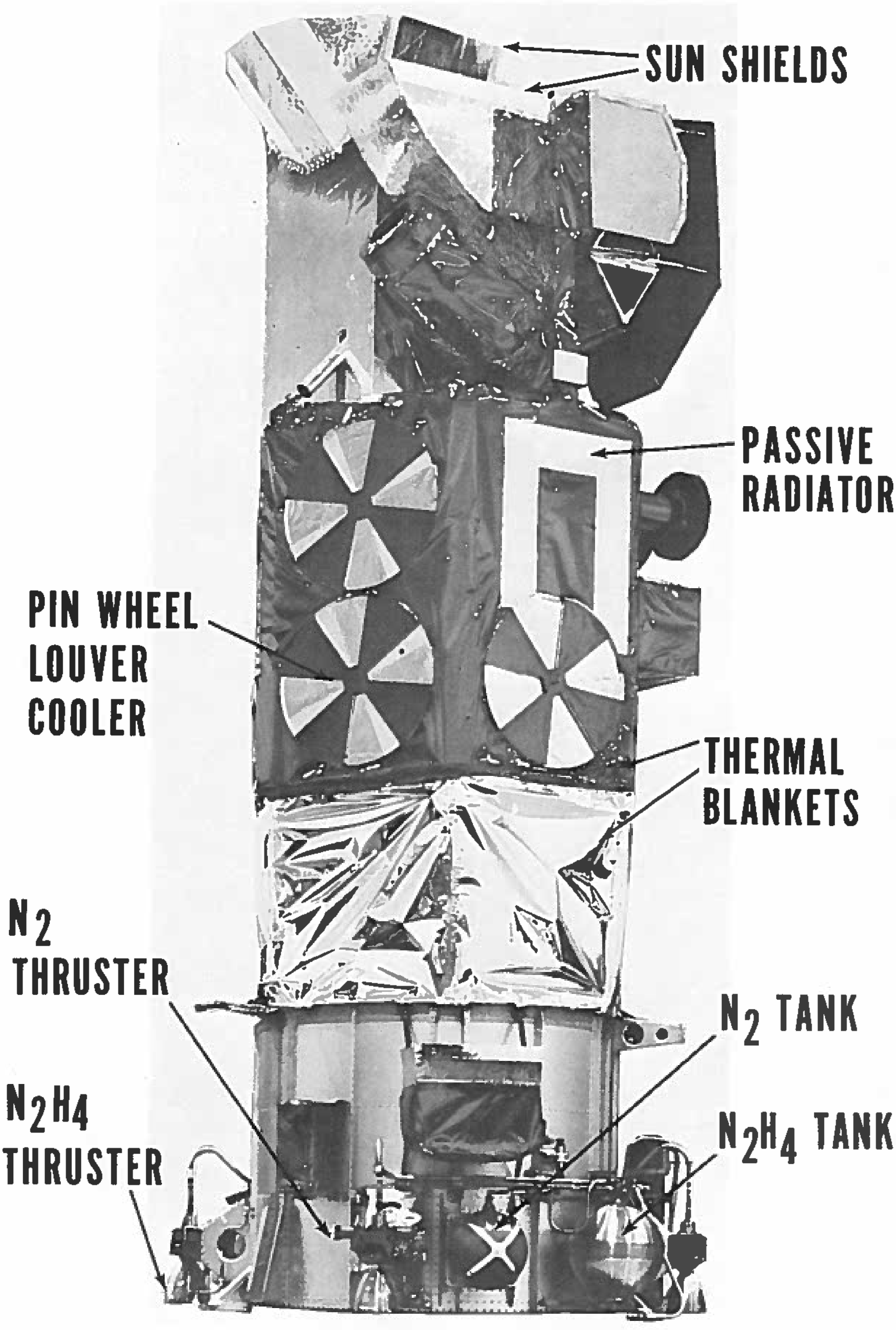
Dual redundant S-band transmitters are provided for equipment status telemetry. One radiates through a pair of bifilar antennas which provide spherical coverage, allowing all-attitude telemetry communication with the fixed ground sites, and the other radiates through an S-band antenna identical to the earth-oriented data antennas. These transmitters can be used in a back-up mode for transmitting sensor data.

The receiver/demodulator is a redundant S-band unit which is used to receive both command data and central processor programming data for the spacecraft and the primary sensor. The uplinked signals are received through the bifilar omni-antennas. The uplink command rate is 1 kilobit per second (kbs).

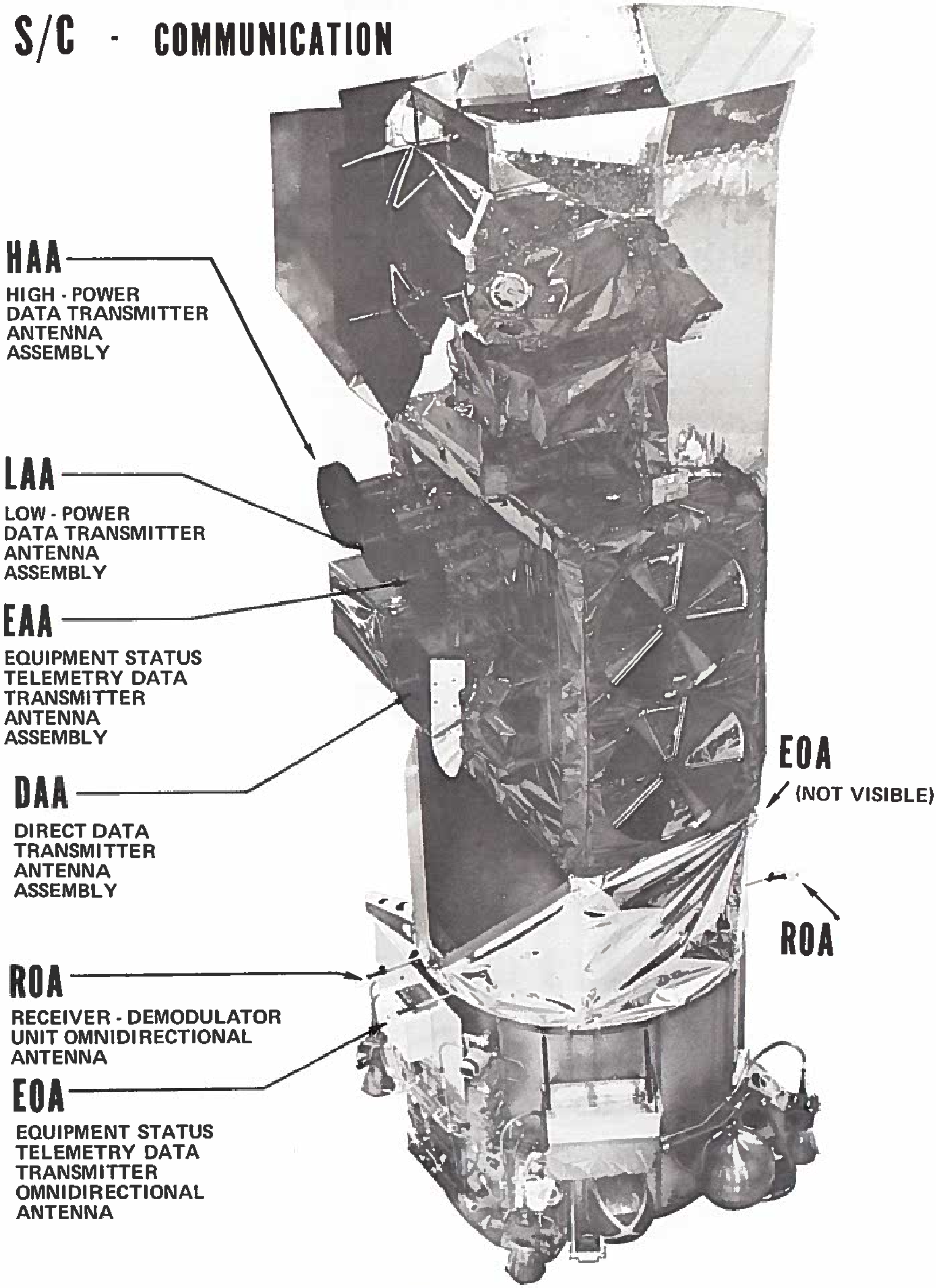
The thermal control subsystem protects all spacecraft components from potentially damaging thermal extremes. The precision mounting platform is carefully controlled to eliminate thermal gradients which could cause distortion and resulting sensor misalignment.

Passive thermal control techniques include the use of selected finishes, first and second surface radiators, and insulation blanketing. Active control requiring heat addition is accomplished with strip heaters. Active control requiring heat rejection is accomplished by placing variable geometry louvers in the radiator's cold space field-of-view.

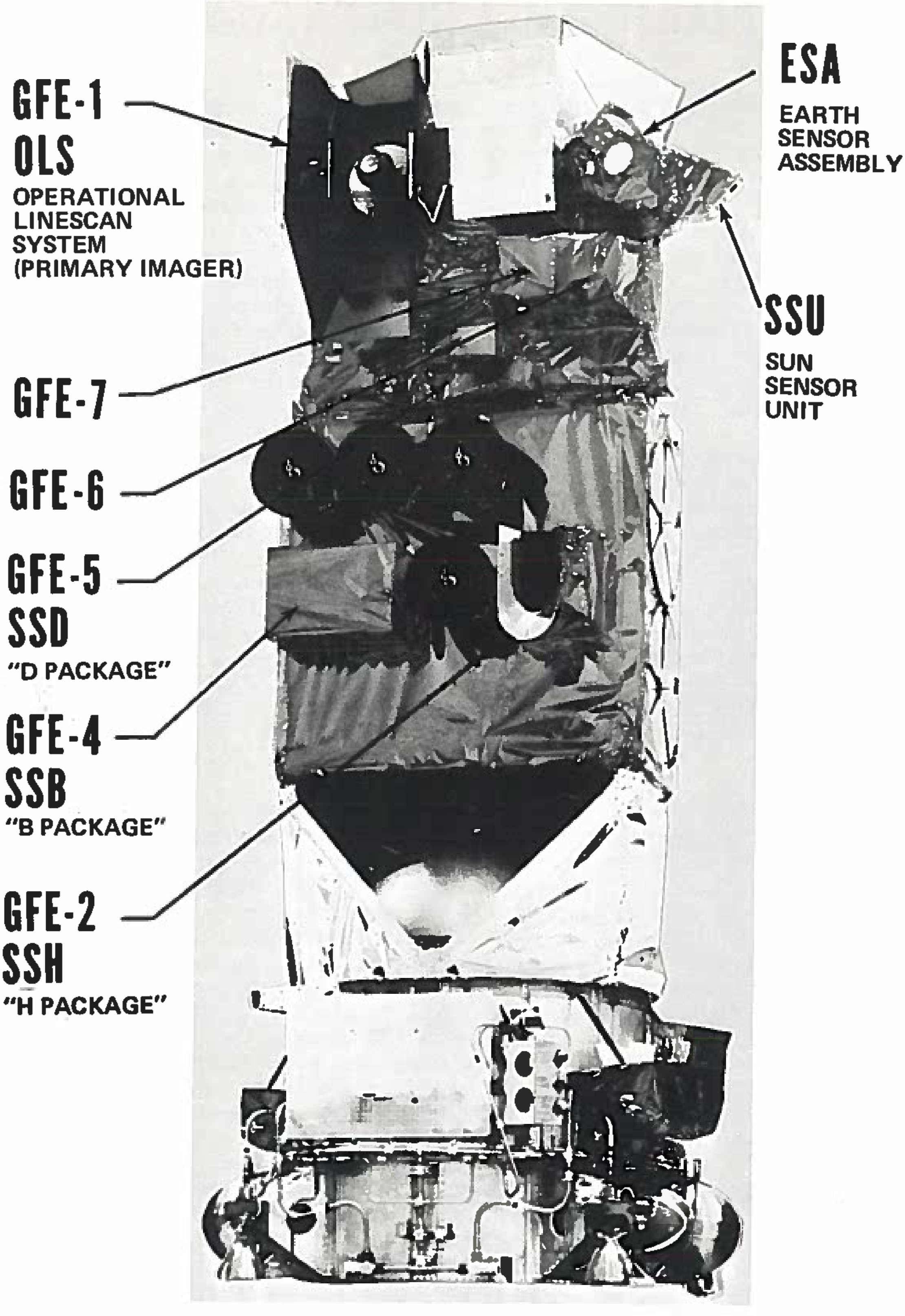
S/C +X, +Y VIEW


SUN SHIELDS
PASSIVE RADIATOR
PIN WHEEL LOUVER COOLER
THERMAL BLANKETS
N_2 THRUSTER
N_2 TANK
N_2H_4 THRUSTER
N_2H_4 TANK

S/C - COMMUNICATION



S/C - SENSORS +X VIEW



THE OPERATIONAL LINESCAN SYSTEM (OLS)

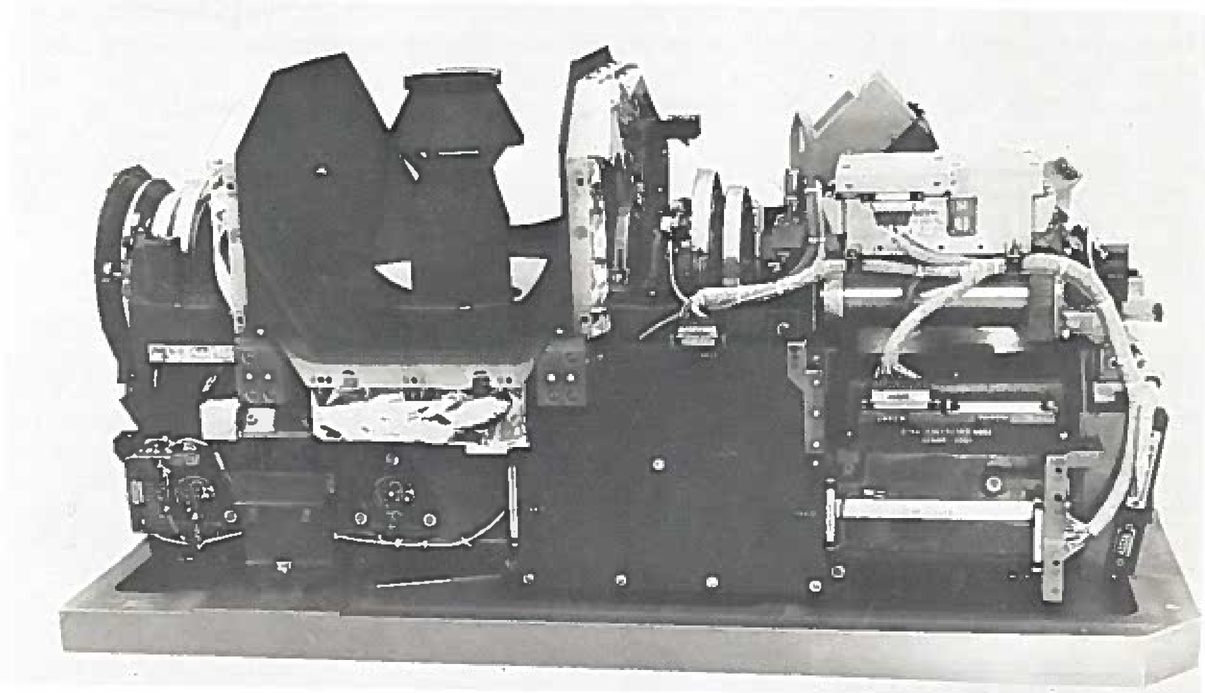
The OLS is the primary imagery data acquisition system on the Block 5D spacecraft. This system gathers visual and infrared imagery data from earth scenes and provides such data, together with appropriate calibration, indexing, and other auxiliary signals, to the spacecraft for transmission to ground stations. The data is collected, stored and transmitted in fine (F data) or smoothed (S data) resolution. The OLS has a scanning optical telescope system driven in a sinusoidal motion by counter-reacting coiled springs and a pulsed motor. This motion moves the instantaneous field-of-view of the detectors across the satellite subtrack, with maximum scanning velocity at nadir and reversals at end of scan. Detector size is dynamically changed to reduce angular instantaneous field-of-view as it nears each end of scan, thereby maintaining an approximately constant footprint size on earth. The swath width is 1600 nm from a nominal altitude of 450 nm.

The optics consist of a cassegrain telescope, whose elements are common to both visual and infrared imagery, and a set of relay optics that separates the wavelengths and fields-of-view for the different detectors. On-board pre-processing of the data by the OLS provides for the various modes of data output. The OLS provides global coverage in both visual (L data) and thermal (T data) modes. Fine resolution data is collected continuously, day and night, by the infrared detector (TF data), and continuously during daytime only by a segmented, silicon diode detector (LF data). Fine resolution data has a nominal linear resolution of 0.3 nm. Tape recorder storage capacity and transmission constraints limit the quantity of fine resolution data (LF or TF) which can be downlinked from the stored data fine (SDF) mode to a total of 80 minutes of LF and TF data per ground station readout.

