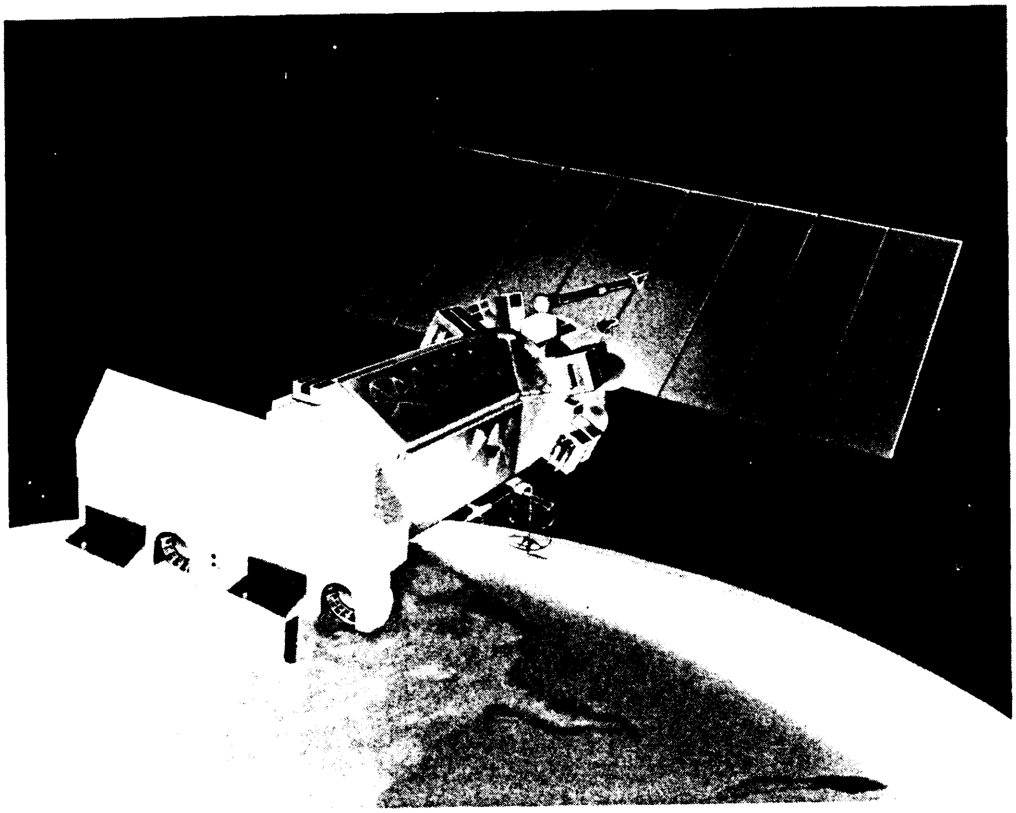
ML000705

NOAA-D.



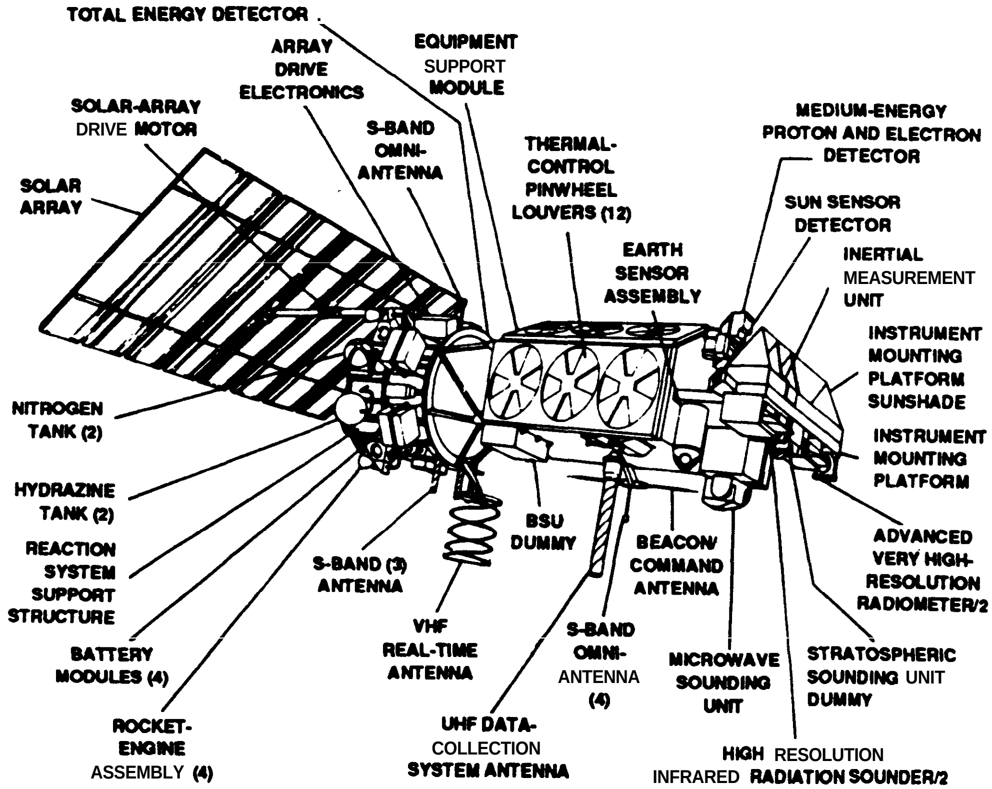
NASA

National Aeronautics and
Space Administration

Goddard Space Flight Center
Green belt, Maryland

May 1989

National Environmental
Satellite, Data, and
Information Service
Suitland, Maryland



