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The RCA Space Constellation

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INTRODUCTION

The constellation of spacecraft being readied at RCA Astro-Electronics for launch in 1981 encompasses a variety of missions. The spectrum of missions that this constellation of satellites covers include commercial communication services from geostationary orbit, meteorological satellites in low-earth orbit for the civilian and military organizations, navigation satellites for the U.S. Navy, government and commercial users, and a pair of scientific explorer satellites that will measure the magnetosphere from a near-earth orbit to an orbit at a distance of 5 earth radii.

Up to eight spacecraft are planned for launch in 1981; namely, the RCA Satcom D and E commercial communication satellites, the U.S. Navy NOVA 1 and 2 navigation satellites, NASA's Dynamics Explorer A and B scientific satellites, the U.S. Department of Commerce NOAA-C operational meteorological satellite, and the Department of Defense DMSP Block 5D-2 operational meteorological satellite. Additionally, a number of RCA color television camera systems will be carried on the Space Transportation System for aiding the astronauts in the inspection and deployment of cargo from the cargo bay and to provide video transmission of engineering and public relations activity in the Shuttle crew compartment. Table 1 summarizes the planned launches for 1981.

DYNAMICS EXPLORER

The Dynamics Explorer A and B spacecraft will be launched from the Western Test Range in the summer of 1981 to investigate the strong interactions coupling the hot, convecting plasmas of the magnetosphere and the cooler, denser plasmas and gases co-rotating in the earth's ionosphere, upper atmosphere, and plasmasphere. The specific mission objectives of DE-A and DE-B will be to determine:

a. Electric-field induced convection;

b. Electric currents;

c. Energy coupling;

d. Mass coupling;

e. Wave-particle plasma interactions.

To achieve the above objectives, RCA Astro-Electronics has designed and built two Dynamics Explorer spacecraft patterned after the highly successful Atmosphere Explorer C, D, and E spacecraft launched in 1973 and 1975. These spacecraft designated DE-A and DE-B shown on Figure 1 will be equipped with a total of 15 unique instruments provided by NASA/GSFC. The DE-A and DE-B spacecraft will be launched together by a single Delta 3913 launch vehicle and placed into polar coplanar orbits. DE-A, the high-altitude orbit spacecraft, will have a perigee of 364 nmi (675 km) and an apogee of 4.95 earth radii (13,424 nmi 24,874 km) (geocentric). This highly elliptical orbit will permit the spacecraft to make measurements extending from the hot magnetospheric plasma through the plasmasphere to the cool ionosphere. At apogee the satellite will perform global imaging, auroral wave measurements in the heart of the magnetosphere, and will cross the auroral field lines at several earth radii. Measurements will be made for significant periods along a magnetic field flux tube.

DE-B, the low-altitude orbit spacecraft, will be placed in an orbit with perigee at 165 nmi (305 km) and apogee at 702 nmi (1300 km). In this orbit, measurements will be made in the cool ionosphere and upper atmosphere regions. At perigee measurements will be made of the neutral particles and at apogee (above the

TABLE 1. RCA 1981 CONSTELLATION IN SPACE

Satellite	Date Approx. Launch	Launch Vehicle	Launch Site	Orbit	Owner	Mission
NOAA-C	2nd Qtr	Atlas E/F	WTR	450 nmi 98.8° incl.	NOAA	Operational Meteorological Satellite (TIROS-N Series)
NOVA-1	2nd Qtr	Scout	WTR	600 nmi	U.S. Navy	Operational Navigation Satellite (Transit System)
RCA Satcom-D	2nd Qtr	Delta/PAM-D	ETR	19,105 nmi Geostationary	RCA Americom	Operational Commercial Communication System
Dynamics Explorer DE-A	3rd Qtr	Delta 3910	WTR	364 nmi x 13,424 nmi	NASA/GSFC	Scientific Satellite to Investigate Magnetosphere
DE-B		Dual-Stacked Launch		165 nmi x 702 nmi		
RCA Satcom-E	4th Qtr	Delta/PAM-D	ETR	19,105 nmi	RCA Americom	Operational Commercial Communication System
NOVA-2	4th Qtr	Scout	WTR	600 nmi	U.S. Navy	Operational Navigation Satellite (Transit System)
DMSP BL 5D-2	4th Qtr	Atlas E/F	WTR	450 nmi	U.S. Air Force	Operational Military Meteorological System
CCTV - Cameras	1st Qtr and 3rd Qtr	Space Shuttle	ETR	160 nmi	NASA-JSC	Remote Control TV for STS

NOTE: The above projected launch schedules are subject to change due to launch vehicle availability or program redirection.