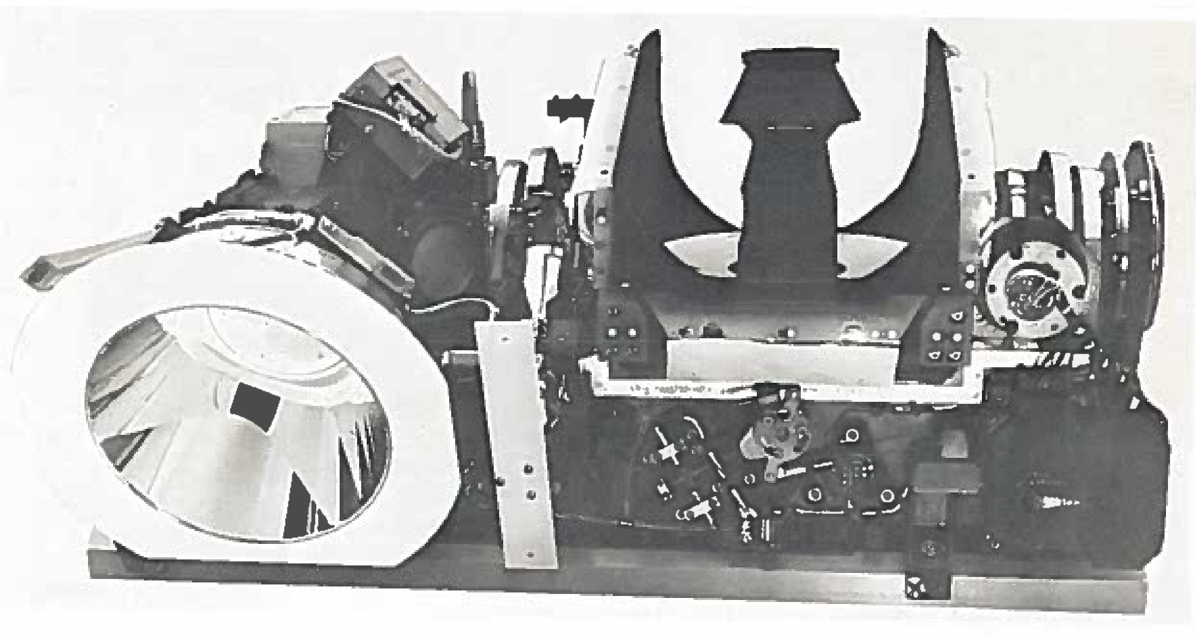
Data smoothing permits global coverage in both the infrared (TS) and visible (LS) spectrum to be stored on the tape recorders in the stored data smoothed (SDS) mode. Smoothing is accomplished by electrically reducing the sensor resolution to 1.5 nm in the along scan direction, then digitally averaging five such .3 x 1.5 nm samples in the along track direction. A nominal linear resolution of 1.5 nm results. 400 minutes of LS and TS data may be downlinked in a single ground station readout. An additional detector allows collection of visible data (LS) with a 1.5 nm nominal linear resolution under low light level conditions. In the fine mode visual (LF) channel, a 3-segment silicon diode detector is switched at ±400 nm from subtrack, using either of two segments from that point to end of scan. All three segments are used and summed together within 400 nm of nadir. Detector geometry and segment switching compensate for the optical rotation of the field-of-view, as a function of scan angle. A mirror in the telescope assembly is dynamically driven to accomplish image motion compensation by removing the satellite's along track motion of the instantaneous field-of-view to preserve scan line contiguity. The visual daytime response of the OLS is in the spectral range of 0.4 to 1.1 microns; chosen so as to provide maximum contrast between earth, sea and cloud elements of the image field. The visual fine mode is provided for day scenes only. The infrared detector, consisting of two segments, is switched at nadir to

OLS-OPERATIONAL LINESCAN SYSTEM

PRIMARY IMAGER FOR BLOCK 5D



SSS +Z VIEW



SSS –Z VIEW

provide approximately constant ground footprint and image derotation. The detector is a tri-metal (HgCdTe) detector operating at approximately 105°K. The OLS infrared spectral response of 8 to 13 microns was chosen to optimize detection of both water and ice crystal clouds. The sensor output is normalized in terms of the equivalent blackbody temperature of the radiating object. A shaping network is employed to change the fourth-power-of-temperature response of the detector so that sensor output voltage is a linear function of scene temperature. This detector is passively cooled by a radiative cooler viewing free space. This tri-metal detector is accurate to within 1°K rms across the (equivalent blackbody) temperature range 210°K to 310°K. The noise equivalent temperature difference (NETD) of the infrared system is well within 1°K across this same range.

The OLS data processing subsystem performs command, control, data manipulation, storage, and management functions. Commands are received from the ground through the spacecraft command system, stored in the OLS and processed by the OLS according to time codes. The OLS executes commands, accomplishes the smoothing of fine resolution data, derives gain commands from orbital parameters for normalization of visual data and dynamic signal control, and outputs the data to the spacecraft communications system. All data is processed, stored and transmitted in digital format. The OLS also provides the data management functions to process, record and output data from up to six additional meteorological sensors.

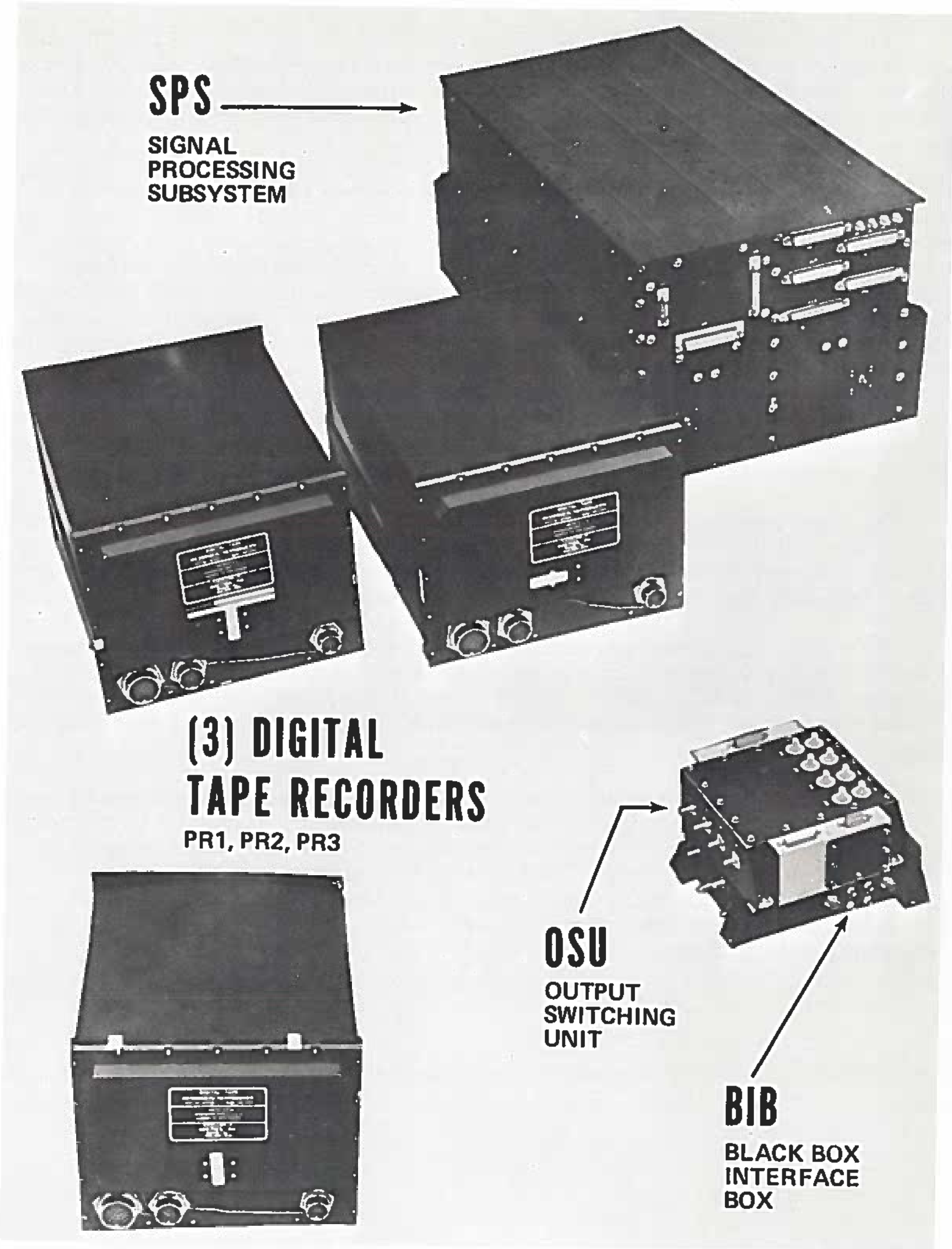
A combination of either fine resolution data and the complementary smoothed resolution data (i.e., LF and TS or TF and LS) can be provided in the direct digital transmission mode. Either encrypted or clear direct data can be output simultaneously with two channels of stored data. The OLS system includes and controls three digital tape recorders, each with a storage capacity of 1.67×10^9 bits. Each recorder can record at any one of three data rates and play back at either of two data rates. These rates are:

INPUT	STORAGE (Per Recorder)
66.56 Kbps (LS and TS interleaved bit by bit)	400 minutes
1.3312 Mbps (LF and TF interleaved bit by bit)	20 minutes
665.6 Kbps (LF or TF only)	40 minutes

OUTPUT	TIME/DATA
2.6624 Mbps	10 minutes/All LS and TS
2.6624 Mbps	10 minutes/All LF and TF
1.3312 Mbps	20 minutes/All LF or TF

All tape recorders are interchangeable in function, providing operational redundancy and enhanced system life expectancy.

OLS -DATA PROCESSING EQUIPMENT



SPECIAL SENSOR H (SSH)

The Defense Meteorological Satellite Program (DMSP) block 5D satellite will contain an infrared multispectral sounder for humidity, temperature and ozone. The SSH provides soundings of temperature and of humidity and a single measurement of ozone for vertical and slant paths lying under and to the side of the sub-satellite track.

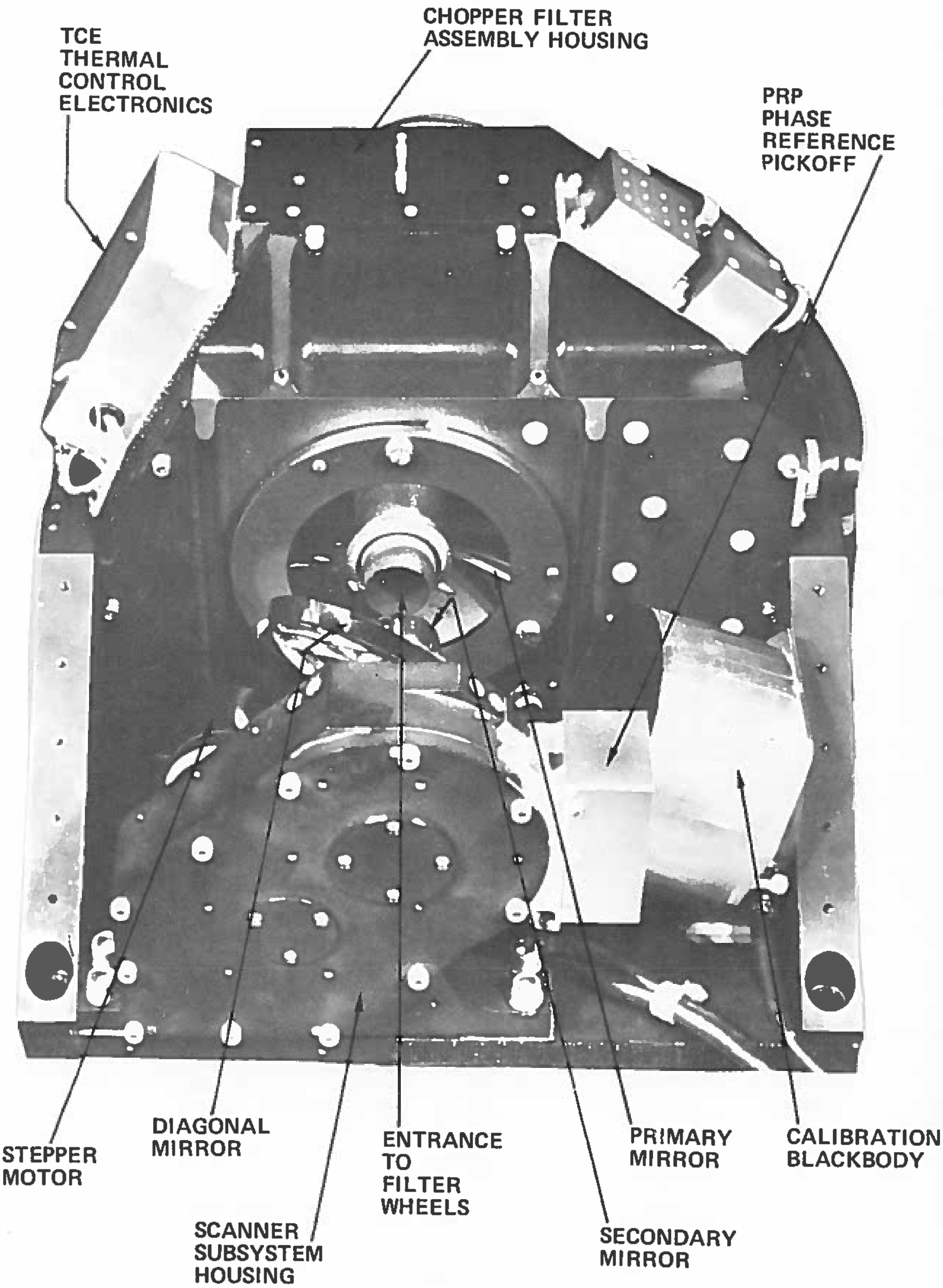
The SSH makes a set of radiance measurements in narrow spectral channels lying in the absorption bands of carbon dioxide, water vapor, and ozone. These radiance measurements are mathematically inverted to yield vertical profiles of temperature and of water vapor and the total ozone content. The radiative transfer equation expresses upwelling radiance in each spectral channel as a function of the vertical temperature profile, the vertical compositional profile and spectroscopic transmission functions. Transmission functions have been developed from laboratory and field measurements, correlated by molecular theory and compiled. Several inversion techniques have been developed to provide approximate solutions to the radiative transfer equation, yielding either the temperature profile or the compositional profile if the other profile is known.

For temperature sounding, radiances are measured in narrow channels in the wing of the 15 μm carbon dioxide absorption band. CO_2 is taken to have a constant mixing ratio or other assumed vertical compositional profile. Solution then yields the vertical temperature profile.

For humidity sounding, channels are selected to provide a range of absorption coefficients in the rotational water vapor band. The vertical temperature profile is available from simultaneously measured data as described above. The inversion therefore yields the vertical humidity profile.

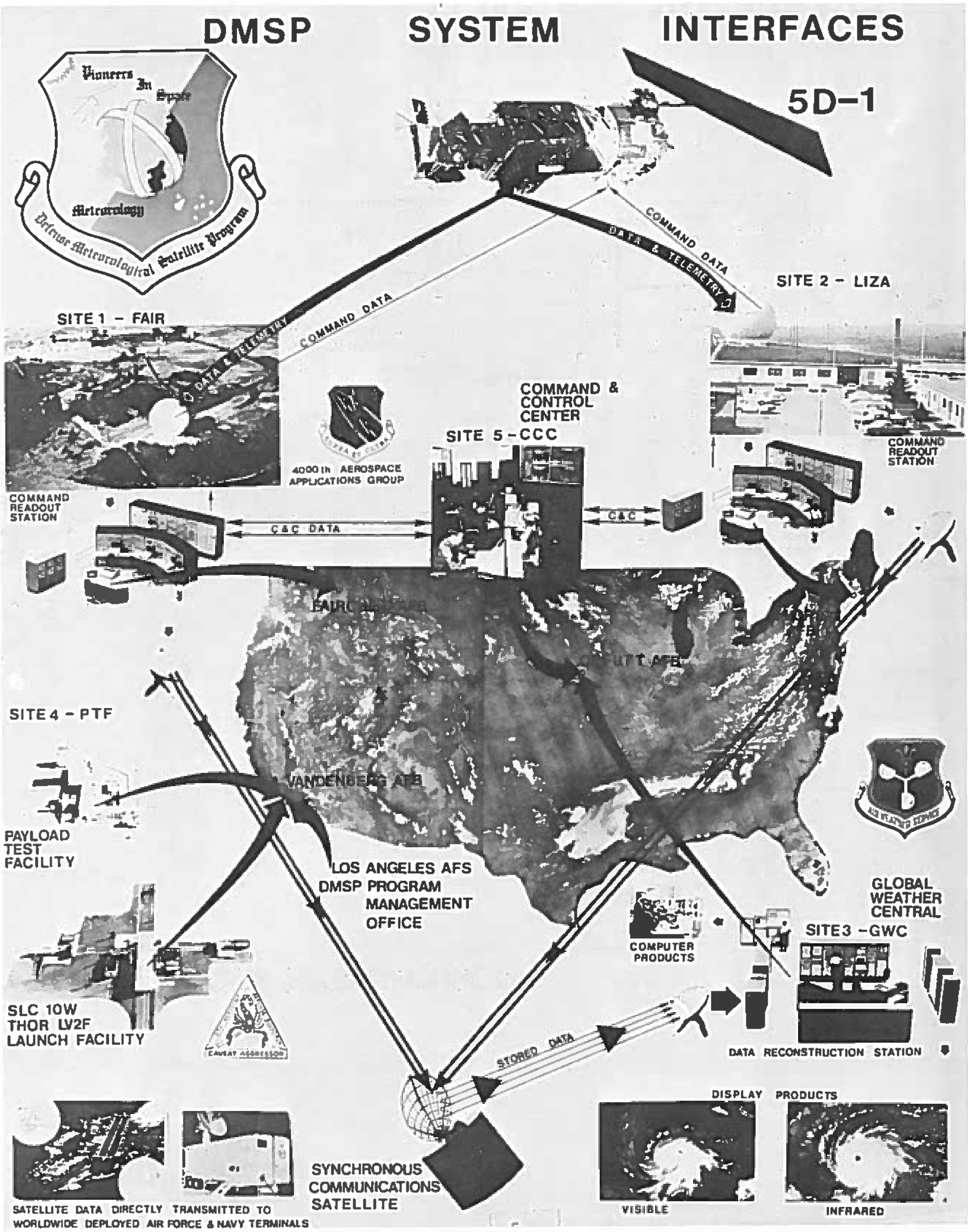
The temperature profile is necessary as an input to obtain the humidity profile. The humidity profile can provide increased accuracy in the temperature profile determination by correcting for the water vapor absorption interfering in the CO_2 band. Because of the interactive effects it is advantageous that both CO_2 band and water vapor band radiances are measured by the same instrument and referred to the same reference sources as is done within the "H" package.