NOAA-D Spacecraft With Major Features Identified

LEGEND	
AVHRR/2	ADVANCED VERY HIGH RESOLUTION RADIOMETER
BDA	BEACON/COMMAND ANTENNA
BSU	BASIC SOUNDING UNIT (DUMMY)
ESA	EARTH SENSOR ASSEMBLY
HIRS/2	HIGH-RESOLUTION INFRARED SOUNDER
IMP	INSTRUMENT MOUNTING PLATFORM
IMU	INERTIAL MEASUREMENT UNIT
MSU	MICROWAVE SOUNDING UNIT
REA	REACTION ENGINE ASSEMBLY
SAD	SOLAR-ARRAY DRIVE
SBA	S-BAND ANTENNA
SEM	SPACE ENVIRONMENT MONITOR
SOA	S-BAND OMNI ANTENNA (4)
SSD	SUN SENSOR DETECTOR
SSU	STRATOSPHERIC SOUNDING UNIT (DUMMY)
UDA	ULTRA-HIGH-FREQUENCY DATA COLLECTION SYSTEM ANTENNA
VRA	VERY-HIGH-FREQUENCY REAL-TIME ANTENNA

TIROS PROGRAM

INTRODUCTION

The TIROS program is a cooperative effort of the National Aeronautics and Space Administration (NASA), the National Oceanic and Atmospheric Administration (NOAA), the United Kingdom, and France for providing day and night global environmental and associated data for operational purposes on a regular daily basis. General Dynamics Space Systems Division (GDSSD) is the prime contractor for the ATLAS launch vehicle and is under contract to the United States Air Force, Headquarters-Space Systems Division, which provides launch vehicle management and launch services.

TIROS-N was launched October 13, 1978, at 11:23 Z, into a 470-nmi orbit. It was the first in the series of a fourth-generation operational environmental satellite system. TIROS-N was a research and development spacecraft serving as a protoflight for the operational follow-on series, NOAA-A through -H spacecraft. * Advanced instruments measure parameters of the Earth's atmosphere, its surface and cloud cover, solar protons, positive ions, electron-flux density, and the energy spectrum at the satellite altitude. As a part of its mission, the spacecraft also receives, processes, and retransmits data from free-floating balloons, buoys, and remote automatic observation. stations distributed around the globe. The General Electric Astro Space Division* * was the prime contractor for the spacecraft. The operational system consists of two satellites in Sun-synchronous orbits; one in a morning orbit at 450 nmi and one in an afternoon orbit at 470 nmi.

NOAA-A (-6) was launched June 27, 1979, at 15:51:59 Z. The satellite, which was launched into a 450-nmi orbit, greatly exceeded its 2-year lifetime. The satellite was deactivated on March 31, 1987.

NOAA-B was launched May 29, 1980, at 10: 53 Z, and failed to achieve a usable orbit because of a booster engine malfunction.

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*NOAA-A and -C through -H have been redesignated NOAA-6 through -11 after launch. NOAA numbers successfully launched satellites in the order that they attain orbit. Because NOAA-B failed, it has no number. NOAA-D will be NOAA-l 2 in orbit, because it follows NOAA-H, which was designated NOAA-l 1 in orbit.

* . Formerly RCA Astro Space Division.

NOAA-C (-7), launched June 23, 1981, at 10:52:59 Z, into a 470-nmi orbit was deactivated in June 1986 following failure of the power system.

NOAA-E (-8) was launched March 28, 1983, at 15:51:59.95 Z, into a 450-nmi orbit. The Redundant Crystal Oscillator (RXO) failed after 14 months in orbit but recovered in May 1985, locking up on the RXO backup side. The spacecraft was stabilized and declared operational by NOAA July 1, 1985. The satellite was finally lost December 29, 1985, following clock and power system failure.

NOAA-F (-9) was launched December 12, 1984, at 10:41:59.8 Z, into the 470-nmi afternoon orbit. DTR 1 A/I B failed two months after launch. The ERBE-Scanner stopped outputting science data in January 1987. The AVHRR has exhibited anomalous behavior in its synchronization with the MIRP, MSU channels 2 and 3 have failed, and the power system is degraded. A solar backscatter ultraviolet (SBUV/2) instrument is also aboard and it is operating satisfactorily. NOAA-9 is currently on standby status, with ERBE and SBUV/2 data still being processed.

NOAA-G (-10) was launched September 17, 1986, at 15:52 Z, into the 450-nmi morning orbit and is transmitting data directly to users around the world for local weather analysis. All instruments and subsystems are performing well except the ERBE-Scanner, which has exhibited a scan sticking anomaly.

NOAA-H (-11) was launched September 24, 1988, at 10:02:00.385 Z, into a 470-nmi afternoon orbit with a 1:40 p.m. ascending node crossing time. The NOAA-H has been modified for a 0 to 80° Sun angle and includes fixed and deployable sunshades on the Instrument Mounting Platform (IMP). The increase of maximum Sun angle from 68° to 80° allows an afternoon nodal crossing closer to noon to enhance data collection. All instruments and subsystems are performing well.

NOAA-D (-12 in orbit) will be launched into a 450-nmi morning orbit with a 7:30 a.m. descending node crossing time. This satellite will transmit data for local weather analysis directly to users around the world. The operational ground facilities include the Command and Data Acquisition (CDA) stations in Alaska and Virginia, the Satellite Operations Control Center (SOCC) and Data Processing Services Subsystem (DPSS) facilities in Suitland, Maryland, and a data-receiving location in Lannion, France.

