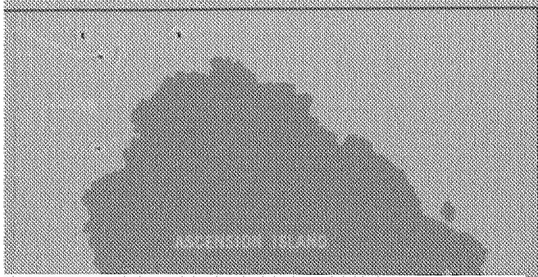
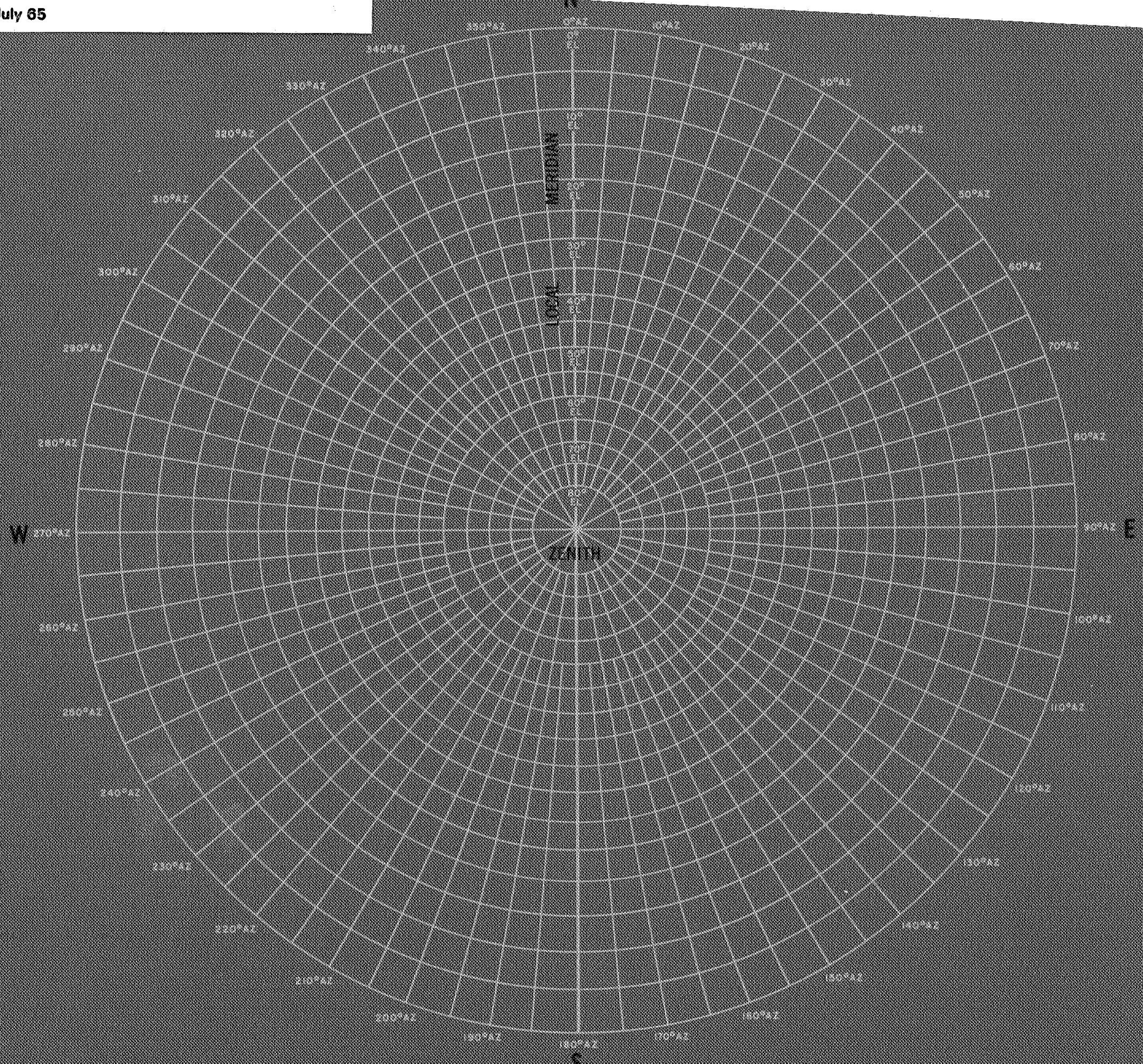
JPL TECHNICAL MEMORANDUM No. 33-284



DSIF: ASCENSION ISLAND



NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

JET PROPULSION LABORATORY/CALIFORNIA INSTITUTE OF TECHNOLOGY

FRONT COVER: *A stereographic projection of the azimuth-elevation coordinates used by the DSIF to define antenna-pointing angles for locating the spacecraft.*

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

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DSIF: ASCENSION ISLAND

JET PROPULSION LABORATORY/CALIFORNIA INSTITUTE OF TECHNOLOGY

Prepared Under Contract No. NAS 7-100
National Aeronautics & Space Administration

Foreword

In the National Aeronautics and Space Administration's program of space exploration, most of the scientific investigations of the space environment thus far have been made possible by unmanned, automated spacecraft. These advance explorers are dependent upon man's control from Earth to execute their missions, and if the missions are to be of value, there must be some means of returning the scientific findings to Earth. The ground-based space communications and command system that supplies this support for NASA's unmanned deep space flight projects is known as the Deep Space Network.