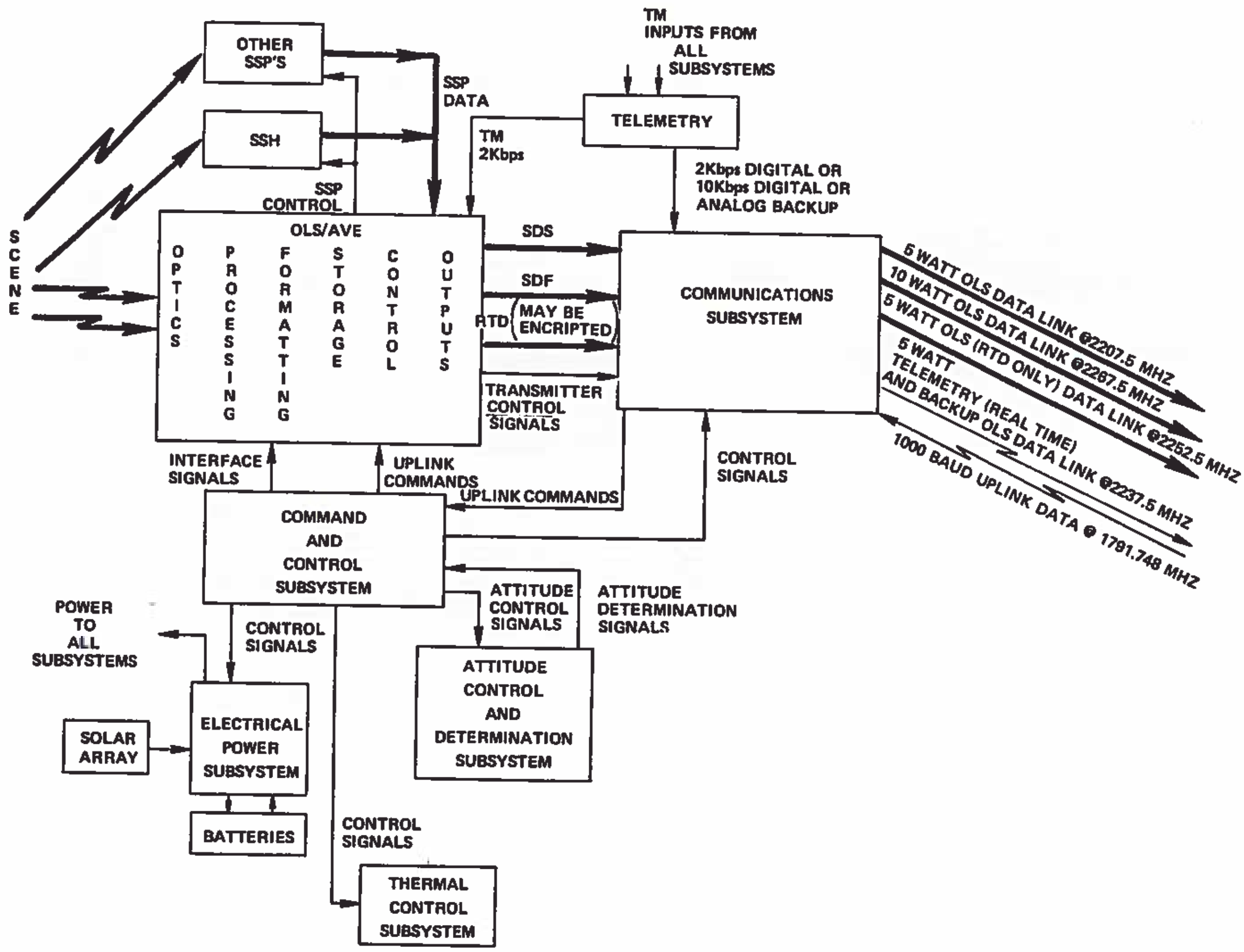
SPECIAL SENSOR H



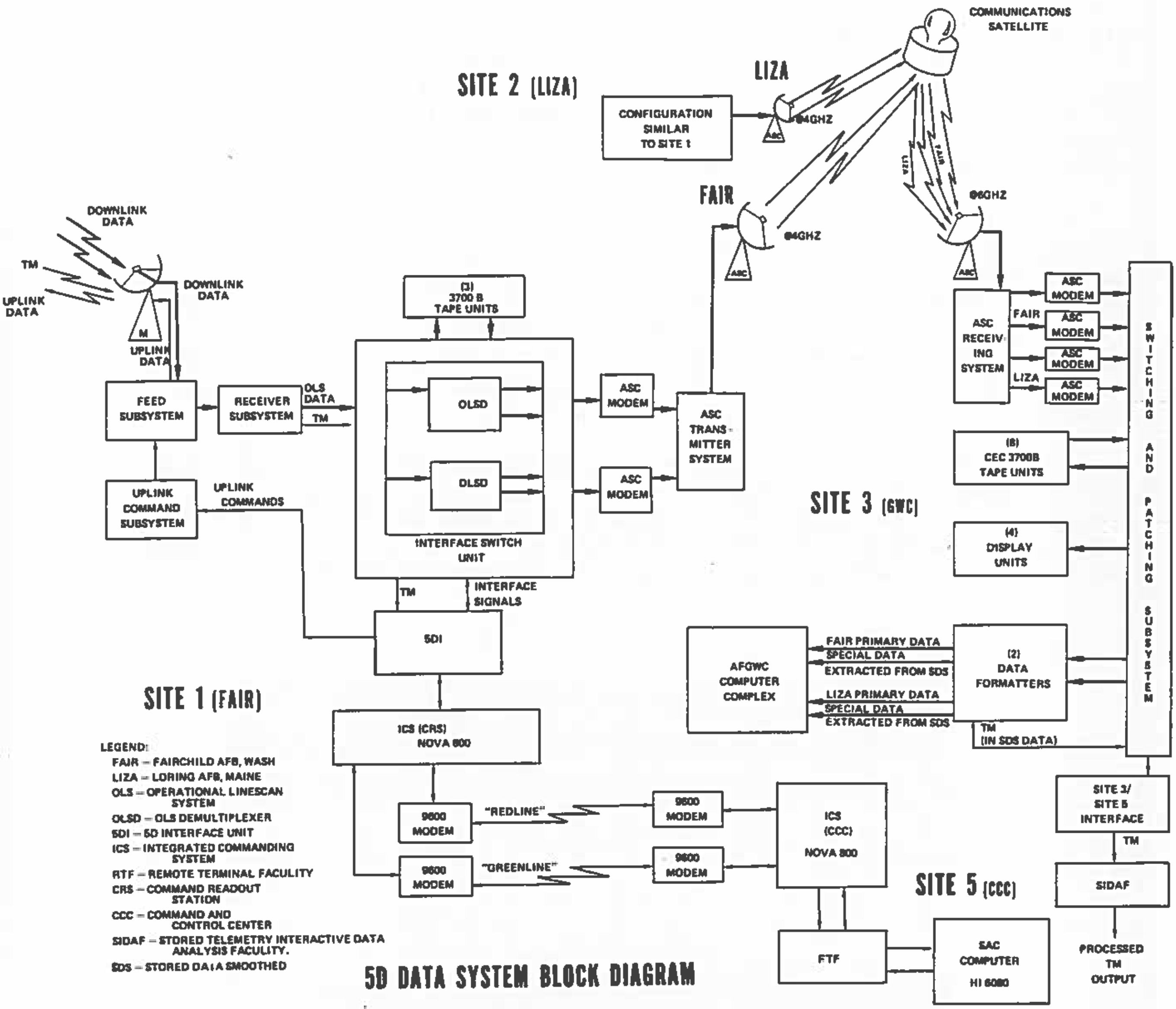
KEY DMSP SYSTEM INFORMATION

SATELLITE CONFIGURATION AT LAUNCH	
THOR LV-2F:	First Stage Liquid Propellant (LOX + RP-1) Steering correction signals supplied from spacecraft
Integrated Spacecraft System: - Heatshield, Booster Adaptor, 2nd stage, 3rd stage with s/c & sensor payload	
- Second & Third Stages	Solid-propellant TEM 364-4 & TEM 364-15 Hydrazine-Nitrogen Thrusters for attitude control during ascent
- Spacecraft	Solar Array Stowed around satellite located within heatshield 3-Axis Stabilized
ORBIT	Circular Sun-Synchronous Altitude: 450 $\pm$ 9 nautical miles Period: 101 minutes Apogee-to Perigee: 17 nautical miles Inclination: $98.7^{\circ} \pm .12^{\circ}$ Sun Angle: 0° to 95°
PAYLOAD	Meteorological sensors for tri-service users - Primary sensor (OLS) & electronics (OLS/AVE) - Up to Six Special meteorological sensors & electronics
BLUE SUIT TEAM	
- DMSP Systems (PMO)	Dep for Def Met Sat Sys (TRI-SERVICE) (SAMSO) LA AFS, CA
- Command & Control of Sat Sys (Sites 1, 2, & 5)	4000 AEROAG(SAC) Offutt AFB, NE
- Logistics	AFLC
- Training	ATC (Keesler)
- Communications	AFCS
- Stored Data User (AFGWC - Site 3)	AWS - Air Weather Service
- Direct Data User (Transterms)	AF,NAVY
- Launch Agency (SLC-10W)	10TH Aerospace Defense Squadron (ADC) VAFB, CA
CONTRACTORS	
- WESTINGHOUSE	OLS Sensor, Selected Ground Equipment
- RCA	Spacecraft, Site 4, Satellite Integrator
- BARNES	SSH
- HARRIS	Ground Equip & Ground Equip Integrator
- ASC	Site 1 & 2 Sat Com Link to Site 3
- MDAC	Launch Vehicle


DMSP SYSTEM INTERFACES
5D-1
Pioneers In Space
Meteorology
Defense Meteorological Satellite Program
COMMAND DATA
DATA & TELEMETRY
SITE 2 - LIZA
SITE 1 - FAIR
COMMAND DATA
DATA & TELEMETRY
COMMAND & CONTROL CENTER
SITE 5 - CCC
4000 th AEROSPACE APPLICATIONS GROUP
COMMAND READOUT STATION
COMMAND READOUT STATION
C&C DATA
C&C
OFFUTT AFB
SITE 4 - PTF
VANDENBERG AFB
PAYLOAD TEST FACILITY
LOS ANGELES AFS DMSP PROGRAM MANAGEMENT OFFICE
GLOBAL WEATHER CENTRAL
SITE 3 - GWC
COMPUTER PRODUCTS
SLC 10W THOR LV2F LAUNCH FACILITY
DATA RECONSTRUCTION STATION
STORED DATA
DISPLAY PRODUCTS
SYNCHRONOUS COMMUNICATIONS SATELLITE
SATELLITE DATA DIRECTLY TRANSMITTED TO WORLDWIDE DEPLOYED AIR FORCE & NAVY TERMINALS
VISIBLE
INFRARED



5D SATELLITE BLOCK DIAGRAM



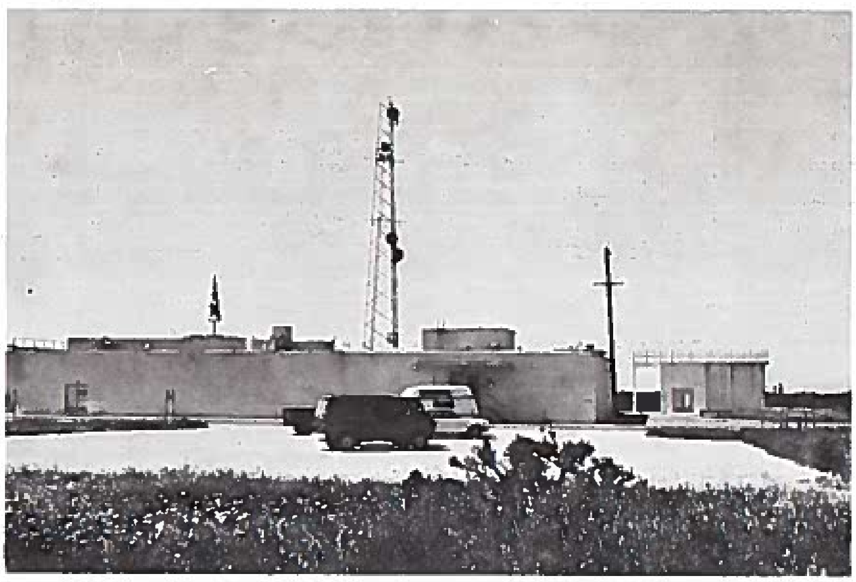
5D DATA SYSTEM BLOCK DIAGRAM

PAYLOAD TEST FACILITY

The Payload Test Facility (PTF) (Site 4) is located in Building 1768, Vandenberg Air Force Base, California. Its primary function is to support pre-launch, launch, and early orbit operations of DMSP satellites. The PTF houses and contains all equipment necessary for the complete pre-launch electrical performance test and checkout of the Block 5D satellite. RF communication links connect the PTF with the launch pad complex. The Control Room in the PTF acts as the command post for monitoring the early orbit performance of spacecraft.

The site commands, receives, records, and displays all data transmission during checkout of the spacecraft prior to launch and during the launch ascent phase. On-orbit telemetry, real time data (RTD) and stored data (SDS, SDF) can be received through a microwave link from Vandenberg Tracking Station of the Air Force Satellite Control Facility. This provides the PTF with the capability for anomaly analysis of on-orbit equipment malfunction should the need exist. This analytical capability is supplemented by the SIDAF located at CCC (Site 5).

The PTF will have complete prelaunch test capability for a Block 5D satellite only during the period of a launch operation, the required AGE (Aerospace Ground Equipment) being a Mobile AGE (MAGE) which will be returned to the factory following each launch. Block 5D on-orbit telemetry and display capability will be continuously available in the PTF.



PTF

PTF EQUIPMENT RACKS

TELEMETRY & SPECIAL DATA RECORDING EQUIPMENT

COMMAND & TELEMETRY EQUIPMENT

DATA RECOVERY & DISPLAY EQUIPMENT

DATA COMMUNICATIONS & RECORDER EQUIPMENT

SLC-10W FACILITY

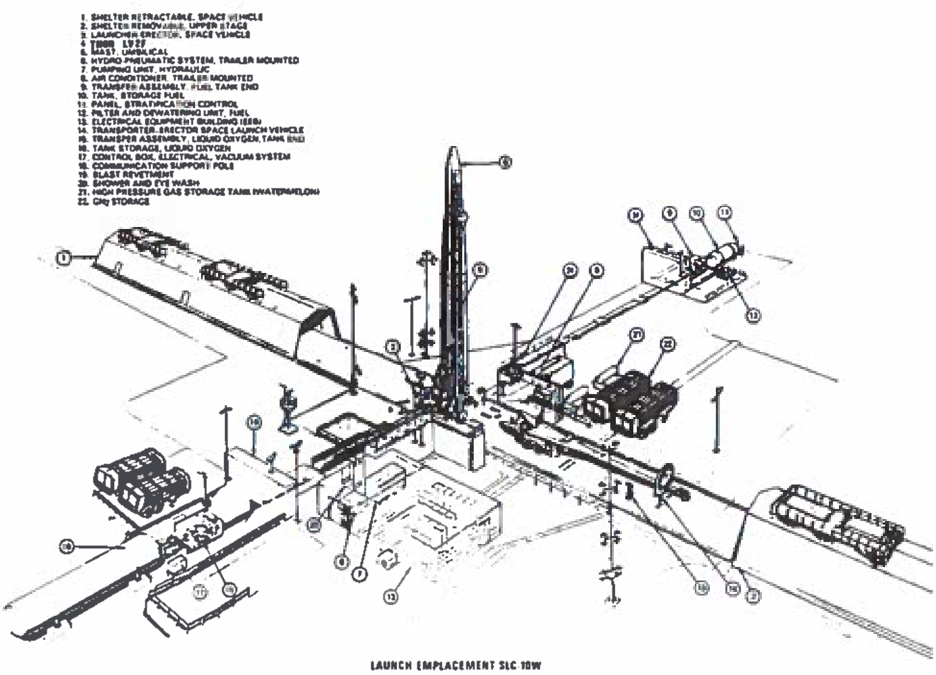
The 10 AERODS (ADC) maintains and operates SLC-10W and associated equipment at Vandenberg AFB in support of DMSP launch activites. The capabilities and support functions of the 10 AERODS are listed below.

MAINTAIN, operate, modify, and test all Booster and upper stage related equipment.
- SLC 10W
- BLOCKHOUSE
- Upperstage Assembly Building
- Booster Assembly Building

MODIFY, maintain, test, operate, and launch DMSP boosters-payloads.
- pre-launch booster and upper stage testing
- mating of satellite to booster
- countdown
- launch
- postlaunch ground equipment refurbishment

PROVIDE booster pre-launch and post-launch data
- trajectory analysis
- boost mode performance evaluation

MAINTAIN configuration accounting, quality assurance, system training, and proficiency certification.