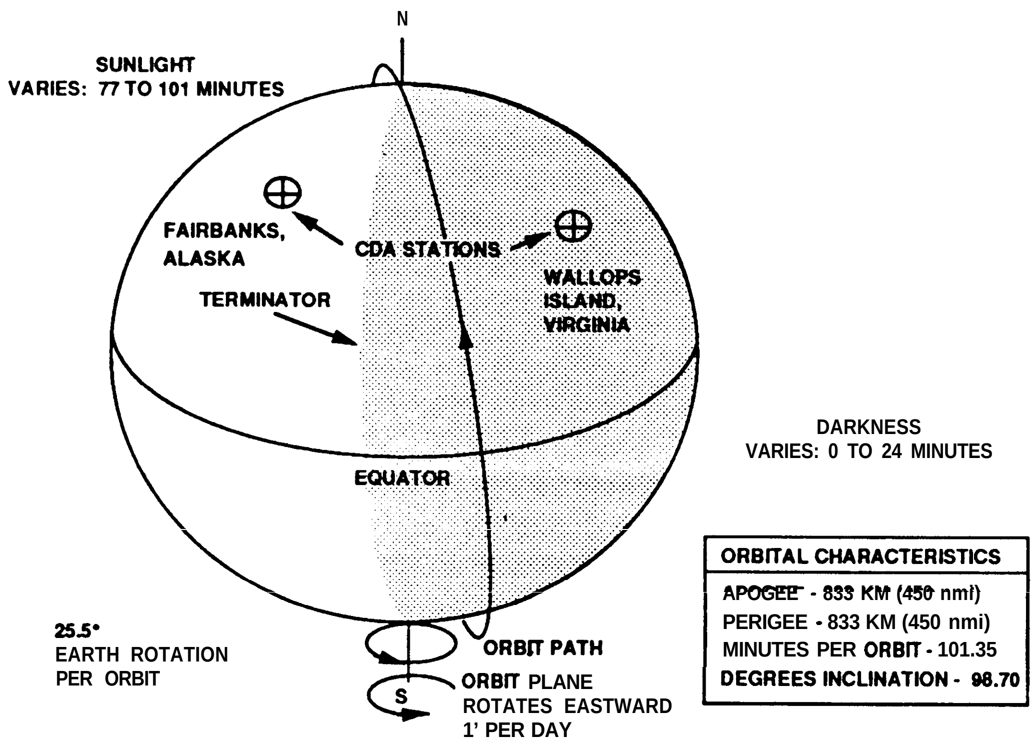
PHYSICAL CHARACTERISTICS

The physical characteristics of the NOAA-D Spacecraft are:

- **Main body:** 3.71 m (12.2 ft) long, 1.88 m (6.2 ft) in diameter
- **Solar array:** 2.37 by 4.91 m (7.8 by 16.1 ft), 11.6 m^2 (125 ft^2)
- **Weight:** At liftoff, 1418 kg (3127 lb); on orbit, 735 kg (1620 lb)
- **Power:** Orbit average end of life-453 W for gamma angle = 0°, 435 W for gamma angle = 68°
- **Lifetime:** Greater than 2 years

ORBIT

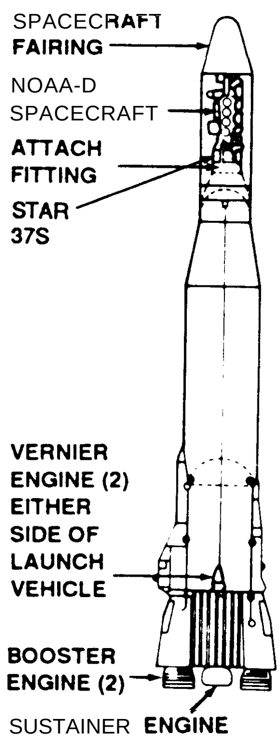
NOAA-D is a three-axis-stabilized spacecraft that will be launched into an 833-km (450-nmi) circular, near-polar orbit with an inclination angle of 98.70° (retrograde) to the Equator. Total orbital period will be approximately 101.35



NOAA-D ORBIT

minutes. The sunlight period will vary from 77 to 101 minutes with a corresponding 24 to 0 minutes in the Earth's shadow. Because the Earth rotates beneath the orbit 25.3° during each orbit, the satellite observes a different portion of the Earth's surface each orbit.

The nominal orbit is planned to be Sun-synchronous and to precess (rotate) eastward about the Earth's polar axis 0.986 degrees per day (the same rate and direction as the Earth's average daily rotation about the Sun). This precession will keep the satellite in a constant position with reference to the Sun for consistent illumination throughout the year. The launch time is selected so NOAA-D will cross the Equator at about 7:30 p.m. northbound and 7:30 a.m. southbound local solar time.



Atlas-E Launch Vehicle

LAUNCH VEHICLE

The spacecraft will be launched from the Air Force Western Space and Missile Center at Vandenberg Air Force Base, California, by an Atlas-E launch vehicle. The standard Atlas launch vehicle consists of an E-series Atlas ballistic missile that has been refurbished and modified to a standard configuration for use as a launch vehicle for orbital missions. It is capable of launching a spacecraft into a variety of low Earth orbits. The launch vehicle was manufactured and refurbished by GDSSD, under contract to the United States Air Force.

The vehicle stands 28.1 m (92.25 ft) tail and is 3.05 m (10 ft) in diameter. The fairing is 6.86 m (22.5 ft) long and is 2.13 m (7 ft) in diameter. At liftoff, it carries 70 kiloliters (18,457 gallons) of liquid oxygen and 43 kiloliters (1 1,351 gallons) of RP-1 fuel, a highly refined kerosene. Sea level engine data are presented in Table 1.

An airborne autopilot programmer in the launch vehicle flight control system provides preprogrammed steering and backup discrete commands. The General Electric Radio Tracking System (GERTS) ground system acquires the vehicle at approximately liftoff + 85 sec and performs the guidance function by means of the launch vehicle's pulse beacon decoder.

The vehicle is powered by one sustainer, two boosters, and two Vernier engines using liquid oxygen, liquid hydrocarbon propellants. A 0.97-m (38-in.) diameter attach fitting fastens the NOAA-D spacecraft to the launch vehicle. The fairing attached to the forward face of the launch vehicle protects the spacecraft during the boost flight.

Table 1
Atlas-E Sea Level Engine Data

	Booster	Sustainer	Vernier
No. of Engines	2	1	2
Thrust oer engine (lb)	165,000	57,000	1,000
Thrust per engine (N)	733,920	253,536	4,448
Thrust duration from liftoff (sec)	121	321	340

APOGEE KICK MOTOR

Apogee manuever is accomplished by use of a Morton Thiokol Elkton Division STAR 37S solid propellant motor. This 94-cm (37-in.) spherical rocket motor, which has flown on all previous TIROS-N type missions to date, provides an average 42.77 kN (9542 lbf) of thrust during a motor burn time of 43.5 sec. The STAR 37S motor, which is attached to the NOAA spacecraft, remains with the spacecraft after burnout.