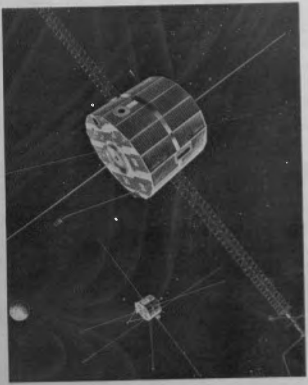

Figure 1. Dynamics Explorer DE-A and DE-B

interaction region for suprathermal ions) measurements of plasma flow at the feet of the magnetospheric field lines. These objectives will be achieved by a selected instrument complement for each spacecraft, as listed in Table 2.

Spacecraft Design

The DE-A and DE-B spacecraft design was based on the design of the predecessor spacecraft, Atmosphere Explorer, however, the requirement for coplanarity of the DE-A and DE-B spacecraft and the obvious cost benefits dictated that both spacecraft be launched from a single booster. Table 3 summarizes the System parameters. The modified design permits the dual mounting of the DE-A and DE-B spacecraft in a single stack. It also accepts different instrument complements and layouts and is configured with a large number of deployable devices such as booms, masts, and antennas. The unique design of each solar array compensates for the presence of booms, antennas, and masts that produce shadowing patterns on the body mounted solar array. The sensitivity of the scientific measurements to be made have dictated a stringent design task in minimizing

TABLE 3. DYNAMICS EXPLORER SYSTEM PARAMETERS

Spacececraft	DE-A	DE-B
Orbit		
Apogee: nmi (km)	13,424 (24,874)	702 (1300)
Perigee: nmi (km)	364 (675)	165 (305)
Inclination-degrees	90°	90°
Period-minutes	439	101
S/C Weight: lb (kg)	888 (403)	901 (409)
Payload Weight: lb (kg)	187 (85)	214 (97)
Power - Array - Max. Watts	108	125
Power - Payload - Watts	63	91
Attitude Control	Spin Stabilized	3-Axis Momentum Bias
Instruments	6	9

degree. The yaw axis is aligned to within ±1 degree of local vertical and the roll axis points to within 1 degree of the velocity vector. By ground command, other orientations may be selected about the pitch axis. The spacecraft can also be operated in a slow scan mode and thus be rotated at approximately 1 rpm. Infrared, wheel mounted horizon scanners and body mounted solar aspect sensors provide spacecraft attitude sensing to within 0.2 to 0.3 degree in each axis. Passive and active damping are employed to dampen nutational oscillations.

Power System. The basic power for DE-A and DE-B is supplied from solar cell arrays on the sides and ends of the spacecraft. Approximately 40 square feet (3.7 square meters) of surface provide up to 100 watts for each spacecraft. A pair of nickel-cadmium batteries on each spacecraft have a nominal storage capacity of 6 ampere hours.

Communications. The DE communications subsystem includes NASA standard S-band (STDN and TDRSS) transponders. The S-band transponders are used for command reception, real-time data transmission, playback of stored data, and turnaround ranging signals.

Spacecraft Configuration. The DE spacecraft which is the shape of a 16-sided polyhedron measures 53.5 inches (135.9 cm) in diameter and is approximately 48 inches (122 cm) high before the appendages are deployed. The external surfaces (except for instrument viewing ports and spacecraft structural attachment areas) are covered either with solar cells or with conductive surfaces that provide for spacecraft field grounding or are finished as suitable thermal control surfaces. Each spacecraft, like Atmosphere Explorer, is configured with machined baseplates attached to a center column, the lower end of which mates with the adapter for the launch vehicle or the second spacecraft.

In mission mode various items are deployed. The DE-A spacecraft deploys the plasma wave instrument antennas consisting of three wire antennas -- two are 328 feet (100 meters) long and the third is 23 feet (7 meters). Additionally, two 19.7-foot (6-meter) booms are deployed for the plasma wave instrument antennas and the magnetometer. The DE-B spacecraft deploys six antennas, each 36 feet (11 meters) long, to measure the vector electric field. A single 19.7-foot (6-meter) boom is deployed for the magnetometer.