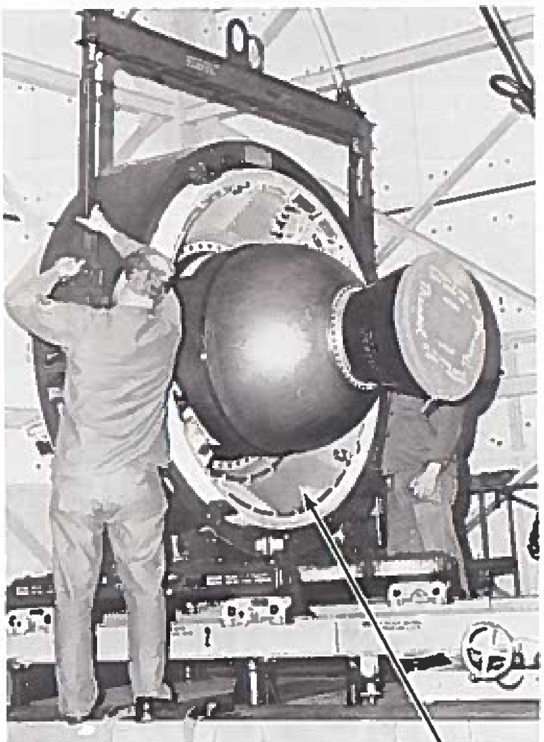


LAUNCH EMPLACEMENT SLC 10W

LAUNCH COMPLEX SLC-10W VANDENBERG AFB

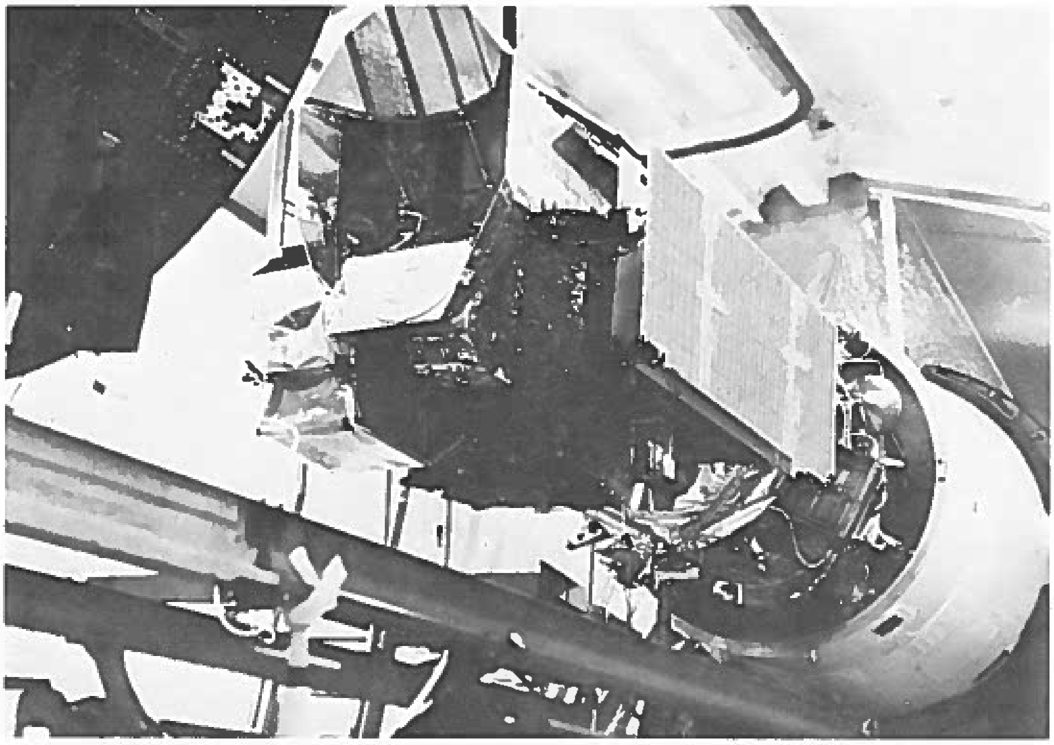
BOOSTER ASSEMBLY BUILDING

SECOND STAGE MOTOR

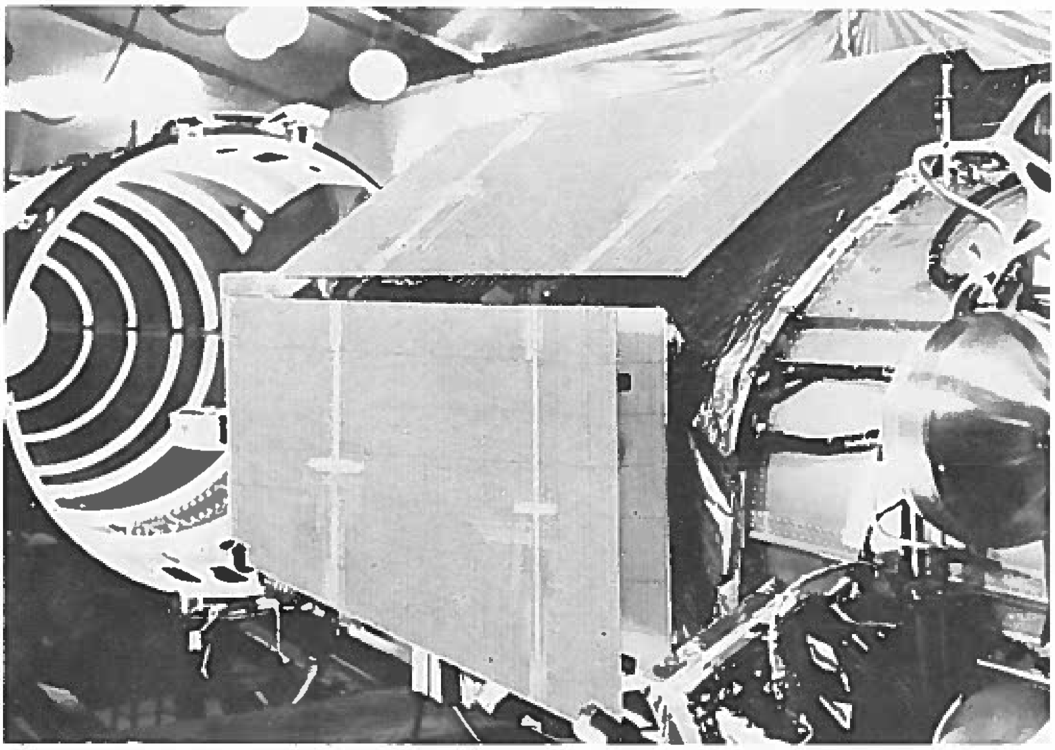


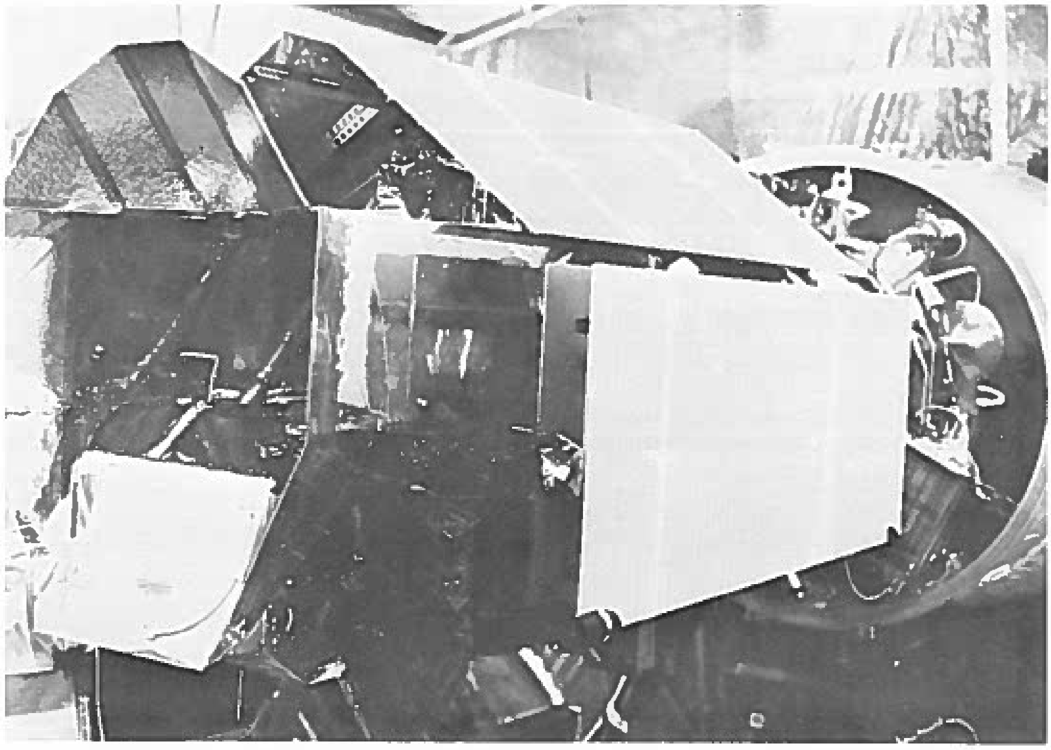
BOOSTER ADAPTER

SECOND STAGE STRUCTURE

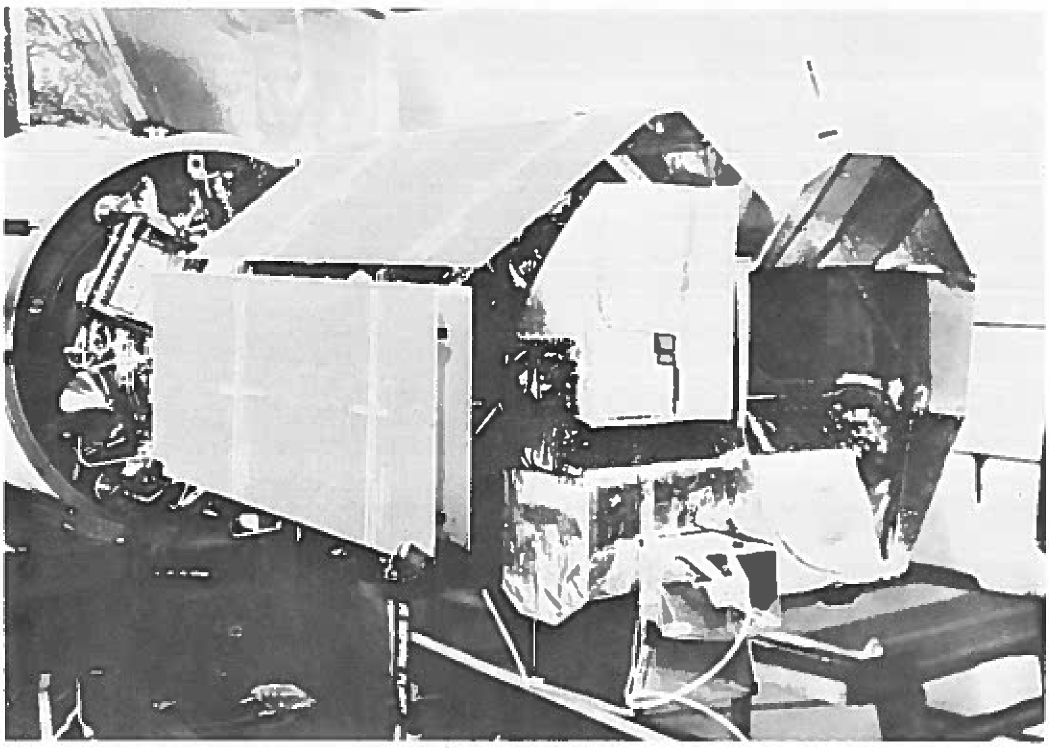


MATE OF 5D SATELLITE TO BOOSTER

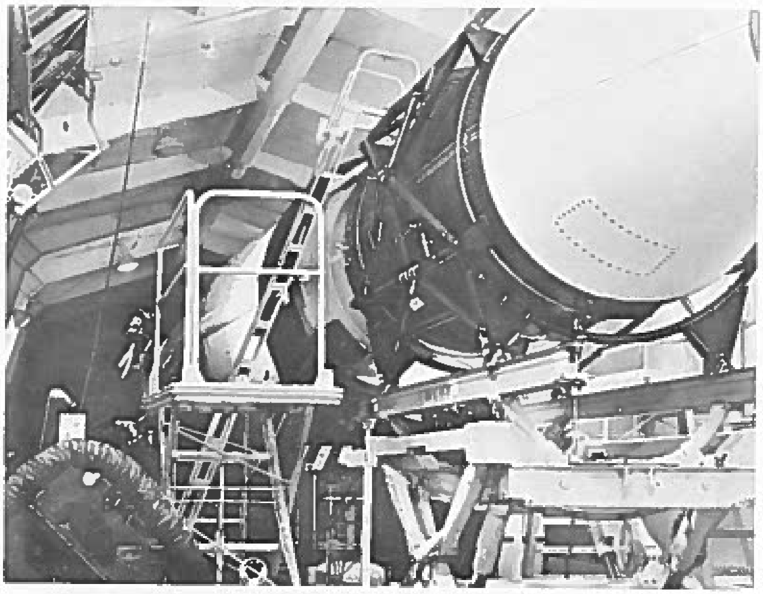




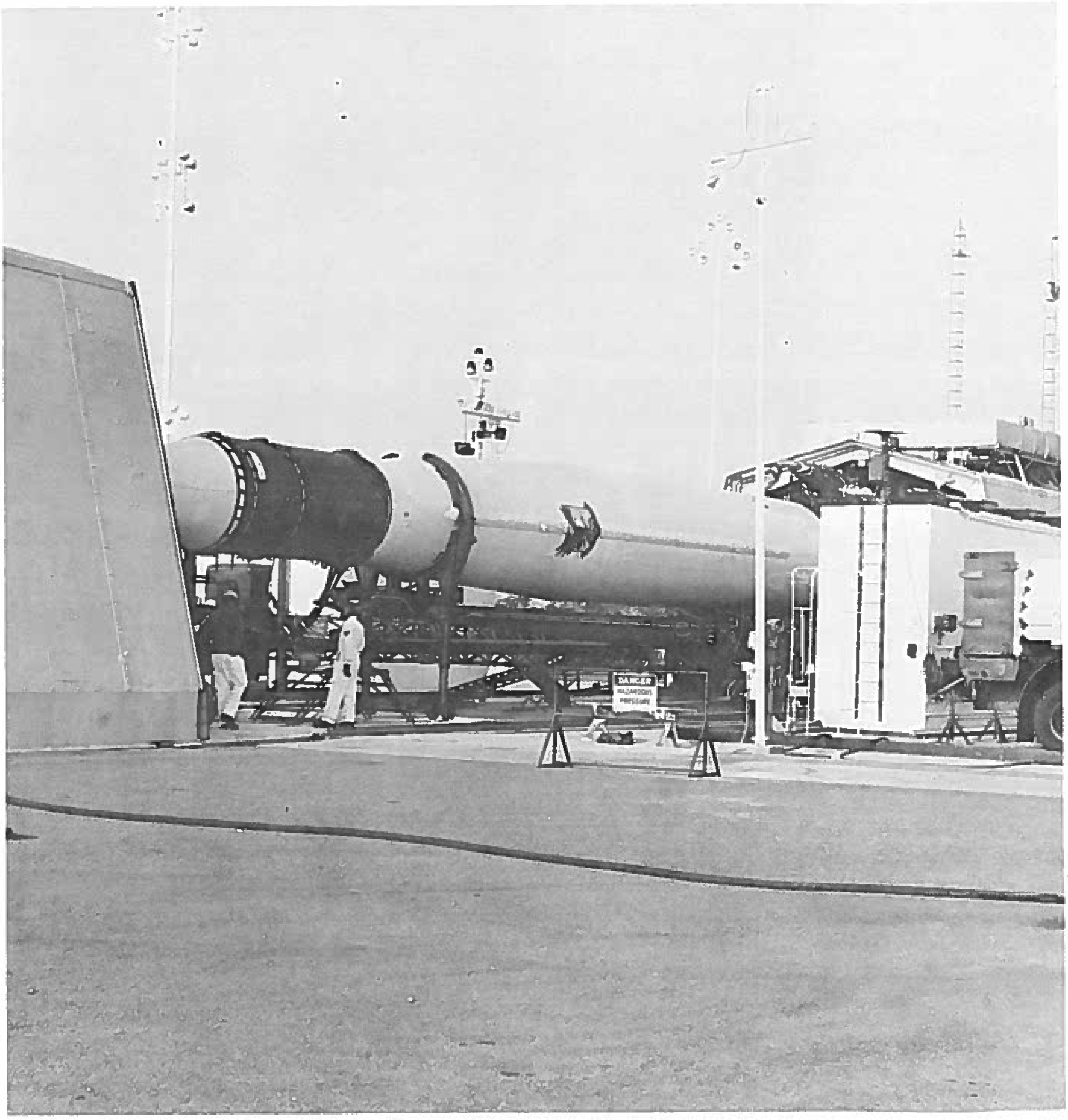
MATE OF 5D SATELLITE TO BOOSTER



HEATSHIELD MATING

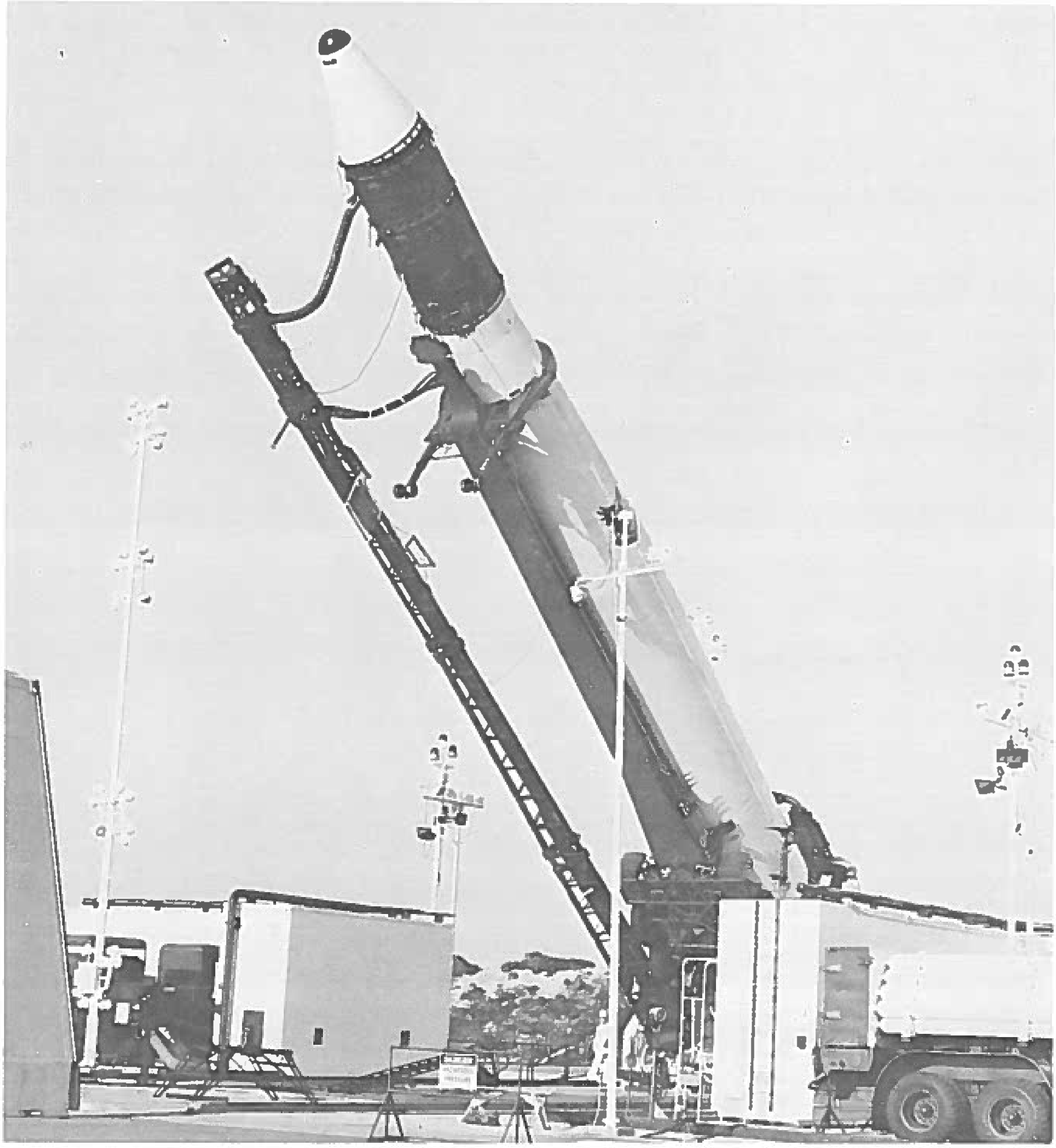


BOOSTER COMPLETE

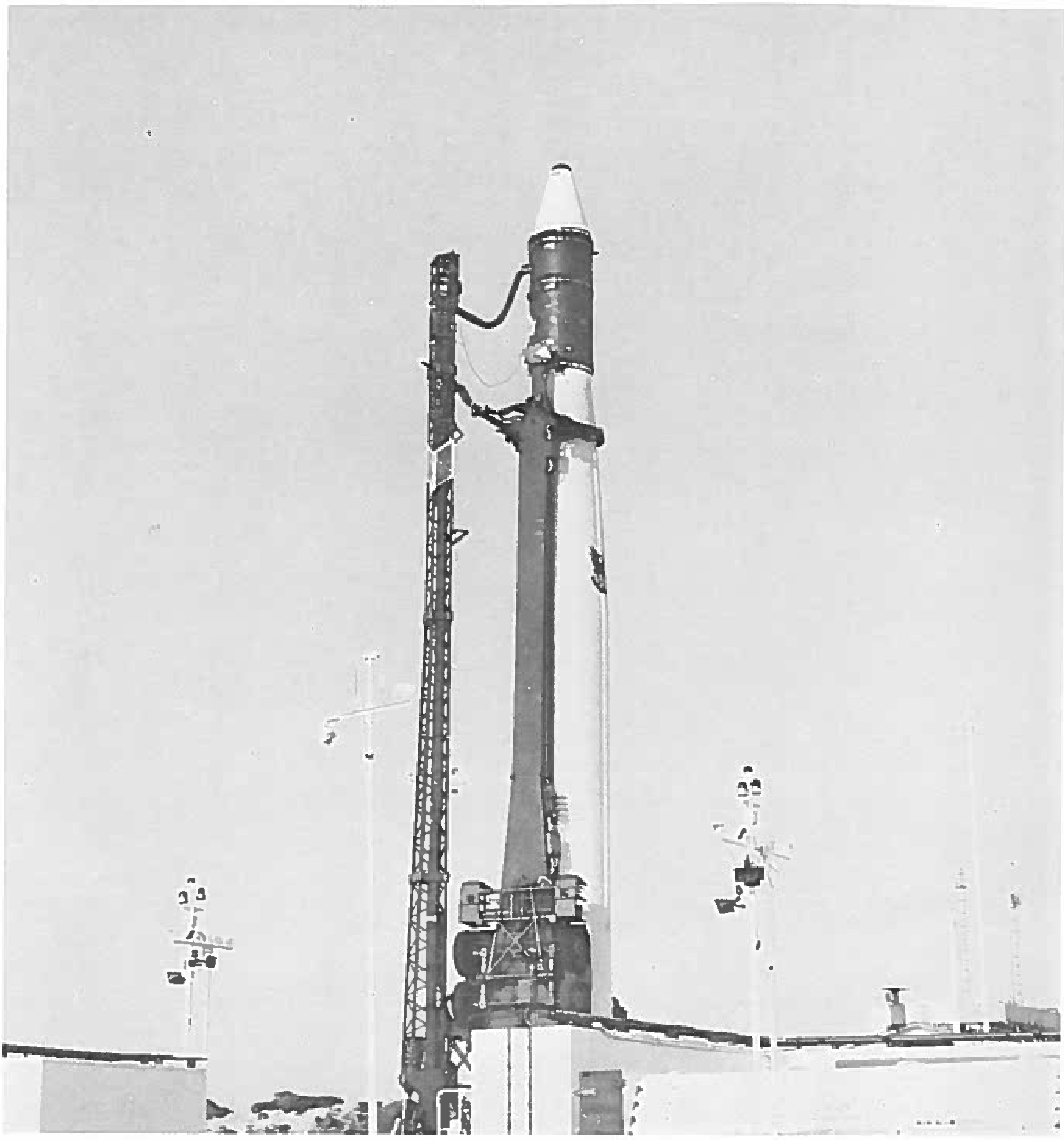


SHELTER RETRACTION

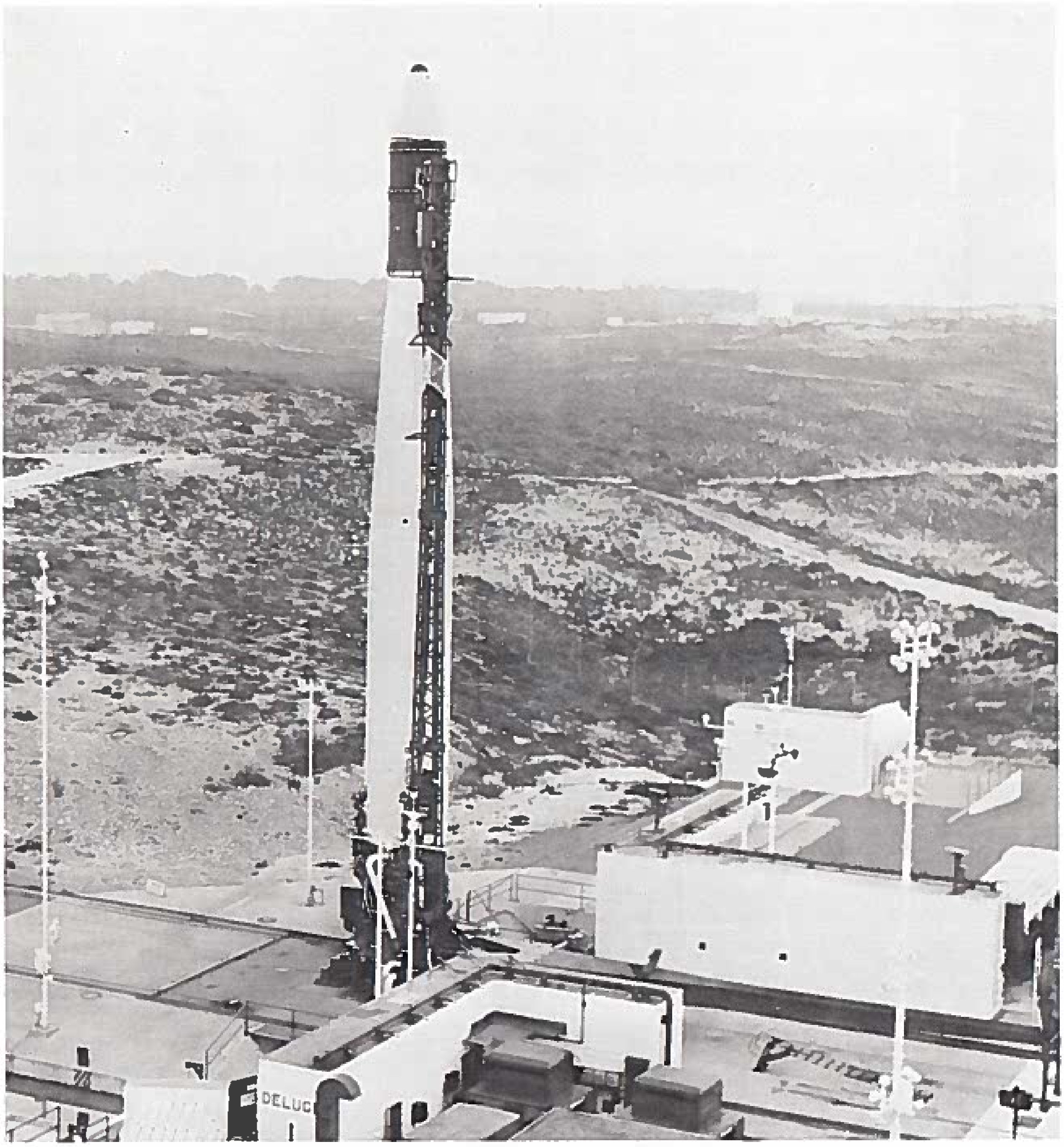
ERECTION OF BOOSTER



ERECTION OF BOOSTER

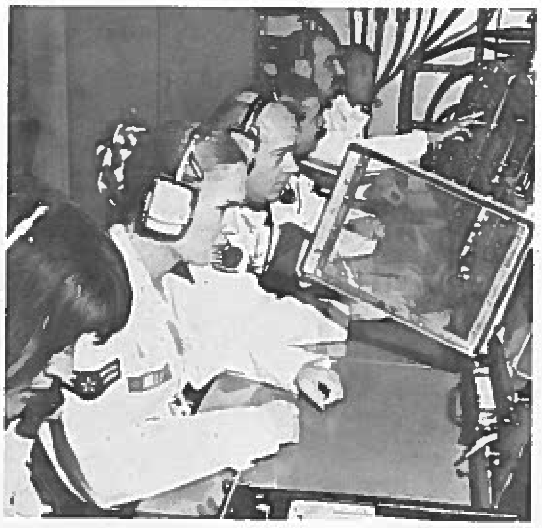


COMPLETION OF BOOSTER ERECTION

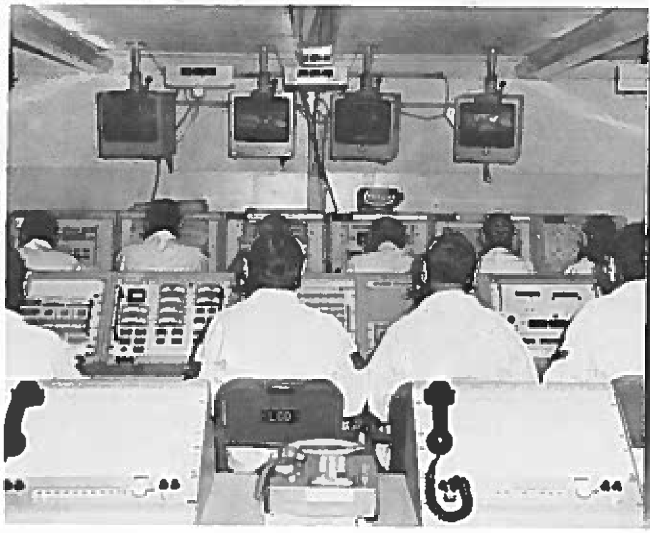