NOAA-D INSTRUMENTATION

The instrument systems provide both direct readout (real time) and onboard recording (playback) of environmental data during day and night operation. The primary instruments carried by the NOAA-D spacecraft with the manufacturer in parentheses are:

- Advanced Very High Resolution Radiometer/2 (5 Channel) (ITT)
- High Resolution Infrared Radiation Sounder/2 (ITT)
- Space Environment Monitor (FACC)
- Microwave Sounding Unit (JPL)
- ARGOS Data Collection (CNES/France)

ADVANCED VERY HIGH RESOLUTION RADIOMETER

The Advanced Very High Resolution Radiometer (AVHRR/2) is a radiation-detection instrument used to remotely determine cloud cover and the surface temperature. This scanning radiometer uses five detectors that collect different bands of radiation wavelengths as shown in Table 2. Measuring the same view, this array of diverse wavelengths, after processing, will permit multispectral analysis for more precisely defining hydrologic, oceanographic, and meteorological parameters. One channel will monitor energy in the visible band and another in the near-infrared portion of the electromagnetic spectrum to observe vegetation, clouds, lakes, shorelines, snow, and ice. Comparison of data from these two channels can indicate the onset of ice and snow melting. Depending on which instrument is used, the other two or three channels operate entirely within the infrared band to detect the heat radiation from and, hence, the temperature of, the land, water, and sea surfaces and the clouds above them. Use of two adjacent frequency bands eliminates the hindrance in determining surface temperatures caused by clouds.

HIGH RESOLUTION INFRARED RADIATION SOUNDER (HIRS/2)

This instrument, provided by ITT, detects and measures energy emitted by the atmosphere to construct a vertical temperature profile from the Earth's surface to an altitude of about 40 km. Measurements are made in 20 spectral regions in the infrared band. (One frequency lies at the high end of the visible range.) Table 3 summarizes the HIRS/2 instrument characteristics.

MICROWAVE SOUNDING UNIT (MSU)

This unit, provided by Jet Propulsion Laboratory, detects and measures the energy from the troposphere to construct a vertical temperature profile to an altitude of about 10 km. Measurements are made by radiometric detection of microwave energy divided into four frequency channels as shown in Table 4.

Table 2
Advanced Very High Resolution Radiometer12
(AVHRR/2)

Characteristics	Channels				
	1	2	3	4	5
Spectral range (μm)	0.58 to 0.68	0.725 to 1.0	3.55 to 3.93	10.5 to 11.5	11.4 to 12.4
Detector	Silicon	Silicon	InSb	(HgCd)Te	(HgCd)Te
Resolution (km at nadir)	1.1	1.1	1.1	1.1	1.1
Instantaneous field of view (IFOV) (milliradians)	1.3 sq.	1.3 sq.	1.3 sq.	1.3 sq.	1.3 sq.
Signal-to-noise ratio at 0.5 albedo	>3:1	>3:1	—	—	—
Noise-equivalent temperature difference (NEAT) at 300 K (K)		— —	<0.12	<0. 12	<0.12
Scan angle (deg)	±55	±55	±55	±55	±55

Optics -8-in. diameter afocal Cassegrainian telescope

Scanner — 360-rpm hysteresis synchronous motor with beryllium scan mirror

Cooler-Two-stage radiant cooler, infrared detectors controlled at 105 or 107 K

Data output — 1 O-bit binary, simultaneous sampling at 40-kHz rate

Each measurement is made by comparing the incoming signal from the troposphere with the ambient temperature reference load. Since its data are not seriously affected by clouds, it is used in conjunction with the HIRS/2 to remove measurement ambiguity when clouds are present.

SPACE ENVIRONMENT MONITOR

The Space Environment Monitor (SEM) is a multichannel charged-particle spectrometer. It measures the population of the Earth's radiation belts and the particle precipitation phenomena resulting from solar activity (both of which contribute to the solar/terrestrial energy interchange). The SEM consists of two separate sensor units and a common data processing unit (DPU). The sensor

Table 3
High Resolution Infrared Radiation Sounder (HIRS/2)

Characteristics	Channels		
	1-12	13-19	20
Spectral range (μm)	6.72-14.95	3.76-4.57	0.69
Detector	(HgCd)Te	InSb	Silicon
Resolution (km at nadir)	17.45	17.45	17.45
IFOV (milliradians)	20.9	20.9	20.9
Noise-equivalent radiance (NEΔN)	0.03 to 0.96	0.003 0.0002 to 0.001	—
Scan width from nadir (deg)	±49.5	±49.5	±49.5

Optics- 15.0-cm (5.9 in.) diameter Cassegrainian telescope

Scanner — 1.8 ° stepper, 56 scan steps, then retrace

Cooler -Two-stage radiant cooler, infrared detectors controlled at approximately 105 K

Data output — 13-bit binary, channels sampled sequentially at 2.88-kbps rate

units are the total-energy detector (TED) and the medium-energy proton/electron detector (MEPED). The lower-energy sensors (the TED, plus the proton and electron telescopes of the MEPED) have pairs of sensors with difterent orientations because the direction of the particle fluxes is important in characterizing the energy interchanges taking place.