NOVA

The U.S. Navy's Transit Navigation Satellite System, which has evolved over the past two decades, has pioneered in geodesy, navigation, and doppler surveying. Its constellation of five satellites is providing reliable operational precision navigation data on a worldwide basis to the U.S. Navy and commercial shipping. Over the past few years, the Navy developed the TIP (Transit Improvement Program) to enhance the present system. Three developmental satellites were launched. The design improvements have been incorporated in a new generation, the NOVA spacecraft, now in limited production at RCA. Figure 2 shows the NOVA spacecraft in mission mode. The first of the three spacecraft in this series will be launched by a 4-stage Scout launch vehicle from the Western Test Range in 1981. Table 4

TABLE 2. DYNAMICS EXPLORER INSTRUMENT COMPLEMENT

Instrument	Responsible Investigator	Institution
DE-A (High-Altitude Mission)		
Fields		
1. Magnetometer-A	Sugiura	Goddard Space Flight Center
2. Plasma Wave Instrument	Shawhan	University of Iowa
Optical Emissions		
3. Spin-Scan Auroral Imager	Frank	University of Iowa
Charged Particles		
4. Retarding Ion Mass Spectrometer	Chappell	Marshall Space Flight Center
5. High Altitude Plasma Instrument	Burch	Southwest Research Institute
6. Energetic Ion Composition Spectrometer	Shelly	Lockheed
DE-B (Low-Altitude Mission)		
Fields		
1. Magnetometer-B	Sugiura	Goddard Space Flight Center
2. Vector Electric Field Instrument	Maynard	Goddard Space Flight Center
Neutral Particles		
3. Neutral Atmosphere Composition Spectrometer	Carignan	University of Michigan
4. Wind and Temperature Spectrometer	Spencer	Goddard Space Flight Center
Optical Emissions		
5. Fabray-Periot Interferometer	Hays	University of Michigan
6. Ion Drift Meter	Heelis	University of Texas at Dallas
7. Retarding Potential Analyzer	Hanson	University of Texas at Dallas
8. Low Altitude Plasma Instrument	Winningham	Southwest Research Institute
9. Langmuir Probe Instrument	Brace	Goddard Space Flight Center

the spacecraft generation of electromagnetic radiation and magnetic fields.

Attitude Control. Each spacecraft's orbit, payload, and dynamic requirements resulted in different attitude sensing and control systems for each spacecraft which are unique. The DE-A high-orbit spacecraft will be spin-stabilized at 10 ± 0.1 rpm with the spin axis normal to the orbit plane within ±1 degree. Roll and yaw are measured near apogee by V-mounted body horizon scanners. Precision sun sensors provide additional attitude information. Spacecraft orientation is maintained by air-core magnetic coils that are pulsed at appropriate times to interact with the earth's magnetic field to provide the required control torques. Additional damping of pitch disturbances resulting from nonrigid body behavior of the wire antennas and the spacecraft is provided by a liquid-filled loop damper.

The DE-B spacecraft is a momentum-bias, 3-axis stabilized spacecraft. A momentum bias wheel is used about the pitch axis, which is maintained normal to the orbit plane to within ±1

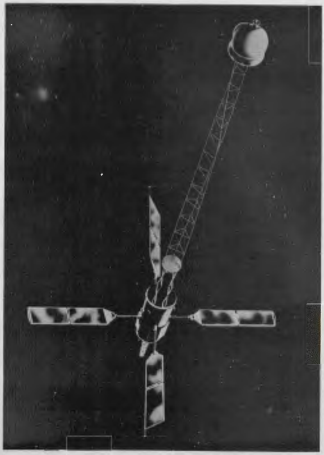

Figure 2. NOVA Navigation Satellite

TABLE 4. TRANSIT/NOVA SYSTEM PARAMETERS

Spacecraft	Transit	NOVA
Launch Vehicle	Scout	Scout
Orbit: nmi (km)	600 (1111)	600 (1111)
Inclination	90°	90°
Period	110 min.	110 min.
S/C Weight: lbs (kg)	130 (60)	360 (163)
S/C Wt. - dry: lbs (kg)	130 (60)	2S0 (127)
S/C Power: watts	50	90
Payload Power: watts	15	38.5
Attitude Control	Gravity Gradient	Gravity Gradient plus Orbit Adjustment and Active Momentum Control

compares the Transit and NOVA system parameters. The following design improvements have been included in NOVA:

a. Improved time and frequency control;

b. Improved satellite signal power and antenna patterns;

c. On-board propulsion to provide a more precise circular orbit;

d. A Disturbance Compensation System (DISCOS) for minimizing in-orbit errors caused by external forces such as atmospheric drag and solar pressure; and

e. Ion engine - pulse plasma teflon thrusters.