BOOSTER POISED FOR LAUNCH

BLOCKHOUSE LAUNCH FACILITY



COUNTDOWN . . . .

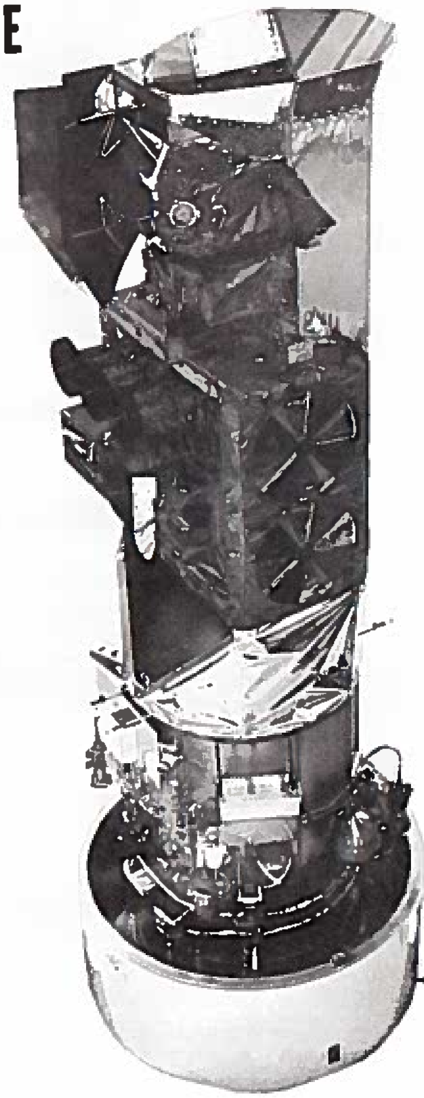


LAUNCH!

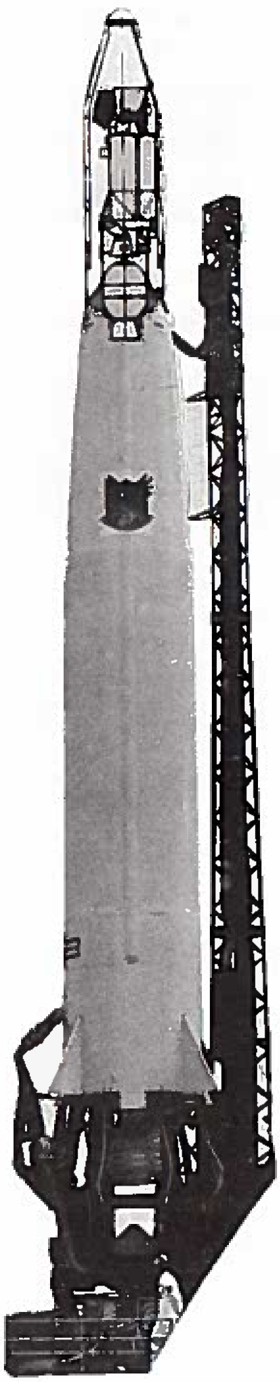
DMSP BLOCK 5D LAUNCH

HEATSHIELD ASSEMBLY

BLOCK 5D SATELLITE
WITHOUT HEATSHIELD

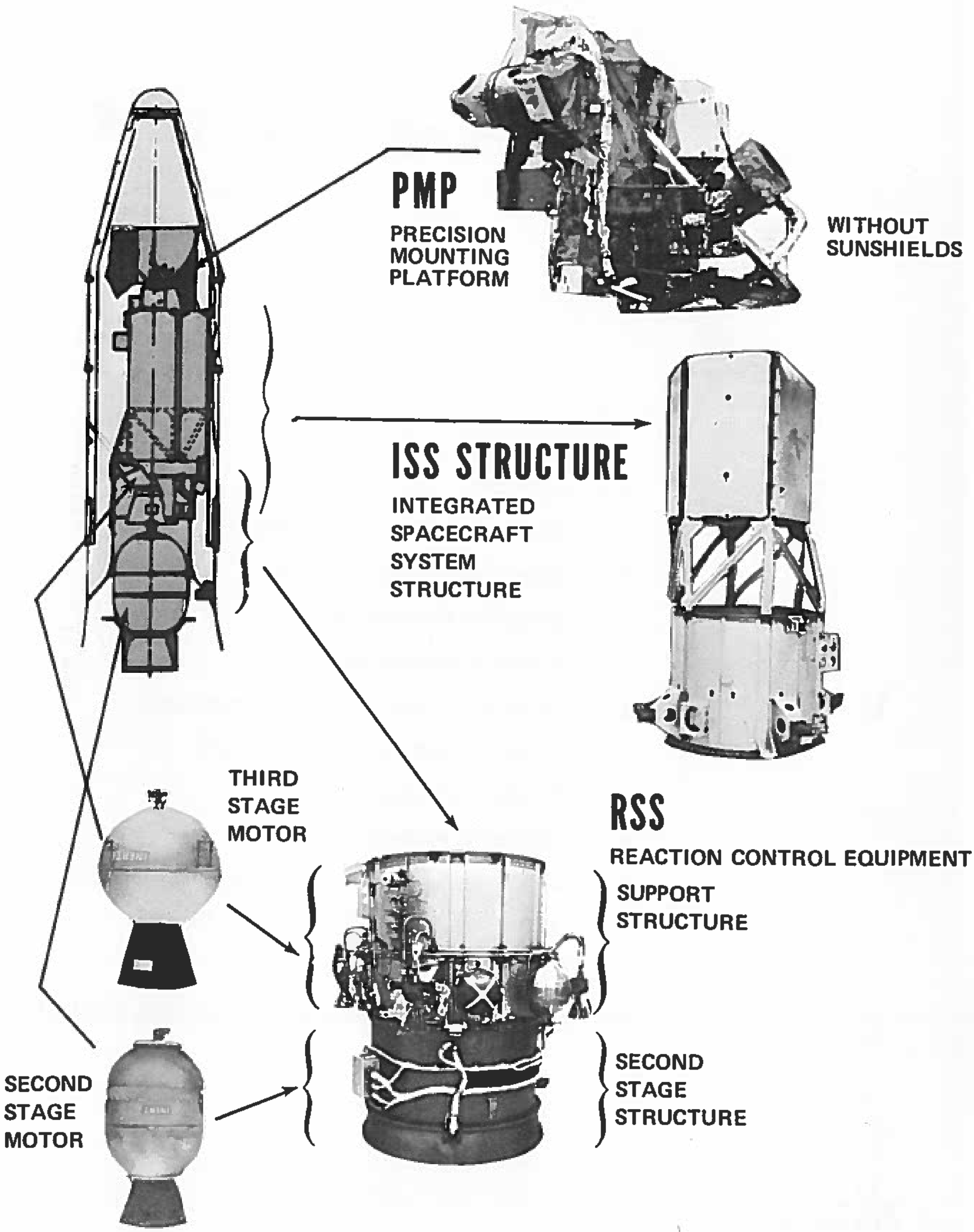


BOOSTER ADAPTER

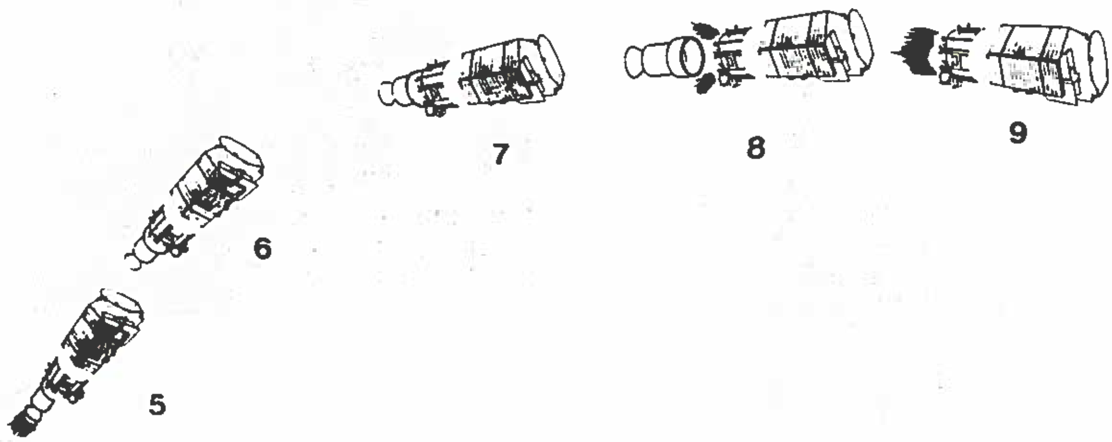


THOR LAUNCH BOOSTER

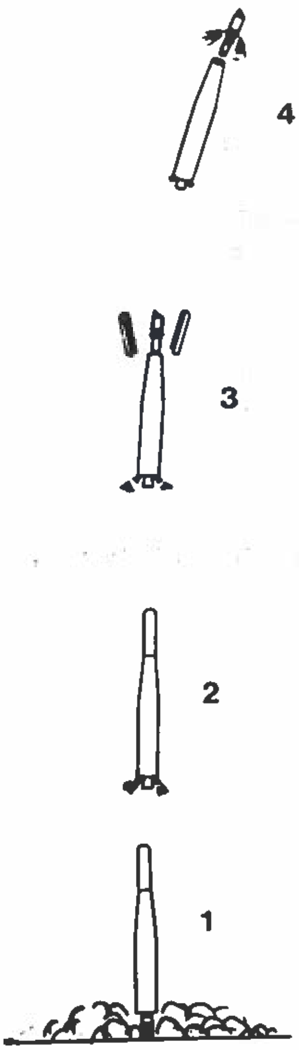
CONFIGURATION



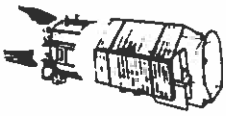
DMSP BLOCK 5D LAUNCH



1 LIFT OFF
2 MAIN ENGINE CUT-OFF (MECO)
3 HEATSHIELD SEPARATION
4 BOOSTER SEPARATION
5 STAGE II PROPULSION
6 ACTIVATE COAST ATTITUDE CONTROL
7 START COAST PHASE PITCH RATE
8 STAGE II SEPARATION
9 STAGE III PROPULSION
10 ATTITUDE MANEUVER AND Δ V THRUSTING
11 MANEUVER TO MISSION ATTITUDE
12 SOLAR ARRAY DEPLOYMENT
13 HANDOVER TO SPACECRAFT CONTROL SYSTEM