Objectives:

- To determine the energy deposited by solar particles in the upper atmosphere
- To provide a solar warning system

Technique:

- Total-energy detector cylindrical electrostatic analyzer and spiraltron
- Medium-energy proton and electron detector solid-state detector telescopes and omnidetectors

Table 4
Microwave Sounding Unit

Characteristics	Channel			
	R_1	R_2	R_3	R_4
Frequency (GHz)	50.30	53.74	54.96	57.95
RF bandwidth (MHz)	220	220	220	220
Resolution (km at nadir)	109	109	109	109
Noise-equivalent temperature difference (NEAT) (K)	0.3	0.3	0.3	0.3
Dynamic range (K)	O-350	O-350	O-350	O-350
Scan width from nadir (deg)	± 47.4	±47.4	± 47.4	± 47.4
Antenna beamwidth (deg)	7.5	7.5	7.5	7.5
Antenna beam efficiency (%)	>90	>90	>90	>90
Optics -Two scanning reflector antennas Scanner — 9.5 ° stepper through 360 ° scan Data output —12-bit binary at a 0.32-kbps rate				

Electrical characteristics:

- Logarithmic digital data and 32-sec subcommunication of housekeeping in two 8-bit words per minor frame
- Twelve commands
- Fifteen analog housekeeping parameters
- Fifteen digital discrete telemetry functions

Performance:

- TED: Proton-O.3 to 20 keV in 11 bands
  Electron-O.3 to 20 keV in 11 bands
- MEPED: Proton-30 to 2500 keV in 5 bands
  Electron->30 to >300 keV in 3 bands
  lons—>6 MeV
  Omniproton —>16 MeV, >36 MeV, >80 MeV

ARGOS/DATA COLLECTION SYSTEM (DCS)

The ARGOS/DCS, provided by France, assists NOAA in its overall environmental mission and in the support of the Global Atmospheric Research Program. Approximately 2000 platforms (buoys, free-floating balloons, and remote weather stations) measure temperature, pressure, and altitude, and transmit these data to the satellite. The onboard DCS receives the incoming signal, measures both the frequency and relative time of occurrence of each transmission, and retransmits these data to the central processing facility. The DCS information is decommutated and sent to the Centre National d'Etudes Spatiales ARGOS processing center where it is processed, distributed, and stored on magnetic tape for archival purposes. The NOAA-D DCS data rate is 720 bits per second.

Characteristics of the DCS are:

- System Specifications

  Elevation angle of visibility. .... 5°

  Number of platforms requiring location/ velocity and four sensor channels, visible in a 5° visibility circle 120

  Total number of such platforms over the globe 2000

  Percentage of platforms with six good Doppler measurements per day. ....>85 percent