Spacecraft Description

The NOVA spacecraft will weigh approximately 360 pounds (163 kg), almost three times heavier than the Transit satellite. It will be placed into an initial orbit of 185 by 400 nmi (343 by 741 km). The on-board propulsion system will circularize the orbit at 600 nmi (1111 km). The main structure is an octagonal body 20.5 inches (52.1 cm) across and 15.5 inches (39.4 cm) high, topped by a cylindrical attitude control section 10.5 inches (26.7 cm) in diameter by 30 inches (76.2 cm) long. Four hinged body mounted adjustable solar panels are deployed 90 degrees apart to provide 65 watts of power for the system. A 12 ampere-hour nickel-cadmium battery is available for operating the spacecraft during the eclipse phase.

Attitude Control. The attitude control system satisfies the mission performance requirements during a sequence of three post-launch phases: (I) a spin stabilized phase, (2) a magnetically stabilized phase, and (3) a two-axis gravity gradient phase. The principal components of the attitude control system include: (1) a magnetic coil for spin axis maneuvering during the spin stabilized phase and for magnetic field tracking during the magnetically stabilized phase; (2) a magnetic spin-despin system for increasing or decreasing the spacecraft spin rate during the first phase; (3) a demagnetizer for removing spurious magnetic dipoles; (4) a momentum wheel for yaw control during the magnetically stabilized and gravity gradient phases; (5) two ball-in-tube nutation dampers for passive damping of the spin-stabilized satellite's nutational or wobbling motion; (6) four magnetic hysteresis rods for passive damping of spacecraft oscillation during the latter two phases; (7) an erectable Z-axis boom, 24.5 feet (7.5 meters) long, for gravity gradient stabilization to keep the spacecraft continuously oriented with respect to local vertical; (8) a 3-axis vector magnetometer, a spinning digital solar attitude detector, and three non-spinning digital solar attitude detectors to provide attitude determination; (9) a momentum wheel in the 3-axis stabilization mode for yaw control; (10) an orbit adjust transfer system utilizing hydrazine propulsion to provide impulse upon command to circularize the orbit and correct booster errors; and (11) the single-axis DISCOS system, a cylindrically shaped package located at the center of mass in the orbital configuration, to counteract environmental disturbances due mainly to solar radiation pressure and atmospheric drag in the orbit plane of the satellite. A proof mass suspended within this body is free of external disturbance forces. An optical sensor detects the proof mass position and provides a signal to fire one set of the pulse plasma teflon thrusters if the spacecraft is moved relative to the proof mass. This allows the spacecraft to follow the nearly pure gravitational orbit of the proof mass along the orbit velocity vector.

Doppler System. The prime functional requirement of the doppler subsystem is to provide signal generation and certain signal conditioning which results in navigation data to the users. Telemetry data is also made available for use in ground control of the spacecraft. The dual 5 MHz ultra-stable oscillator provides a precision frequency source for use throughout the spacecraft. An Incremental Phase Shifter is provided which is programmable by ground command to compensate for oscillator drifts.

Computer System. A computer/memory system processes telemetry data for providing delayed commands. It also stores the spacecraft ephemeral data. The magnetic core memory provides programmable storage for 16K words of 16 bits each.

Command System. The NOVA command system, which is fully redundant, performs the remote execution of relay commands, pulse commands, digital data commands, and fast and slow loading of the computer memories. Redundant command receivers provide redundant reception and demodulation of the amplitude modulated command signals.