AND INJECTION



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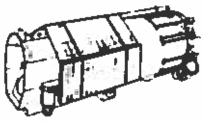

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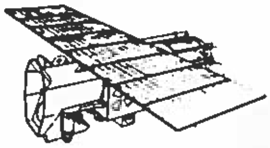

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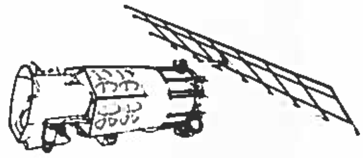

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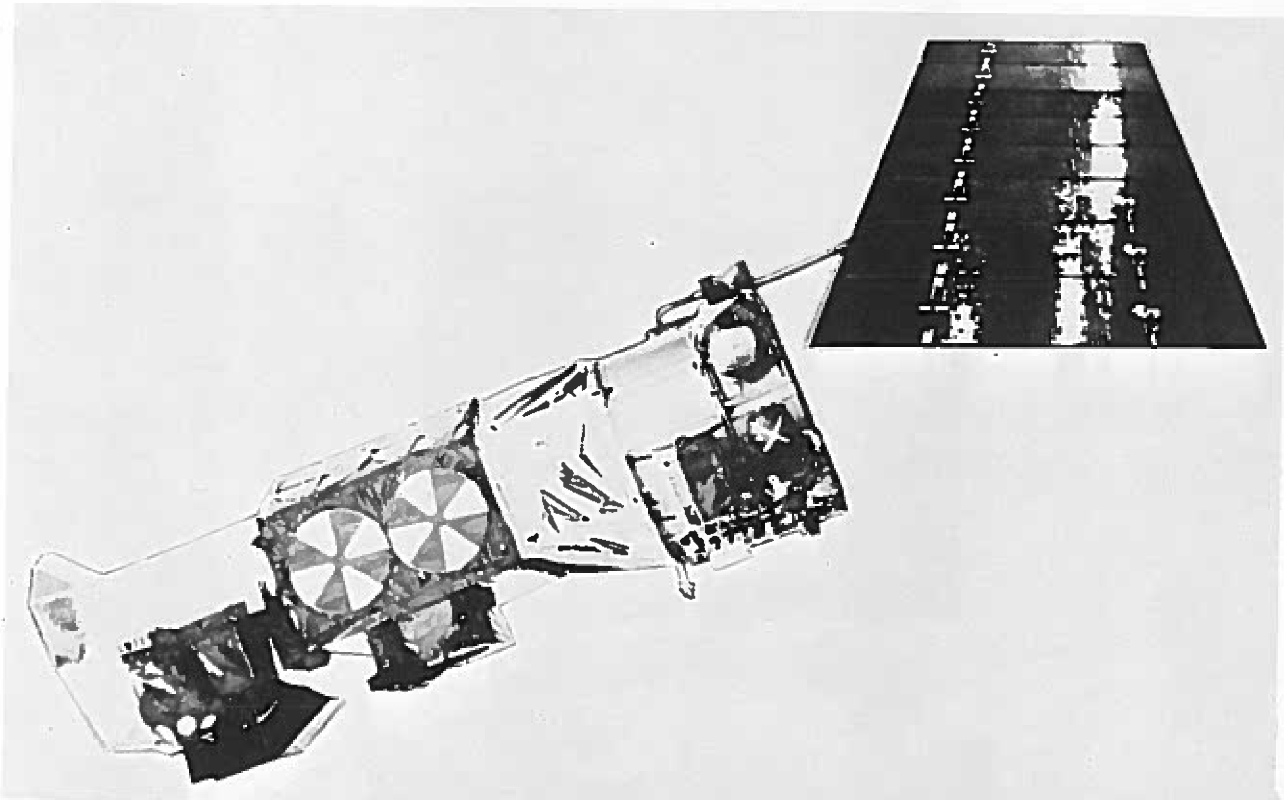
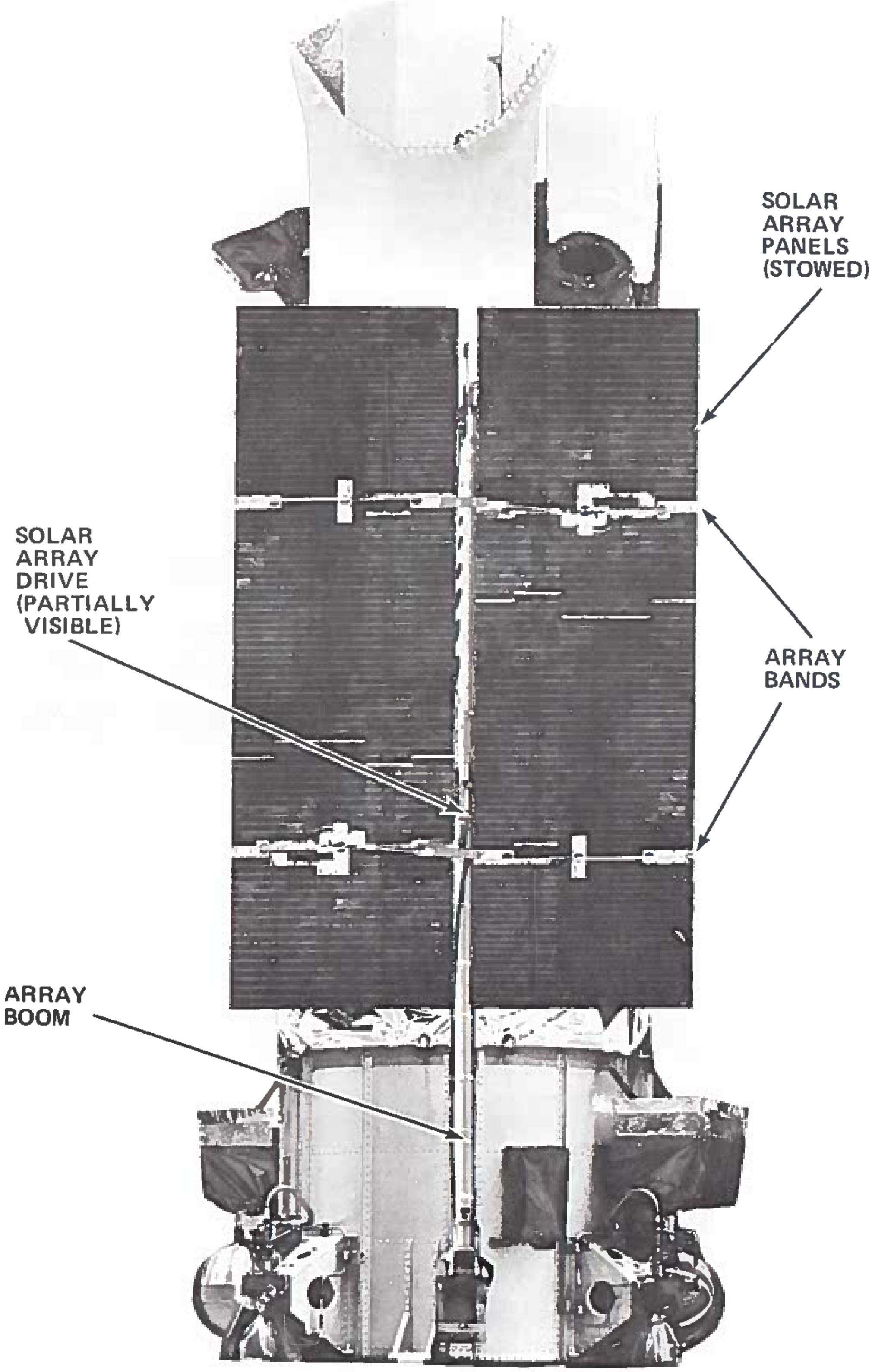
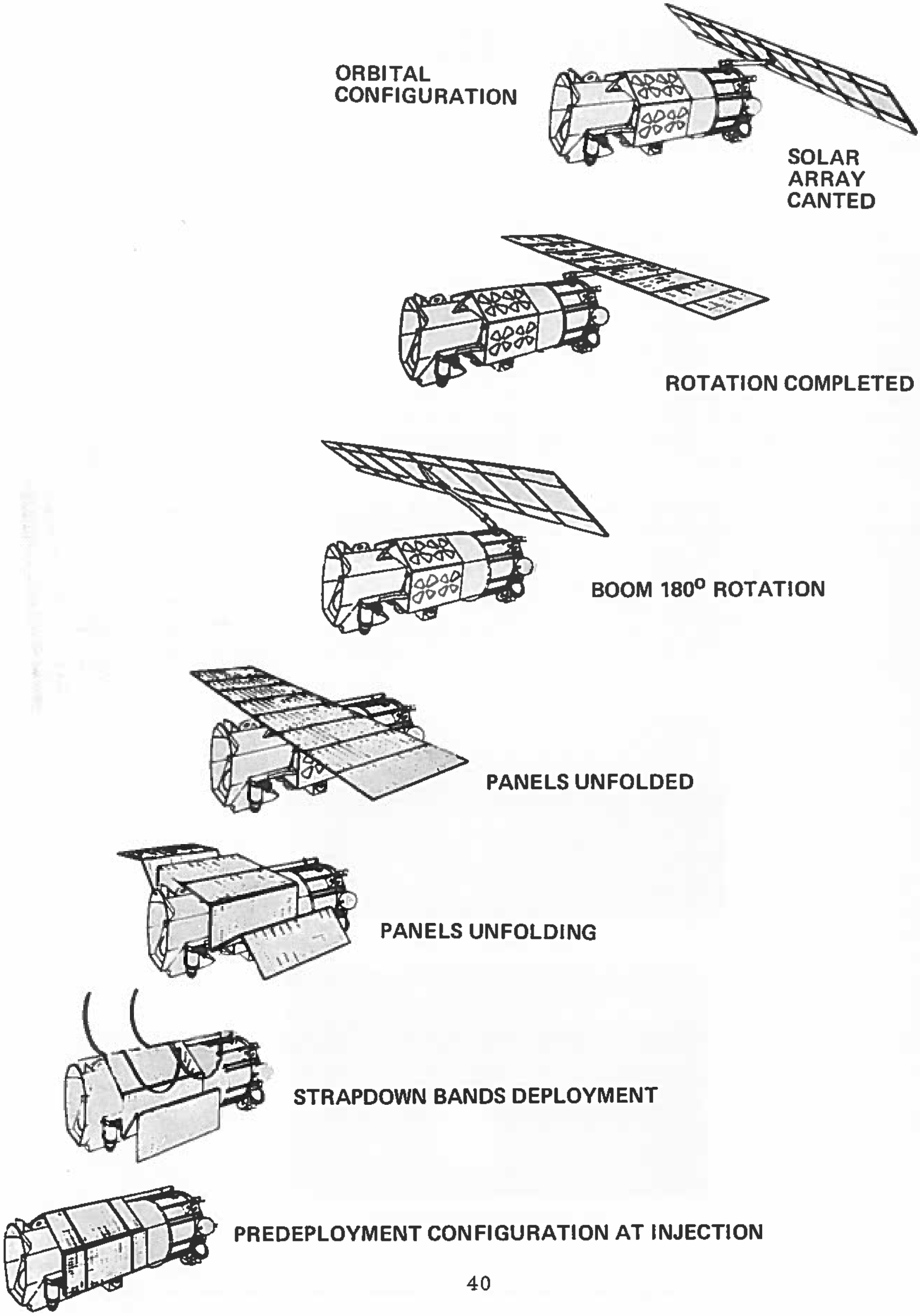


BLOCK 5D SATELLITE ORBITAL CONFIGURATION

S/C -X VIEW PREDEPLOYMENT



SOLAR ARRAY DEPLOYMENT

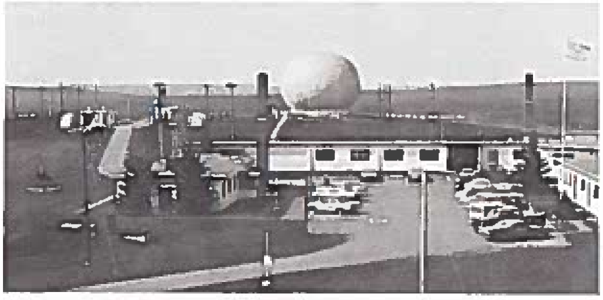


COMMAND READOUT STATION

DMSP has Command Readout Stations (CRS) located at Loring Air Force Base, Maine (Site 2) and at Fairchild Air Force Base, Washington (Site 1).

The primary CRS function is real-time command and control of DMSP satellites, the collection of data from these satellites, and the relay of this data via a synchronous communication satellite link to Air Force Global Weather Central (AFGWC) (Site 3). Each site consists of a fixed 40-foot parabolic antenna subsystem protected by a rigid radome, and an operations building containing RF, ground communications, and computerized command and control subsystems. The CRS configuration provides the capability to simultaneously receive and record stored primary sensor data and satellite attitude and telemetry data, and to transmit selected data types in real time to AFGWC. Recorded data not relayed in real time are played back post-run.

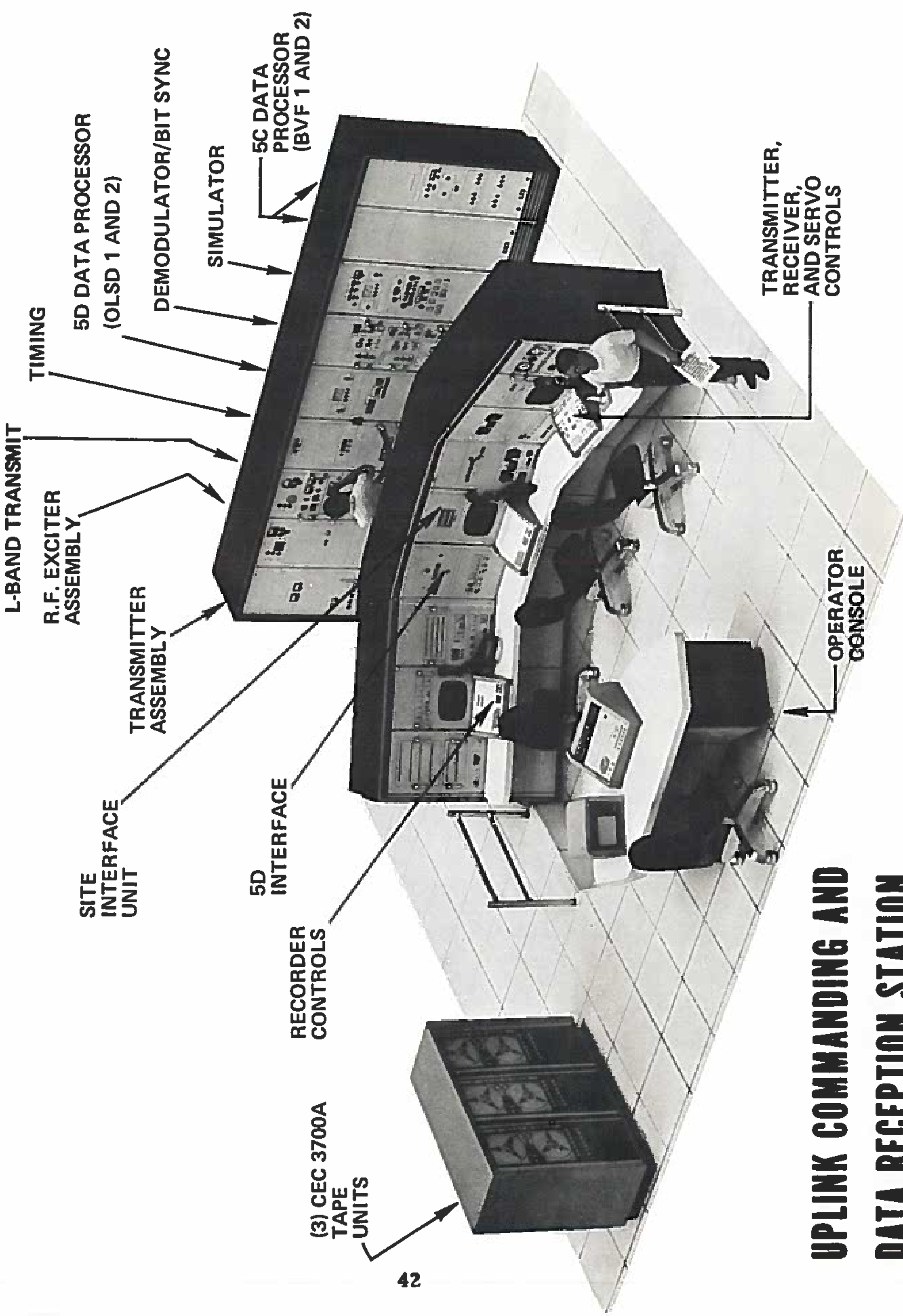
A computer controlled Switching/Patching Subsystem (SPS), under operator control, automatically selects and switches that equipment required for effective data processing and handling during a particular spacecraft operation. This same computer, using an alternate software program, is used in the Antenna Positioning Subsystem (APS) to simultaneously control the CRS antenna servo subsystem, compute highly precise pointing positions, and accurately track the spacecraft during an operational mission.