  Measured location accuracy. .... 5 to 8 km rms

  Measured velocity accuracy. .... 1 to 1.6 mps

- Platform

  Frequency .... 401.65 MHz

  Oscillator stability drift (15 minutes). .... 0.5×10^{-9}/min

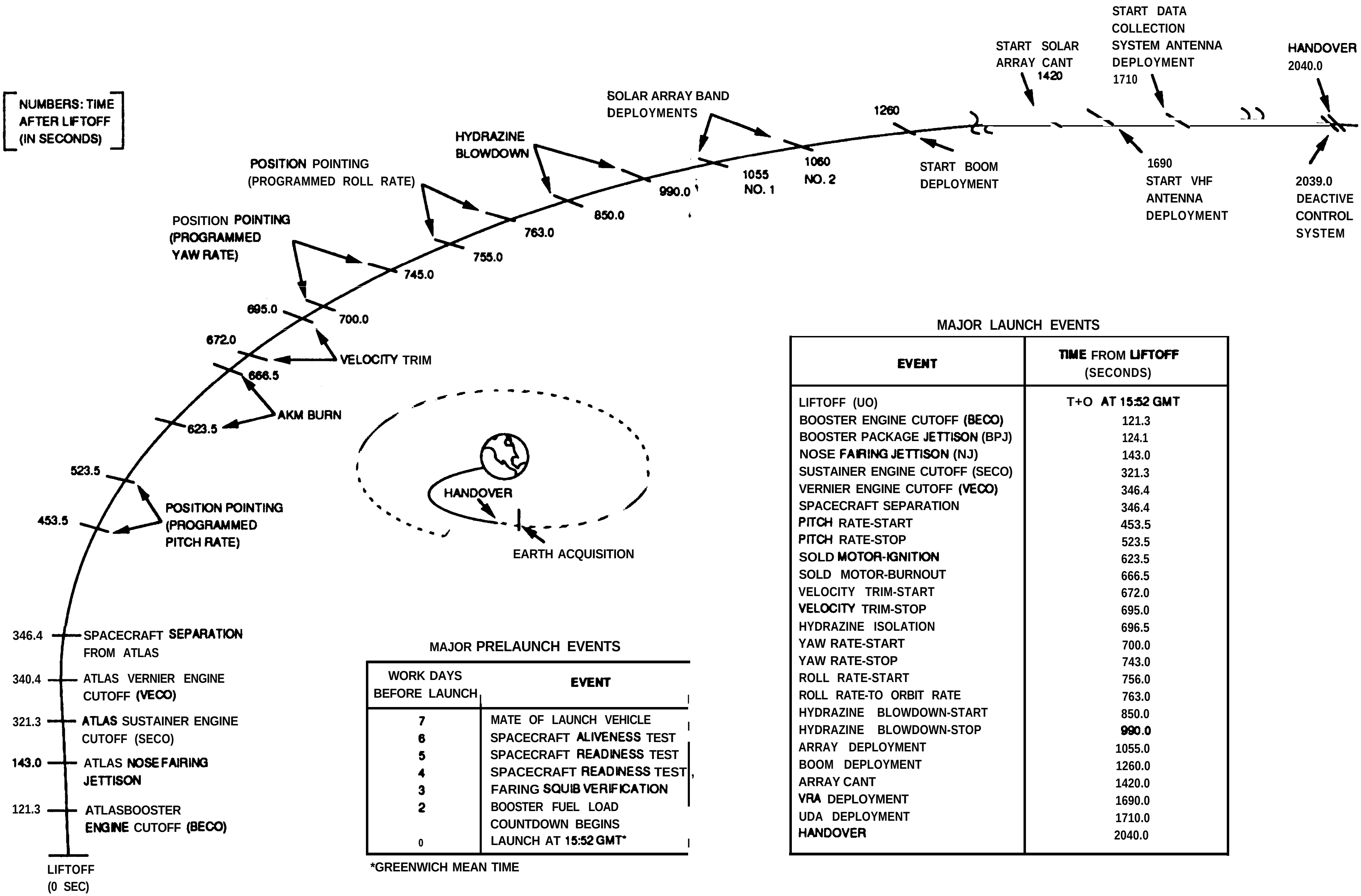
  Jitter. .... 2×10^{-9}

  Power Emitted. .... 3 W

  Message

  Coding: Biphase, 1 .1 ± 0.1 rad. .... 400 bps

  Phase deviation, duration for a standard platform. .... 360 ms



MAJOR PRELAUNCH EVENTS

WORK DAYS BEFORE LAUNCH	EVENT
7	MATE OF LAUNCH VEHICLE
6	SPACECRAFT ALIVENESS TEST
5	SPACECRAFT READINESS TEST
4	SPACECRAFT READINESS TEST
3	FARING SQUIB VERIFICATION
2	BOOSTER FUEL LOAD
	COUNTDOWN BEGINS
0	LAUNCH AT 15:52 GMT*

*GREENWICH MEAN TIME

MAJOR LAUNCH EVENTS

EVENT	TIME FROM LIFTOFF (SECONDS)
LIFTOFF (UO)	T+O AT 15:52 GMT
BOOSTER ENGINE CUTOFF (BECO)	121.3
BOOSTER PACKAGE JETTISON (BPJ)	124.1
NOSE FAIRING JETTISON (NJ)	143.0
SUSTAINER ENGINE CUTOFF (SECO)	321.3
VERNIER ENGINE CUTOFF (VECO)	346.4
SPACECRAFT SEPARATION	346.4
PITCH RATE-START	453.5
PITCH RATE-STOP	523.5
SOLD MOTOR-IGNITION	623.5
SOLD MOTOR-BURNOUT	666.5
VELOCITY TRIM-START	672.0
VELOCITY TRIM-STOP	695.0
HYDRAZINE ISOLATION	696.5
YAW RATE-START	700.0
YAW RATE-STOP	743.0
ROLL RATE-START	756.0
ROLL RATE-TO ORBIT RATE	763.0
HYDRAZINE BLOWDOWN-START	850.0
HYDRAZINE BLOWDOWN-STOP	990.0
ARRAY DEPLOYMENT	1055.0
BOOM DEPLOYMENT	1260.0
ARRAY CANT	1420.0
VRA DEPLOYMENT	1690.0
UDA DEPLOYMENT	1710.0
HANDOVER	2040.0

LAUNCH-TO-ORBIT **INJECTION** SEQUENCE

- **Satellite**

  Receiver

  Noise factor. . . . . 3 dB
  Doppler shift, drift, and oscillator
  tolerance . . . . 24 kHz

  Search unit

  Number of zones analyzed. . . . . 4 of 6 kHz each
  Analysis filter bandwidth. . . . . 300 Hz (20 steps)

  Data recovery units

  Number 4
  Carrier phase loop tracking
  bandwidth . . . . 40 Hz
  Doppler counting duration. . . . . 120 ms

  Interface to satellite telemetry system

  Periodically interrogated buffer,
  average-bit rate. . . . . 720 bps

COMMUNICATIONS AND DATA HANDLING

The communications subsystem uses 8 separate transmission links to handle communications between the satellite and the ground stations. Table 5 summarizes the communications links.

Communications and data handling characteristics are:

- TIROS Information Processor (TIP)
  - Flexible low-rate data formatter and telemetry processor
  - Boost, orbit, and dwell modes
  - 8,320 bps (orbit)
  - 16,640 bps (boost)

Table 5
Communications and Data Handling

Link	Carrier Frequency	information Signal	Baseband Bit-Rate	Modulation	Subcarrier Frequency
Command •	148.56 MHz	Digital commands	1 kbps	Ternary frequency-shift keyed (FSK/AM)	8, 10, and 12 kHz
Beacon	137.77 and 136.77 MHz	HIRS, MSU, SEM, DCS data, spacecraft attitude data, time code, house-keeping telemetry, memory verification; all from TIP	8,320 bps	Split-phase phase-shift keyed PSK	
VHF real time	137.50 and 137.62 MHz	Medium-resolution video data from AVHRR	2 kHz	AM/FM	2.4 kHz
S-band real time	1698 or 1707 MHz	High-resolution AVHRR and TIP data	665.4 kbps	Split-phase PSK	
S-band playback	1698, 1702.5, or 1707 MHz	High-resolution AVHRR data from MIRP, medium-resolution AVHRR data from MIRP; all TIP outputs	2.6616 Mbps	Randomized nonreturn-to-zero/PSK	
Data collection (uplink)	401.65 MHz	Earth-based platforms and balloons	400 bps	Split-phase PSK	
S-band playback to European ground station	1698, 1702.5, or 1707 MHz	TIP data recovered from tape recorders	332.7 kbps	Split-phase PSK	
S-band contingency	2247.5 MHz	Real-time TIP in orbit	TIP in orbit 8.32 kbps	Split-phase PCM/BPSK	1.024 MHz

•Uplink to the satellite

- Manipulated Information Rate Processor (MIRP)
  - High-rate data formatter and processor
  - Performs multiplexing, formatting, resolution reduction, and geometric correction functions
  - Analog Automatic Picture Transmission (APT): Global Area Coverage (GAC) data (66.54 kbps); High Resolution Picture Transmission (HRPT) data (665.4 kbps); Local Area Coverage (LAC) data (665.4 kbps) outputs
- Digital Tape Recorder (DTR)
  - Five digital data recorders
  - Record 8.32 kbps-225.0 min.
    16.64 kbps- 113 min.
    66.54 kbps- 113 min.
    665.4 kbps- 11.3 min.
  - Playback 1.3308 Mbps-5.6 min.
    332.7 kbps- 5.6 min.
    2.6616 Mbps-2.8 min.