RCA SATCOM

The RCA Americom Satellite Communication System (Satcom) has been in U.S. domestic operation since 1975. The RCA Satcom F1 and F2 satellites are in geostationary orbit at 119°W and 135°W Longitude. Each provides efficient, low-cost telecommunications services to all 50 states. The commercial service includes private line and message toll service, commercial television and radio, digital data, cable television (CATO), and specialized voice, video and data services. The five-year-plus operational flight performance of the RCA Satcom 3-axis stabilized spacecraft has been quite successful. Performance of the attitude control, propellant utilization, and power subsystems has exceeded specifications. Each satellite is equipped with 24 transponders and features cross-polarization and frequency reuse to maximize C-Band (6/4 GHz) capability in orbit. RCA Satcom F1, which was launched by Delta 3914, is the first commercial domestic communication satellite with power and propellant capacities for continuous operation of all channels for eight years in orbit. The first two 24-channel RCA Satcom satellites have been highly utilized. The next satellites of this series, RCA Satcom D and E, are now being readied for an ETR launch on a Delta 3910/PAM-D in June and October 1981. Figure 3 shows the on-orbit configuration of RCA Satcom D. These new spacecraft have been designed for compatibility with STS/PAM-D or Delta 3910/PAM-D launch vehicles. With the Star 30 apogee motor, the total transfer orbit weight is 2,385 lbs (1082 kg) as compared to 2,000 lbs (907 kg) for the earlier satellites. The baseline for RCA Satcom D and E is for 24 TWTA channels with an additional four TWTA's for redundancy.

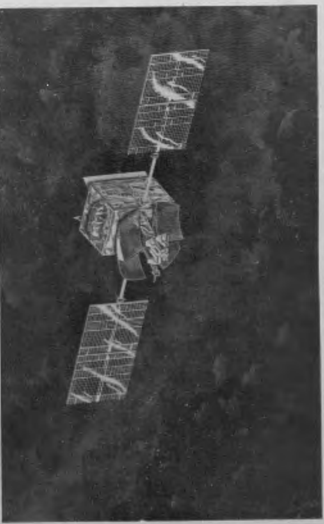

Figure 3. RCA Satcom D Communication Satellite

Other improvements have been incorporated to extend the orbit life of this spacecraft. Increased TWTA power in all channels, 5.5 watts in 18 and 8.5 watts in 6, provides improved EIRP and allows the operational flexibility to assign some customers higher power channels. The power system has been improved to handle the higher power transponders. The solar array has increased from 75 to 90 square feet (6.97 to 8.36 square meters), the average solar cell efficiency has been increased, and the battery capacity has been increased from 12 to 17 amp hours. The attitude control system modifications have been introduced to simplify operational procedures, improve pointing performance of the magnetic torquing system, and decrease ground control activity. A modified reaction-control system provides increased propellant storage capacity to insure that the longer projected life in orbit is met. The total hydrazine load has been increased from 230 lbs to 340 lbs (104 to 154 kg), and the 0.1-lb (0.44N) thrusters have been replaced by 0.2-lb (0.89N) thrusters.

Table 5 briefly highlights the system parameters of the earlier RCA Satcom F1 and F2 as compared to RCA Satcom D and E. Further improvements will be introduced in the next generation, RCA Satcom F, G and H, to be put into service in 1982-83. This system will still employ the space-proven 3-axis stabilization and power system technology; however, the structure will be enlarged for a larger and more efficient communication payload that will use solid state GaAs FET amplifiers in lieu of TWTA's.

TIROS/NOAA METEOROLOGICAL SATELLITE

The TIROS/NOAA meteorological satellite has been the principal operational polar-orbiting system for the U.S. over the past two decades. The current fourth generation in the TIROS series, designated TIROS-N, was introduced into operational service in October 1978. A companion satellite, NOAA-6, was successfully placed into service in June 1979. These complementary satellites are providing the U.S.

Department of Commerce's National Oceanic and Atmospheric Administration with daily orbital observations of the earth's cloud cover, earth's surface and sea surface temperature, atmosphere temperature from sea level to 20-mile (32.2 km) altitude, collection and location of data from fixed and moving platforms, and monitoring of the solar energetic particles in the vicinity of the earth.

The TIROS family of satellites is built by RCA for NOAA under the technical management of NASA. NOAA provides operational control of these satellites after they are in orbit. A broad group of users in this country and the world at large have access to the satellite data either through direct real-time acquisition of data from the satellite as it travels overhead or from data stored for playback, processing, and dissemination by NOAA at Suitland, Maryland.