SITE 2 LORING AFB, MAINE

SITE 1 FAIRCHILD AFB, WASHINGTON

SITES 1 AND 2 - CRS COMMAND READOUT STATIONS



UPLINK COMMANDING AND DATA RECEPTION STATION

SITE 1 & 2 SATELLITE DATA LINK TO SITE 3

The OLS data received at the two DMSP Command Readout Stations is relayed to Site 3 via a transparent satellite data communication link. One transponder of a 12 transponder Hughes HS-333 type satellite is dedicated for DMSP data transfer. This transponder can relay two circuits from Site 1 and two circuits from Site 2 to Site 3 (AFGWC) simultaneously.

SATELLITE DESCRIPTION

The satellite consists of a channelized microwave repeater operating in the 6 GHz (receive) and 4 GHz (transmit) bands allocated for domestic service. The repeater is an all microwave, fixed gain, single conversion, 12-channel design in which each channel is an independent transponder with a 36 MHz bandwidth. The satellite has a 73 inch diameter honeycomb sandwich platform which supports the solar panels, despin motor, and 5 foot diameter parabolic reflector. The overall height to the top of the antenna is 11.6 feet. The on-orbit weight of the satellite is approximately 650 pounds.

GROUND STATION DESCRIPTION

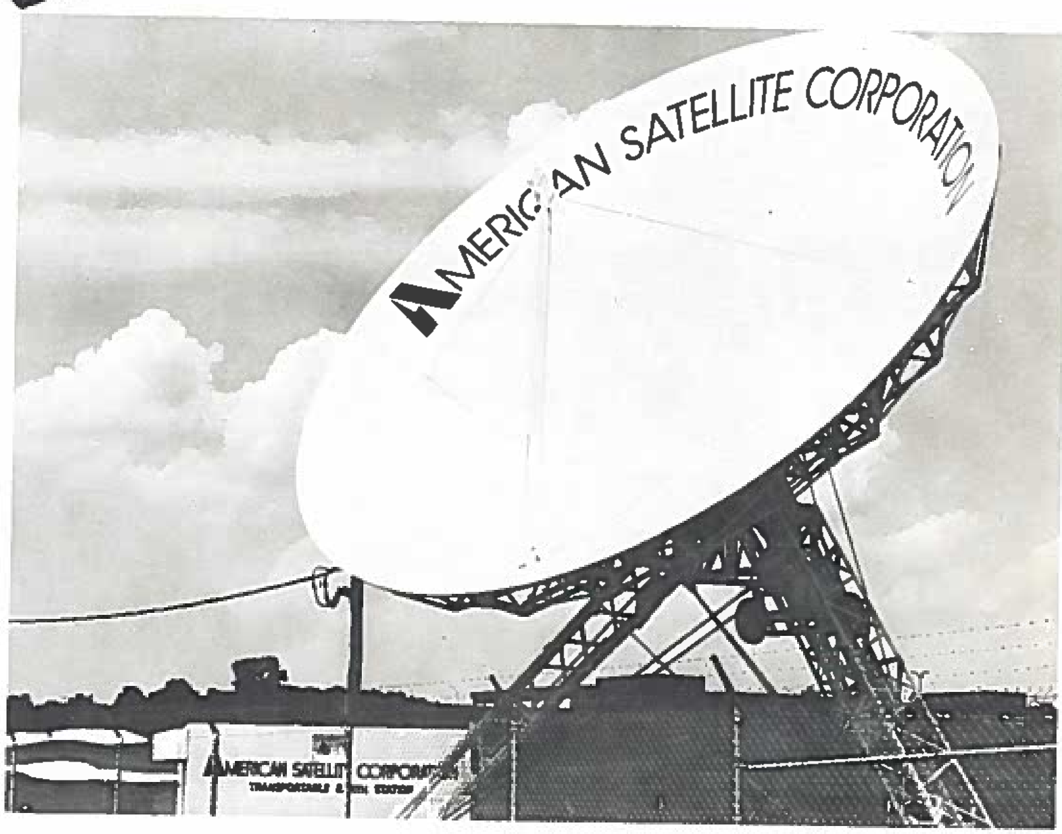
Three earth stations are used for the data link. Two of the stations are configured for transmission only - those at Site 1 and Site 2. The third station is designed only for reception of data. Each station consists of a 33 foot diameter reflector (antenna) and a fully protected environmental enclosure for unattended electronic equipment. Each station has redundant equipment which can be automatically switched into the data stream.

DATA HANDLING CONSIDERATIONS

Each transmit only earth station accepts two 1.344 Mb/s serial data streams and transmits the data over one channel using four-phase coherent PSK modulation. Rate 3/4 forward error correction, using convolutional encoding, is used to enhance channel performance. At the receive only earth station, two channels can be simultaneously received (via one satellite transponder). Using four-phase coherent demodulation and hard decision threshold decoding, four independent 1.344 Mb/s serial data streams can be provided to Site 3 (AFGWC); two from Site 1 and two from Site 2.

SATELLITE COMMUNICATION LINK

SYNCHRONOUS COMMUNICATIONS SATELLITE



ASC GROUND STATION

DATA RECONSTRUCTION STATION

The Data Reconstruction Station (DRS) Site 3, is located at Offutt Air Force Base, Nebraska, within Air Force Global Weather Central. Its primary function is to reconstruct and process the data transmitted real-time and post-pass from each CRS. Block 5D DRS equipment consists of three sets of Block 5 primary data display equipment, magnetic tape recorders, Data Formatter and Display, a computer processing facility, and a Digital Facsimile System (DFS) transmitter. This DRS configuration provides the capability to simultaneously display data real-time as photographic imagery, magnetically record this for further processing and archival purposes, and input it directly via the Data Formatter into the computer processing facility. Post-run CRS data transmissions are similarly displayed, recorded, and processed.

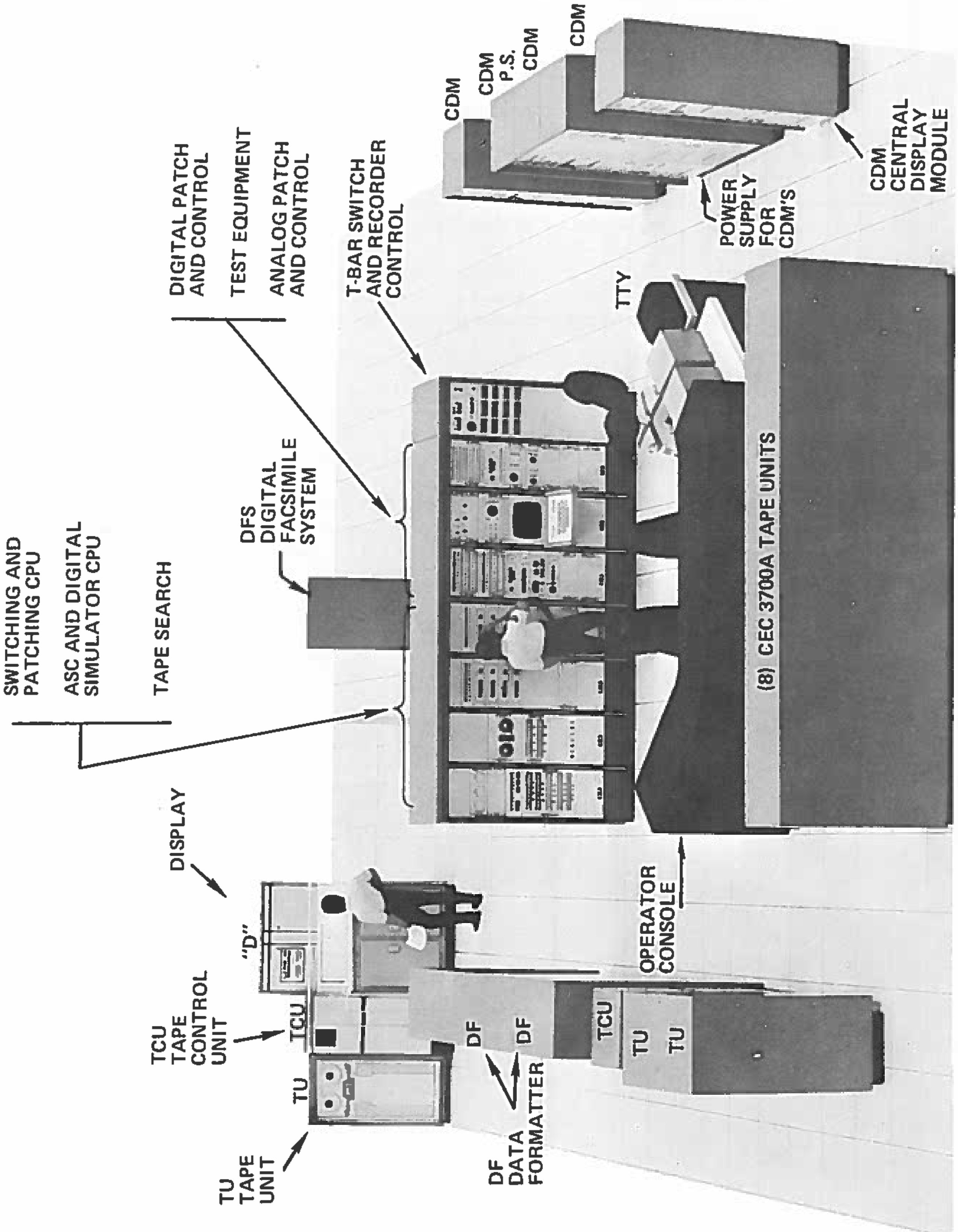
A computer controlled Switching/Patching Subsystem (SPS), under operator control, references a standard library tape recorder file, selects and switches the correct recorder for the data type to be processed and then automatically completes the equipment patch required.

A computerized Test and Maintenance System (TMS) will be provided for system checkout prior to active data processing and for diagnostic testing of selected system hardware.

AFGWC is the global hub of AWS. The facility receives, processes, produces, and disseminates meteorological and aerospace environmental data (forecasts, observations, and studies) required to support DOD agencies, military operations of the USAF and U.S. Army, and AWS field units.

AIR WEATHER SERVICE

SITE 3 - AFGWC DATA RECONSTRUCTION STATION



COMMAND AND CONTROL CENTER

The Command and Control Center (CCC) Site 5, located at Offutt Air Force Base, Nebraska is operated by the 4000th Aerospace Applications Group (AEROAG) (SAC). The primary function of the CCC is on-orbit operational control of all DMSP satellites. This is accomplished by using a computerized Integrated Commanding System (ICS) for the control and monitoring of command load data transmitted to each CRS. Actual command generation is performed at the CRSs with a back-up time generation capability residing at the CCC in the event of a CRS ICS system failure.

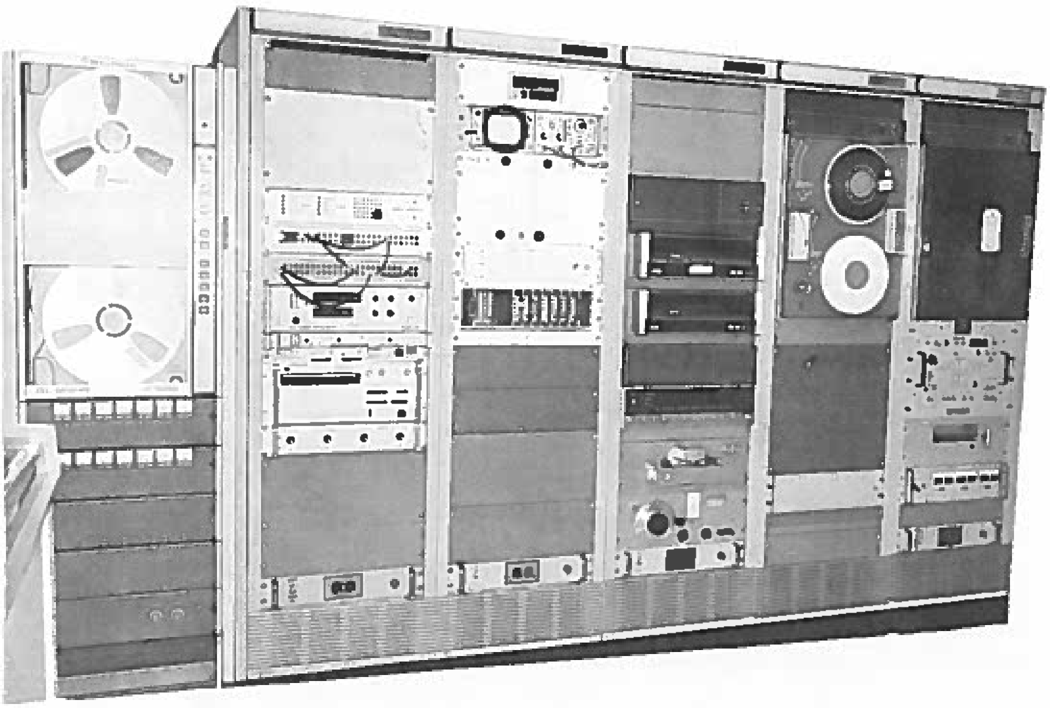
In addition to the ICS, Site 5 contains a Stored Telemetry Interactive Data Analysis Facility (SIDAF) for processing stored orbital telemetry. The SIDAF facility allows anomaly studies and real-time on-orbit malfunction analysis.

A cryptographic communication center is located adjacent to the CCC to provide a necessary link in the overall communications network. The communication center is linked directly to Site 1, Site 2, and the Air Force Satellite Control Facility at Sunnyvale Air Force Station, California.

A Software Development and Maintenance Facility (SDMF) is being developed for the generation of software in support of Block 5D spacecraft and for maintenance of existing software presently used in the ICS and SIDAF.

SITE 5

SIDAF



STORED TELEMETRY
INTERACTIVE
DATA
ANALYSIS
FACILITY

COMMAND AND CONTROL CENTER

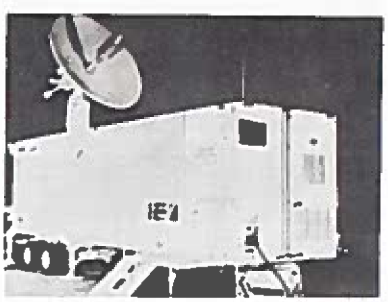
TACTICAL GROUND STATIONS

Program Transportable Terminal Systems (TTS also TRANSTERMS) are deployed to those worldwide weather centers which provide support to major theater commands and to selected shipboard and land terminals. These self-contained tactical ground stations use real-time Block 5 data in direct support of Army, Navy, and Air Force field operations.

A TTS consists of an antenna with a programmed or automatic tracking capability and receiving, decryption, display and recording subsystems integrated into a mobile, transportable 30-foot enclosed semi-trailer van. The TTS display subsystem provides the capability for displaying visual or infrared data as a hard copy, transparent photographic positive. The recording subsystem enables the operator to reproduce, post-pass, real-time data for further processing. An emergency power source is provided at each site.

Six of the TTS have an associated Antenna Protection and Environmental System (APES) for the environmental protection of the antenna/pedestal subsystem. The existing antenna/pedestal is remoted to a 12-foot enclosed tower and covered with a 19-foot rigid radome. This system insures continuous operational capability in high wind and severe cold environments.

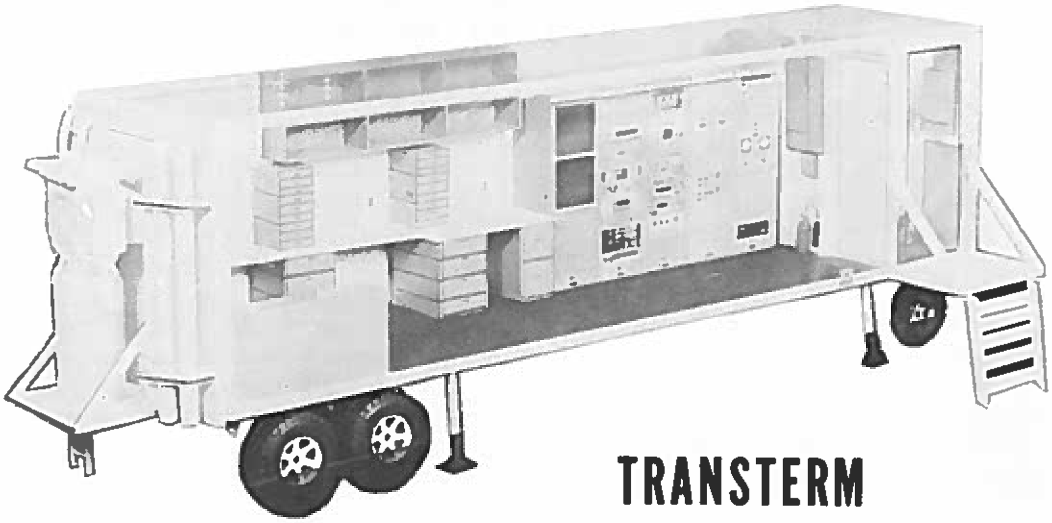
The Transportable Terminal System RF, receiver, display, and recorder subsystems are able to process Block 5D RTD mode data received on one of two selectable frequencies.