HIGH RESOLUTION RADIOMETRY

One of the objectives is to provide timely day and night sea-surface temperature and ice, snow, and cloud information to diverse classes of users. The AVHRR is used to obtain these data. Requirements include:

- Worldwide direct readout to ground station of the APT class, at low resolution (4 km)
- Worldwide direct readout to ground stations of the HRPT class (1.1 -km resolution)
- GAC of onboard data at relatively low resolutions (4 km) for central processing
- LAC of onboard storage of data from selected portions of each orbit at high resolution (1.1 km) for central processing

DATA TRANSMISSION

The sounder system data along with radiometry data will be telemetered through the TIROS Information Processor (TIP) telemetry system on NOAA-D. Data will be transmitted full resolution in the following modes:

- Worldwide direct TIP transmission (beacon link)
- Worldwide direct TIP multiplexed with HRPT
- TIP multiplexed with low resolution AVHRR data stored and played back (GAC)
- TIP multiplexed with full resolution AVHRR data stored and played back (LAC)
- TIP-only data stored and played back during blind orbits

COMMAND

The CDA stations control the operation of the satellite by programmed commands transmitted to the satellite on a 148-MHz radio signal

- Command-link bit rate: 1000 bps
- Stored commands
  - Table capacity: 2300 commands at launch and on orbit
  - Time tag: 1.0-sec granularity, 36-hour clock

GROUND SYSTEM

A principal operating feature of the TIROS-N system is the centralized remote control of the satellite, through the CDA stations, by the NOAA National Environmental Satellite Data and Information Service (NESDIS) Satellite Operations Control Center (SOCC). The ground system is made up of the Data Acquisition and Control Subsystem (DACS) and the central processing system designated the Data Processing Services Subsystem (DPSS).

NESDIS SOCC

The central operations and control center for satellite operations is located at Suitland, Maryland. SOCC is responsible for operational control of the entire ground system. Specifically, SOCC is responsible for the following:

CDA Stations-The primary command and data acquisition stations are GFOM, located at Fairbanks, Alaska, and WOMS, located at Wallops Station, Virginia. Through a cooperative agreement between NOAA/ NESDIS and the Establissement d'Etudes et de Recherches Meteorologiques (EERM) in France, stored and real-time TIP data can be relayed from the Lannion Centre de Meteorologie Spatiale (CMS) via the GOES satellite.

The CDA stations transmit command programs to the satellite, acquire and record meteorological and engineering data from the satellite. All data are transmitted between CDA and Suitland via commercial communications links. Commands are transmitted between SOCC and CDA via commercial communications links.

Ground Communications-The ground communications links for satellite operations are provided by SATCOM and NASCOM. NASCOM provides any launch-unique communications links for satellite launch. This support is defined in the Network Operations Support Plan (NOSP) and the NASA Support Plan (NSP). SATCOM provides all voice and data links between the SOCC and the CDA stations after launch. SATCOM is provided and operated by NESDIS.

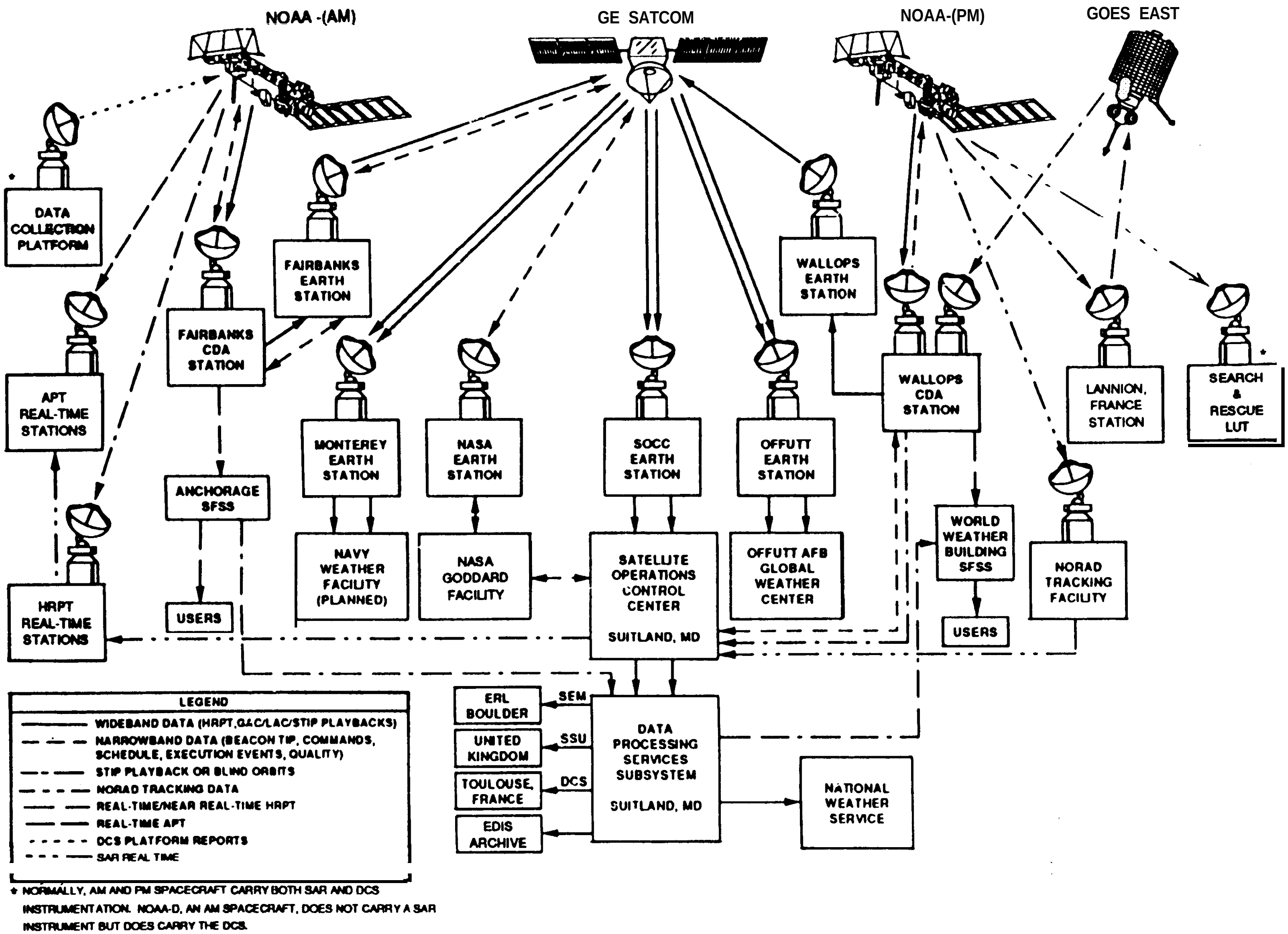
NESDIS Data Processing Services Subsystem (DPSS) — DPSS acquires data from the CDA stations via SOCC and is responsible for the data processing and generation of meteorological products on a timely basis to meet the TIROS program requirements. NOAA provides all hardware and software for DPSS.