To fulfill the mission requirements, NOAA-C spacecraft will be similar to the TIROS-N/NOAA-6 series and is equipped with a complement of instruments, data processors and storage devices to assure timely reliable acquisition and transmission of global weather data

TABLE 5. RCA SATCOM SYSTEM PARAMETERS

Spacecraft	Satcom F 1 and 2	Satcom D and E
Orbit: nmi (km)	19,105 (35,402)	19,105 (35,402)
Launch Vehicle	Delta 3914	Delta 3910/PAM D
Weight: lb (kg)		
Transfer Orbit	2,000 (907)	2,385 (1,082)
Geostationary Orbit	790 (358)	942 (427)
Payload	220 (100)	248 (112)
Propellant-Hydrazine	230 (104)	340 (154)
Array Power BOL Watts	755	985
EOL Watts	650 8 yrs	830 10 yrs
Total Transponders	24	28 (4 redundant)
Transmit Freq-MHz	3700-4200	3700-4200
Receive Freq-MHz	5925-6425	5925-6425

routinely on a 24-hour basis. Figure 4 shows the NOAA-C configuration and Table 6 highlights the system parameters.

The TIROS-N/NOAA A-G series is launched by an Atlas E/F launch vehicle from the Western Test Range and operates in a near-polar, circular, sun-synchronous orbit with a nominal altitude of either 450 or 470 nmi (833 or 870 km). In the operational configuration two satellites are positioned with a nominal orbit plane separation of 90 degrees.

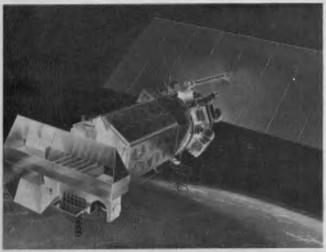

Figure 4. NOAA-C Meteorological Satellite

TABLE 6. NOAA-C SYSTEM PARAMETERS

Orbit: nmi (km)	450 (833)
Inclination: degrees	98.8
Period: minutes	102
Launch Vehicle	Atlas E/F
Integrated S/C Stage	TEM 364-15
Lift-Off Weight: lb (kg)	3,127 (1,418)
On-Orbit Weight: lb (kg)	1,700 (771)
Array Power BOL Watts	1,250
Avg. Power Watts	320
Payload Power Watts	200
Attitude Control	3-Axis Zero Momentum

Instrument Payload

The principal instrument payload for NOAA C is as follows:

a. The Advanced Very High Resolution Radiometer (AVHRR), a four-channel, cross-track scanning instrument, provides image and radiometric data in the visible, near-infrared, and far-infrared portions of the spectrum and was utilized on TIROS-N and NOAA-6. The AVHRR instrument is used to observe clouds, land-water boundaries, snow and ice, temperature of clouds, and land and sea surface. A fifth channel has been added for NOAA-C to enhance sea surface temperature measurements.

b. The TIROS Operational Vertical Sounder (TOVS), a subsystem consisting of three instruments, provides temperature profiles of the atmosphere from sea level to 20 miles (32.2 km), water vapor contents, and total ozone content.

- The High-Resolution Infrared Sounder (HIRS/ 2), a 20-channel step-scanned, visible and infrared spectrometer, is used to produce tropospheric temperature and moisture profiles.
- The Stratospheric Sounding Unit (SSU), a 3-channel, pulse-modulated, step-scanned, far-infrared spectrometer, is used to produce temperature profiles of the stratosphere.
- The Microwave Sounding Unit (MSU), a 4-channel, step-scanned spectrometer with response in the 60-GHz oxygen band, is used to produce temperature profiles in the atmosphere in the presence of clouds.

c. The Data Collection System (DCS) is a random-access system for the collection of meteorological data from in-situ platforms, both movable and fixed, such as buoys, balloons, and remote weather stations.

d. The Space Environment Monitor (SEM), a 3-instrument multidetector unit, is used to monitor solar particulate energies in the vicinity of the satellite. The SEM measures solar proton, alpha particle and electron flux density energy in the vicinity of the satellite.

Spacecraft Description

The NOAA-C spacecraft is an integrated system designed to provide for its controlled injection into a nominal circular, near-polar, sun-synchronous orbit at an altitude of 450 or 470 nmi (833 or 870 km) and an inclination of 98.9 degrees. After burnout of the Atlas E/F 1st-stage, 2nd-stage propulsion is provided by a solid rocket motor (TEM 364-15) that is integral with the satellite. The Atlas guidance system controls the 1st stage during launch. The spacecraft system monitors the launch parameters and controls the flight after separation from the Atlas vehicle. Body rates and accelerations are provided to the Central

Processing Unit (CPU) by the Inertial Measurement Unit (IMU) which is composed of rate integrating gyros and accelerometers. The CPU uses a stored set of equations to determine the optimum flight profile. The Reaction Control System, consisting of hydrazine and nitrogen thrusters, provides spacecraft control during the 2nd stage burn and coast periods and trims orbital velocity after spacecraft insertion into orbit.