The Jet Propulsion Laboratory pioneered the development of many of the critical elements of deep space telecommunications systems, and in 1958 established the first three-station network of receiving stations to gather data from *Explorer I,* the first U.S. Earth-orbiter. Since the formation of that early network, out of which grew the design of the present Deep Space Network, technological advances have been so great that the DSN capability, measured in quantity of information transmitted per unit of time, has increased more than a thousand times over the pre-1960 capability.

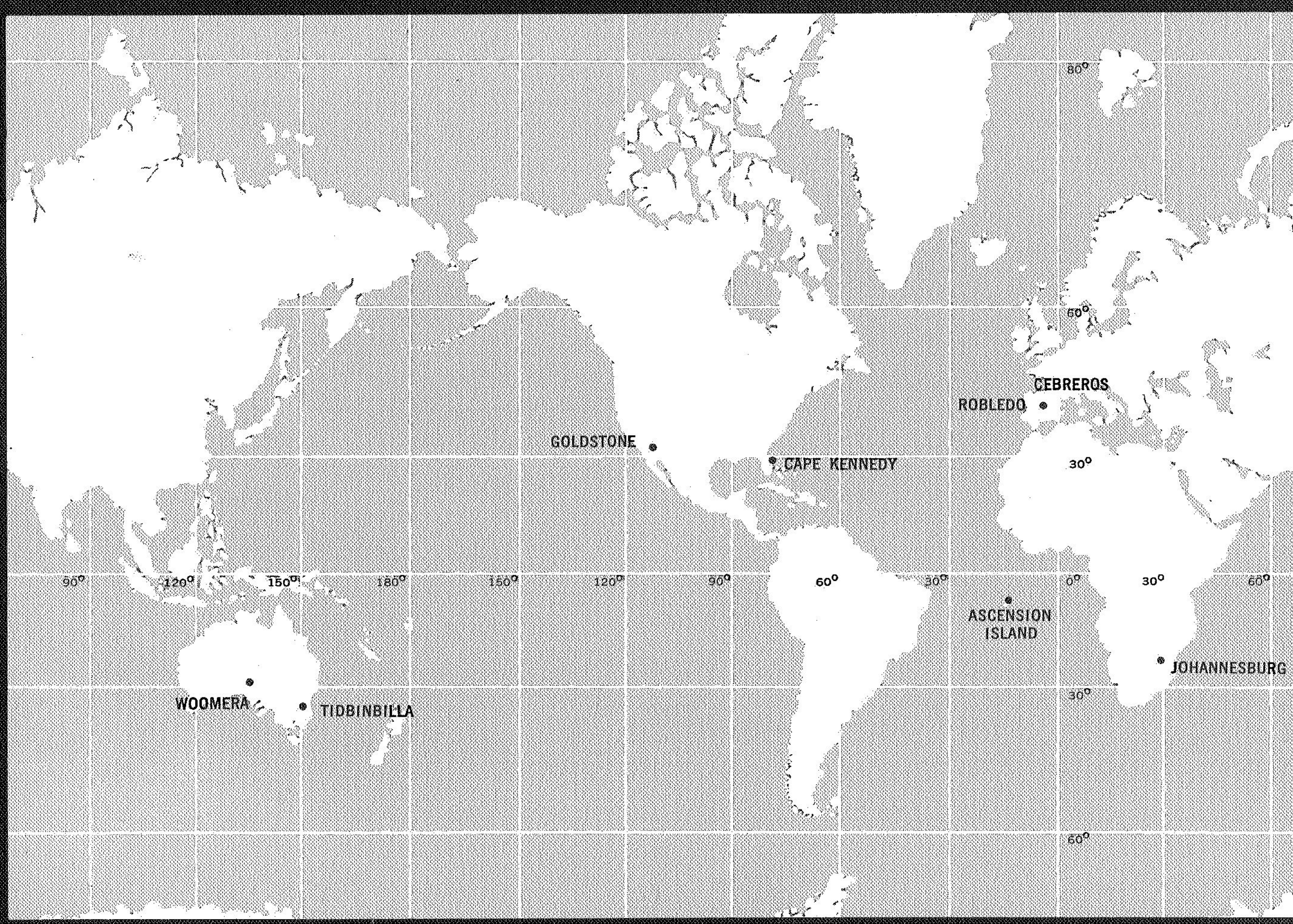
The DSN has contributed to a number of historic U.S. deep space achievements. Among these were the first successful flyby of another planet; the first close-up photographic exploration of the Moon; and the first successful mission to the planet Mars. The capabilities of the Network are continuously being improved to keep up with the demands of the more complex deep space missions undertaken by NASA. One of the notable achievements accruing from advanced work of this nature has been radar observations of several planets.