GSFC Facility Support-Office of Space Operations, NASA Headquarters Code T associated support is requested through the Support Instrumentation Requirements Document (SIRD), with other support as described in Memoranda of Understanding.

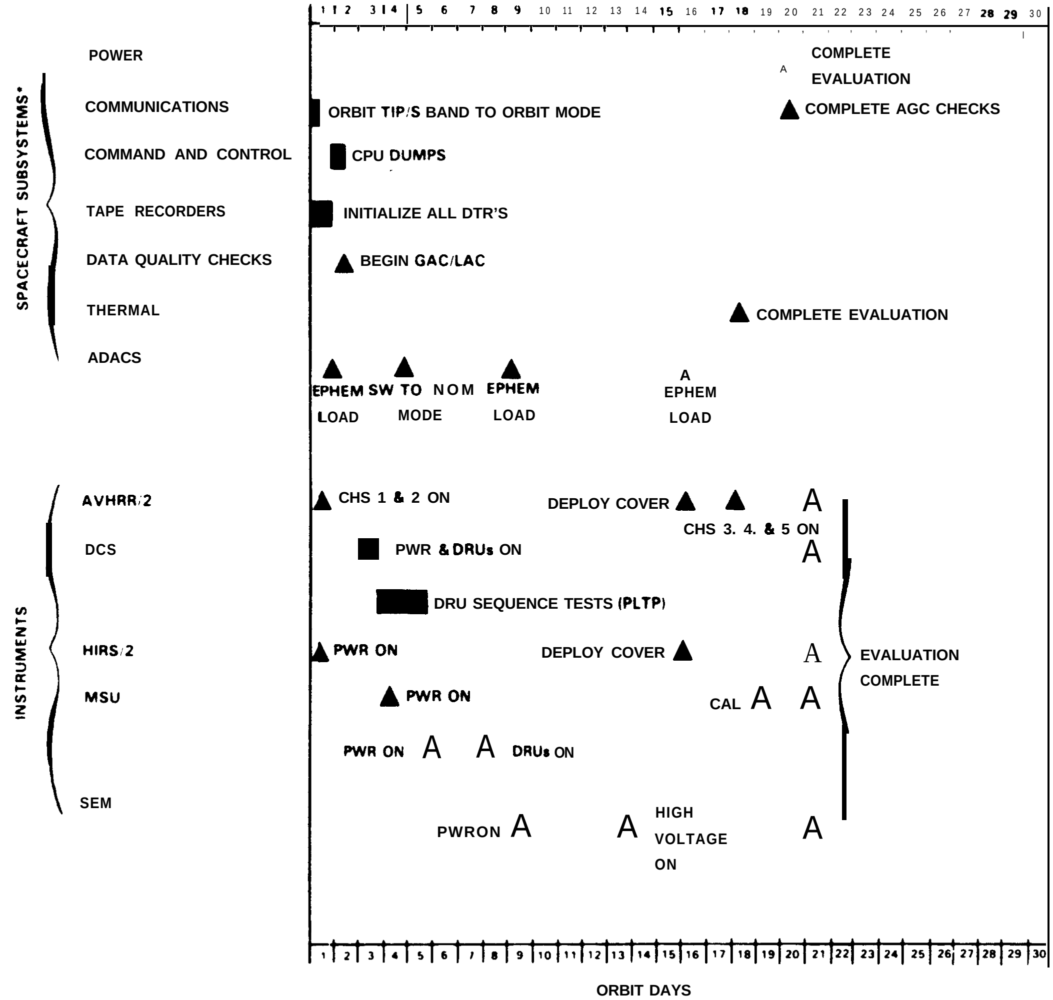
During launch and early orbit (approximately 24 hours), special Ground Network (GN) VHF support for telemetry reception and contingency commanding is being provided by scheduled sites on an as available and best effort basis. There is a requirement for GN to provide emergency support for NOAA spacecraft if requested during their operational lifetimes, provided GN VHF capability exists. This capability is expected to be phased out by September 1989.

The North American Air Defense Command (NORAD) has prime responsibility for orbit determination, which includes establishing the initial orbit solution and providing updated orbital parameters on a routine basis throughout the life of the mission. NORAD provides the orbital information through the NASA/GSFC communications to NOAA/SOCC. NASA/GSFC will provide nominal prelaunch orbital and prediction information, special support for initial orbit estimation, and initial quality-control checks of the NORAD orbital data. All attitude determination is to be accomplished by the NOAA central data processing facility.

Launch and Contingency Downlink- An S-band downlink operating at 2247,. 5 MHz can be used during satellite ascent to recover TIP boost telemetry through WSMC tracking sites. For NOAA-D, the normal ascent link operating at 1702.5 MHz will be used, and no Airborne Range-Instrumentation Aircraft (ARIA) will be scheduled. During in-orbit operations, orbit mode TIP will be available through a 2247.5-MHz link to provide early orbit and contingency support through the Air Force Satellite Control Network (AFSCN) in Sunnyvale, California.



NOAA-D Polar Operational System



* Subsystem baseline evaluation and operational configurrtton complete on Day 4

NOAA-D Activation and Evaluation Timeline