TTS

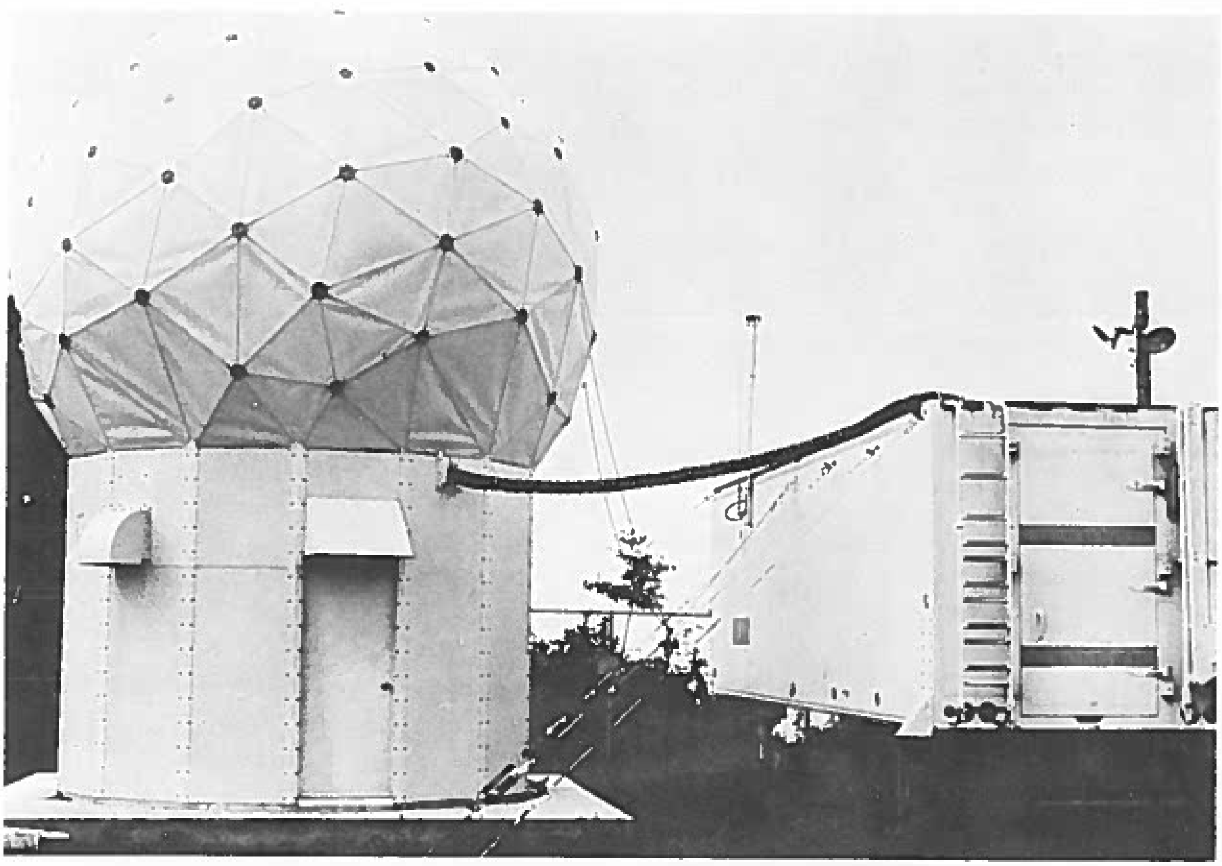
REMOTE DISPLAY

TRANSPORTABLE TERMINAL



TRANSTERM

(INTERIOR MOCK UP)



TRANSTERM WITH ANTENNA PROTECTION AND ENVIRONMENTAL SYSTEM

NAVY SITES

FEASIBILITY MODEL SHIPBOARD RECEIVING TERMINAL (FMSRT)

The Feasibility Model Shipboard Receiving Terminal, a Block 5B/C compatible system, is installed on the USS Constellation. The equipment consists of dual antennas, dual receivers, converters, a digital computer, a receiver transfer switch, a bit synchronizer, tape recorder, decryption devices, and display equipment. The antenna subsystem uses two identical parabolic antennas mounted outboard on the port and starboard sides just below the flight deck. An associated equipment van located on the hangar deck contains the two receivers, a general purpose digital computer, a tape recorder and data processing equipment. The general purpose computer is used to calculate pointing angles, command the antenna system in real-time, and switch the tracking function between the two antennas.

PROTOTYPE MODEL SHIPBOARD RECEIVING TERMINAL (PMSRT)

The Prototype Model Shipboard Receiving Terminal is installed on the USS J. F. Kennedy and incorporates the best features of the FMSRT. It is capable of processing data from the DMSP Block 5D Operational Linescan System (OLS).

PRODUCTION SHIPBOARD RECEIVING TERMINAL (AN/SMQ-10)

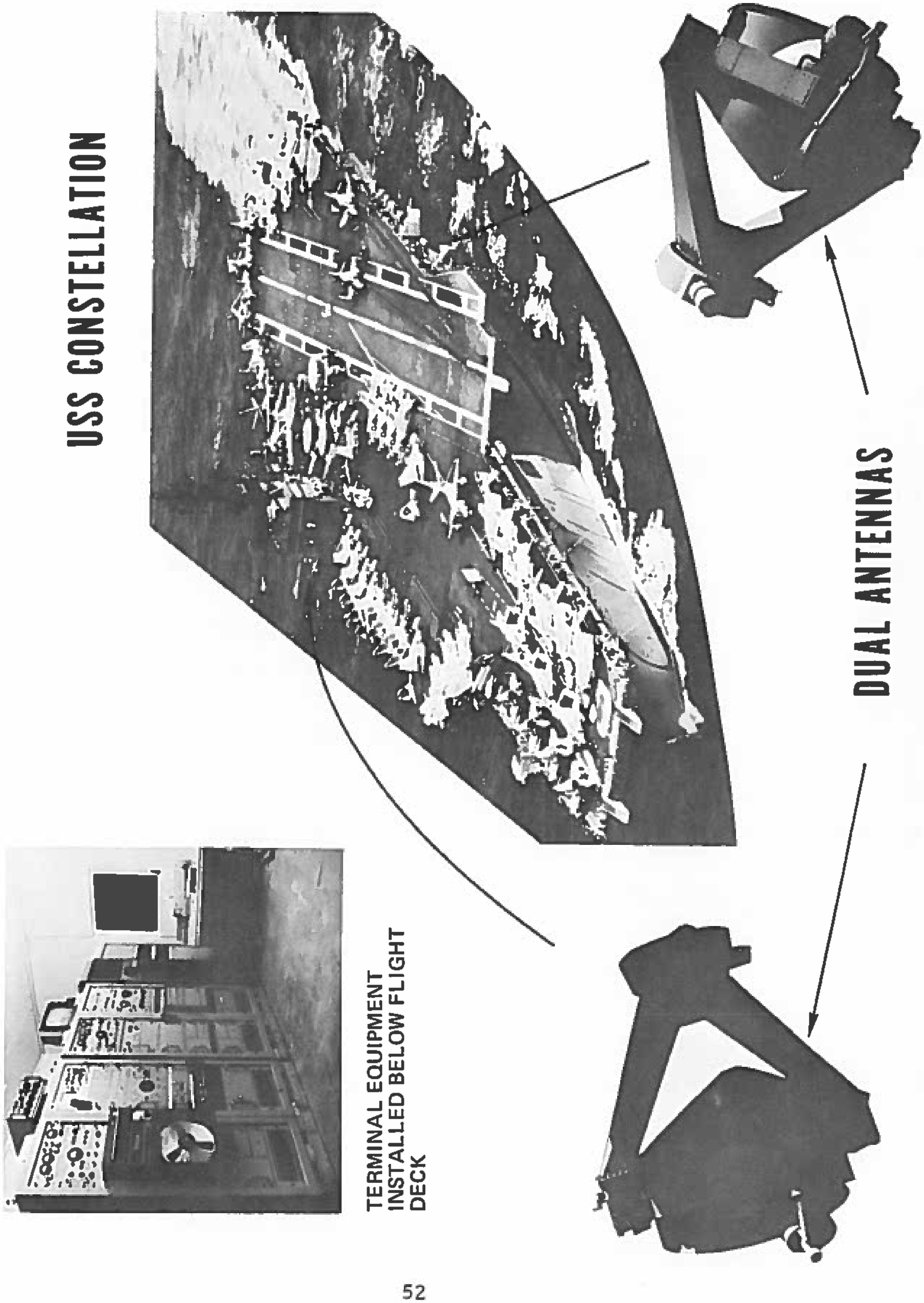
The AN/SMQ-10 will be configured to Navy requirements. Any desired improvements resulting from the development and testing of the PMSRT will be incorporated as required.

NAVY TRANSPORTABLE TERMINALS (AN/TMQ-29)

The land based Navy Transportable Terminal has a configuration which maximizes commonality with the shipboard terminals. The NTT is configured similarly to the Air Force TTS, but will support unique Navy requirements for tactical meteorological data.

NAVY TRANSPORTABLE TERMINAL

SHIPBOARD RECEIVING TERMINAL



DMSP DATA APPLICATIONS

I. <u>METEOROLOGY</u>

A. CLOUDS

a. Cloud Location
b. Cloud Tops
c. Cloud Patterns
d. Cloud Movement
e. Cloud Development
f. Cloud Dissipation
g. Invisible Clouds

B. SYSTEMS

a. Frontal
b. Easterly Waves
c. Vorticity Advection
d. Inter tropical convergence Zone
e. Convergence Lines
f. Squall Lines
g. Screaming Eagles

C. WIND

a. Low Level Direction/Speed
(1) Streamlines
(2) Lee Waves
(3) Patterns
(4) Systems
b. Upper Level
(1) Billow Clouds
(2) Transverse Bands
(3) Plumes
(4) Streaks
(5) Lee Waves
(6) Systems

D. PRECIPITATION

a. Rain
(1) Frontal-Mid Latitude
(2) Tropical
(3) Convective
(4) Wave (Easterly)
(5) Hurricane/Typhoon
b. Snow
(1) Coverage
(2) Runoff

E. SEVERE WEATHER

a. Hurricanes/Typhoons
(1) Development
(2) Intensity (Wind/Precipitation)
(3) Movement
(4) Dissipation
b. Thunderstorms/Tornadoes
(1) Convection (Development/Dissipation)
(2) Frontal
(3) Squall Lines
c. Turbulence
(1) Billow Clouds
(2) Lee Waves
(3) Deep Convection
(4) Patterns

F. MISCELLANEOUS

a. Pollution
(1) Air-Surface Upper Air
(2) Water

II. <u>OCEANOGRAPHY</u>

A. SURFACE TEMPERATURE

B. ICEBERG DETECTION

C. ICE MAPPING

D. ICE FLOW/ROUTES

III. <u>GEOPHYSICS</u>

A. AURORA

a. Communication
b. Spacecraft Effects
c. Solar Relations
d. Density Anomolies
e. Weather Effects

IV. <u>EARTH RESOURCES</u>

A. FOREST FIRES

B. VEGETATION ESTIMATION/DEPLETION

C. CROP HARVEST (Rice/Sugar Cane)

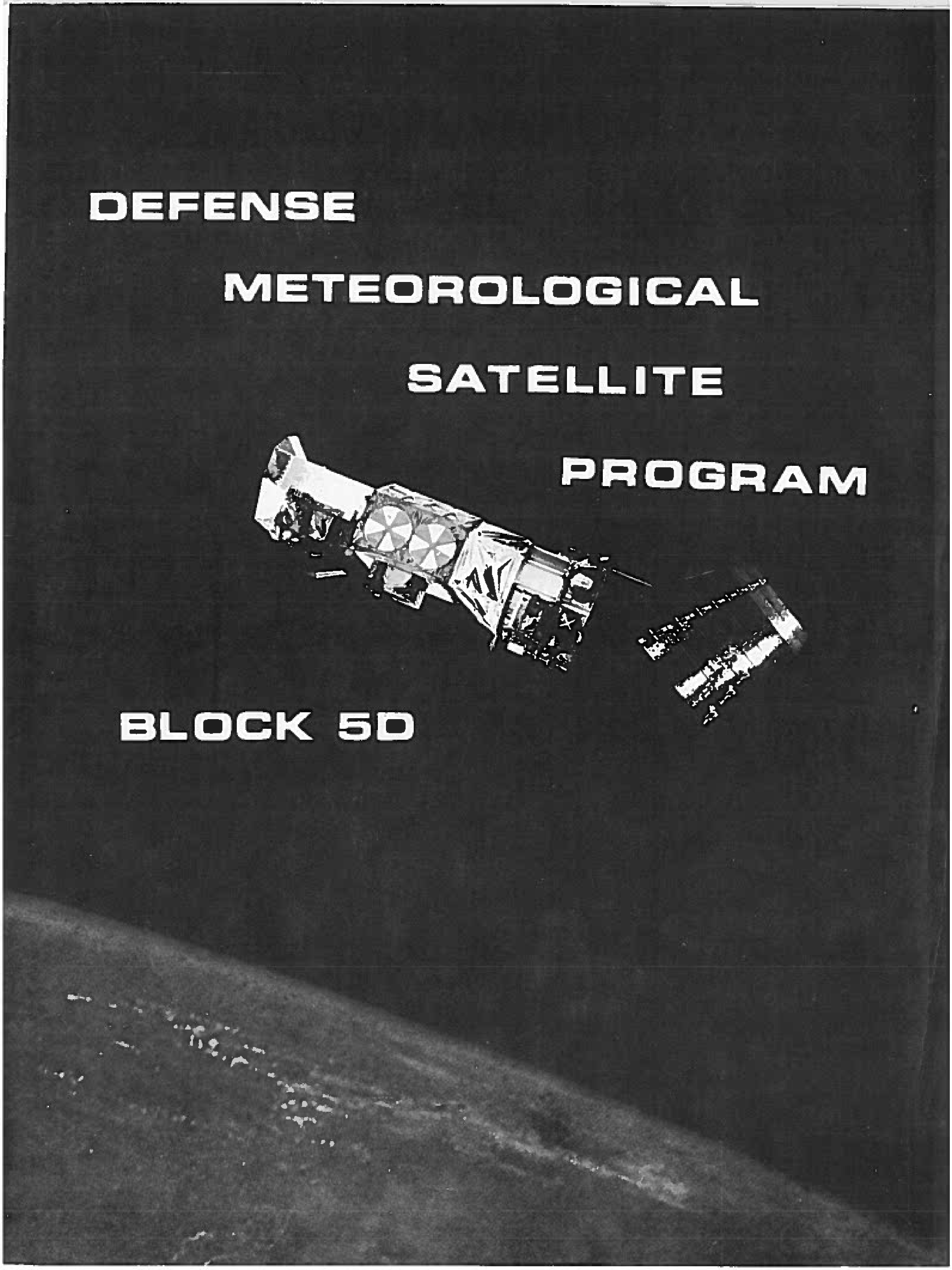
D. OIL REFINERIES/GAS FIELDS

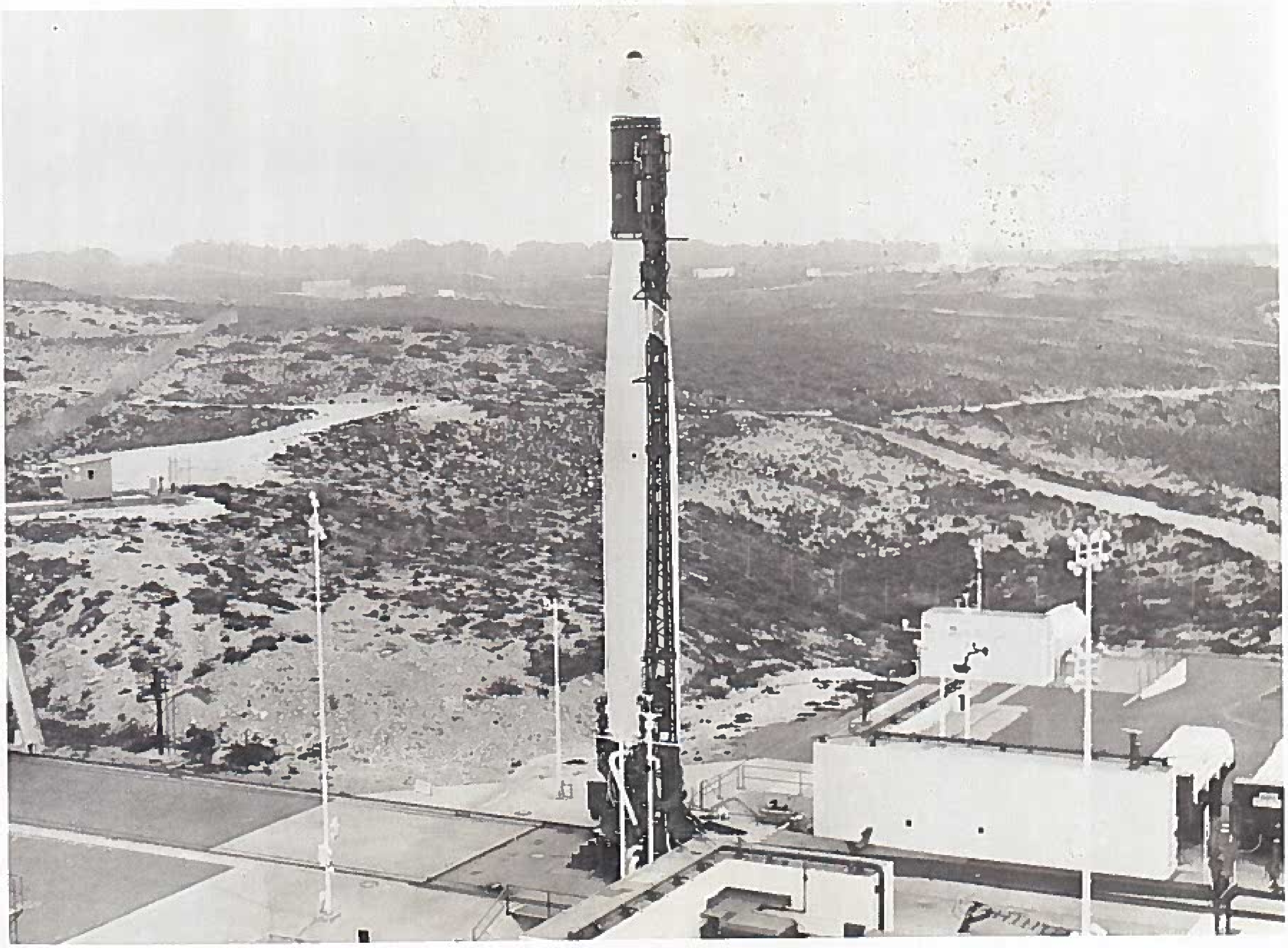
E. VOLCANOES

F. LIGHT POLLUTION

DEFENSE METEOROLOGICAL SATELLITE PROGRAM

BLOCK 5D





5D POSED ON SLC-10W FOR LAUNCH