The structure consists of four sections:

1. The Reaction System Support Module, which supports the solid motor, the reaction control equipment tanks and the mounting structure to the launch vehicle;

2. The Equipment Support Module (ESM), in which are housed electronic components, tape recorders, transmitters, momentum wheels and coils;

3. The Instrument Mounting Platform (IMP) which provides a precision mounting surface for the various instruments, the IMU, and the attitude sensing devices, and;

4. The solar array and its supporting boom which contains the solar array drive that orients the 125-sq. ft. (11.61 sq. meters) planar array towards the sun.

The TIROS-N spacecraft at lift-off weighs 3,127 lbs (1418 kg). Its in-orbit weight is 1,620 lbs (735 kg). When fully deployed and in mission mode the spacecraft length is approximately 21 feet (6.4 meters) long and 6 feet (1.8 meters) in diameter.

Attitude Control System. The zero momentum, 3-axis control system maintains pointing by controlling torque in three mutually orthogonal reaction control wheels. The autonomous control system senses error from the Earth Sensor Assembly for pitch and roll correction and obtains inputs from an inertial reference with sun sensor updates for yaw correction. The Attitude Determination and Control System (ADACS) controls the spacecraft attitude to maintain orientation of the three axes to within ± 0.2 degree (3σ) of the local geographic reference.

Other subsystems are described in greater detail in the referenced paper.

NOAA-C is scheduled to be launched in May 1981 from the Western Test Range.

Additional NOAA and Advanced TIROS-N spacecraft will be launched as required to fulfill the operational requirements at least until 1986. The improvements to this system are described in referenced paper.

DEFENSE METEOROLOGICAL SATELLITE PROGRAM (DMSP)

The U.S. Department of Defense has had the Defense Meteorological Satellite Program (DMSP) in operational service since the mid-sixties. The DMSP polar-orbiting satellite system is under the management of the U.S. Air Force. The DMSP satellites are designed to meet unique military requirements for worldwide weather information, and the processed data is made readily available to Air Force, Navy, Army, and Marine installations.

The satellite observations and data can be transmitted in real time to these installations and naval vessels at sea. Additionally, the stored data is received in the U.S. acquisition sites and relayed to the Air Force Global Weather Center at Offutt Air Force Base, Omaha, Nebraska for processing and distribution to various users, both military and civilian.

Four of the current DMSP Block 5D-1 satellites have been orbited since their introduction into service in 1976.

An improved version, designated DMSP Block 5D-2, is now being readied at RCA for launch late in 1981 from the Western Test Range at Vandenberg, California. The 5D-2 spacecraft has been increased in length by 20 inches (51 cm), the structure strengthened, and additional changes added to the electronic system so that larger and more numerous sensors can be added and the expected operational life of the spacecraft increased. Figure 5 shows the 5D-2 configuration and Table 7 compares system parameters of 5D-1 and 5D-2.

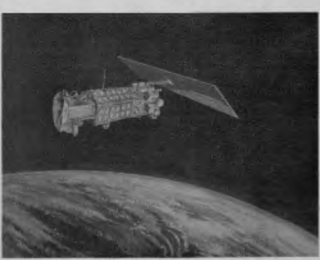

Figure 5. DMSP Block 5D-2 Meteorological Satellite

TABLE 7. DMSP SYSTEM PARAMETERS

Spacecraft	Block 5D-1	Block 5D-2
Orbit: nmi (km)	450 (830)	450 (830)
Inclination: degree	98.7	98.7
Period: minutes	101	101
Launch Vehicle	Thor LV-2F	Atlas E/F
S/C Integrated Stage	TEM 364-4 TEM 364-15	-- TEM 364-15
S/C Lift-Off Wt: lb (kg)	5,900 (2,676)	3,127 (1,418)
On-Orbit Weight: lb (kg)	1,131 (513)	1,656 (751)
Payload Weight: lb (kg)	300 (136)	550 (249)
Array Power BOL watts	1,000	1,250
S/C Avg. Power Watts	260	330
Payload Power Watts	140	180
Attitude Control	3-Axis Zero Momentum	3-Axis Zero Momentum

The in-orbit weight of the spacecraft has been increased by approximately 400 lbs (181 kg). The prior series utilized a Thor (LV-2F) booster. The DMSP Block 5D-2 will utilize the Atlas E/F. The change in launch vehicles resulted in the elimination of one of the two solid motors (TEM-364-4) employed with the 5D-1 spacecraft. The 5D-1 spacecraft weighed 5,900 lbs (2676 kg) at lift-off. 5D-2 will weigh approximately 3,127 lbs (1418 kg).

Spacecraft Description

The DMSP Block 5D-2 and the TIROS-N/NOAA spacecraft designs have commonality in many of the subsystems, such as power, thermal control, on-board computer, and the attitude stabilization system. One exception is that 5D-2 with its star mapper can achieve even greater pointing accuracy. Instrumentation. The operational line scan system is the primary sensor on board to provide visible and infrared imagery. Additional sensors, including the temperature/moisture sounder and the precipitating electron spectrometer, are utilized to forecast the location and intensity of the aurora.

CLOSED CIRCUIT TELEVISION (CCTV) SYSTEM

The Space Transportation System will be equipped with a number of RCA closed circuit television systems to ensure proper payload handling, inspection, deployment, retrieval, storage, and monitoring of mission critical activities in the crew compartment and the cargo bay.

The CCTV system is compatible with standard broadcast rates and quality for use by the NASA Public Affairs Office in disseminating information of interest to the general public. It will also enhance maximum real-time participation by engineers and scientists on the ground during experiment operations, engineering tests, and in-orbit problem solution. All on-board video signals are also ground selectable for viewing and distribution by NASA Mission Control and Public Affairs Office.

The complement of cameras will vary with mission needs. Initially, two cameras will be located in the crew compartment and three in the cargo bay (2 on the forward bulkhead and 1 on the aft). Future flights will include two cameras on the wrist of the remote manipulator arm. Figure 6 shows the CCTV in one of its configurations on the Space Shuttle, and Table 8 lists a complement of the CCTV equipment.

The CCTV is a modular design so that the camera can be converted to color or black and white, interchange lens assemblies, be utilized as a hand-held camera, or mounted on the

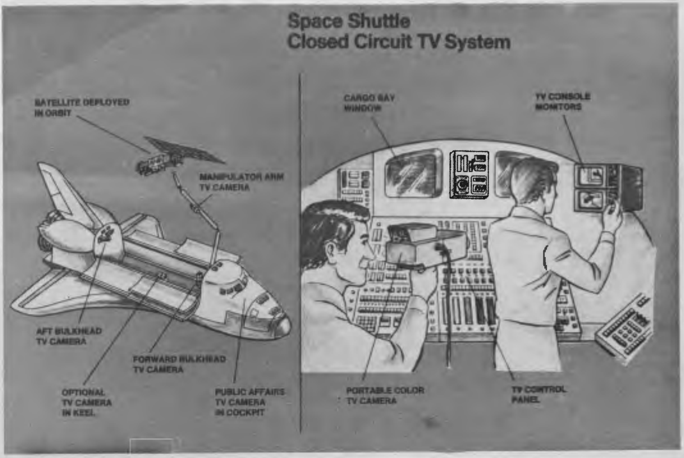

Figure 6. Space Shuttle Closed Circuit Television System

TABLE 8. CCTV SYSTEM ELEMENTS

Unit	Weight (lbs)	Power (watts)	Quantity Used on STS
Camera Assembly	9.5	21	5
Monochrome Lens Assembly	7.0	--	1
Color Lens Assembly	7.5	--	4
Viewfinder Monitor	3.5	7	1
Pan/Tilt Unit	9.5	14	3
Video Switching Unit	19.0	28	1
Remote Control Unit	19.0	28	1
Television Monitor	20.0	35	2

pan/tilt assembly for almost spherical coverage. A dual 8-inch monitor assembly is provided for the crew compartment to display the TV signals to the crew.

The CCTV camera contains a 1-inch Silicon Intensified Vidicon (SIT) image sensor for sensitivity under low light level conditions in the cargo bay.

CONCLUSION

The diversified missions that will be achieved with the launching and orbital operation of the RCA 1981 constellation of satellites will provide beneficial service to people in the U.S. and throughout the world.

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