This Technical Memorandum is one of a series that describes the facilities and functions of the various major elements of the Deep Space Network.

W. H. Pickering

W. H. PICKERING
Director, Jet Propulsion Laboratory

DSIF stations encircle the globe at intervals of 120 degrees in longitude to maintain continuous coverage of the spacecraft.



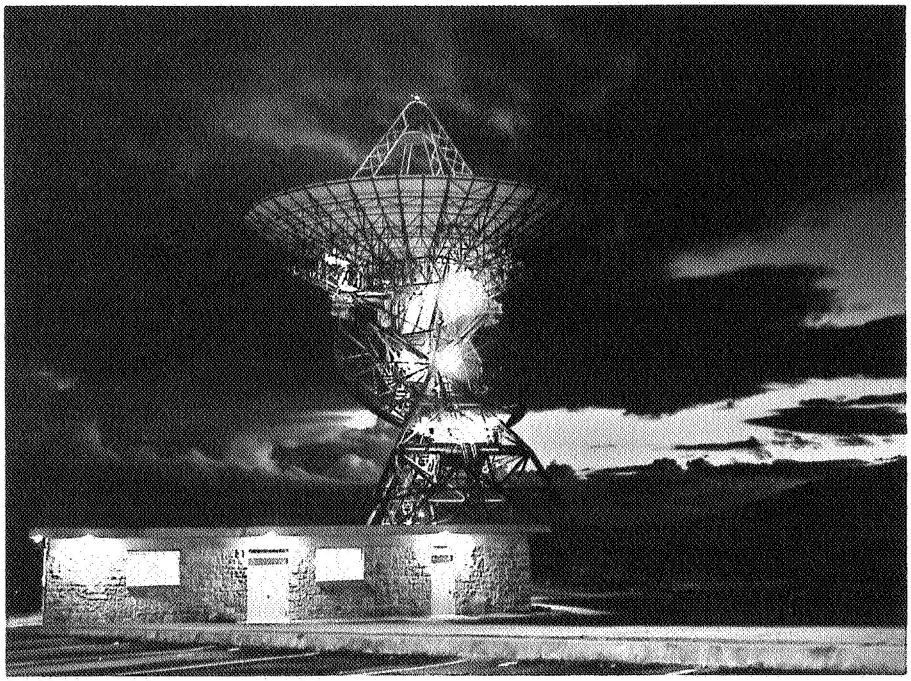
The Deep Space Network

The Deep Space Network (DSN), one of several tracking facilities of the NASA Office of Tracking and Data Acquisition, is operated for NASA under the system management and technical direction of the Jet Propulsion Laboratory (JPL). The DSN is composed of three main elements: the Deep Space Instrumentation Facility (DSIF), which is a network of space communications and tracking stations in the United States and other countries around the world; the Space Flight Operations Facility (SFOF), the JPL command and control center; and the DSN Ground Communication System that connects all parts of the DSN by telephone, radio-teletype, and high-speed data lines.

Stations of the DSIF are situated approximately 120 degrees apart in longitude so that the spacecraft is always within the field of view of at least one of the ground stations. This has been made possible through international cooperation in the network. The DSIF locations are at Goldstone, California; Robledo and Cebreros, near Madrid, Spain; Woomera and Tidbinbilla, Australia; Johannesburg, Republic of South Africa; and Ascension Island, South Atlantic Ocean. Support facilities include a spacecraft monitoring station at Cape Kennedy, Florida. JPL operates the U.S. stations and the Ascension Island Station. The overseas stations are staffed and operated by government agencies of the countries in which they are located, with the technical assistance of JPL/DSN resident engineers.

In addition to the Deep Space Network, NASA operates other spacecraft tracking facilities. These include the Scientific Satellite Network, which tracks Earth-orbiting scientific and communication satellites, and the Manned Space Flight Network, which tracks the manned spacecraft of the *Gemini* and *Apollo* programs. The DSN is the NASA facility for two-way communications with unmanned space vehicles with destinations more than 10,000 miles from Earth.

Most recent in the long list of DSN credits for mission support was the spectacular soft-landing on the Moon of *Surveyor I*, which sent back more than 10,000 TV pictures from the lunar Ocean of Storms. The DSN also supported the highly successful *Ranger* series of TV-picture-taking missions to the Moon, and the *Mariner IV* flyby mission to Mars, which sent back the first close-up TV pictures of that planet and in which the DSN set new telecommunications records in long-distance, long-term control of a spacecraft. Other space flight projects in which the DSN will supply the communications and control link are the follow-on series of *Surveyor* spacecraft soft-landings in other areas of the Moon; a new series of *Mariner* planetary missions that will launch one spacecraft to Venus in 1967 and two spacecraft to Mars in 1969 to make further scientific investigations; NASA's *Lunar Orbiter*, designed to obtain additional pictures of the Moon's surface; and *Pioneer*, a series of solar-orbit probes. In coming years the DSN will take part in the *Voyager* program to explore the near planets, and will lend backup support to the *Apollo* program, the manned spacecraft mission that will put men on the Moon and return them safely to Earth.



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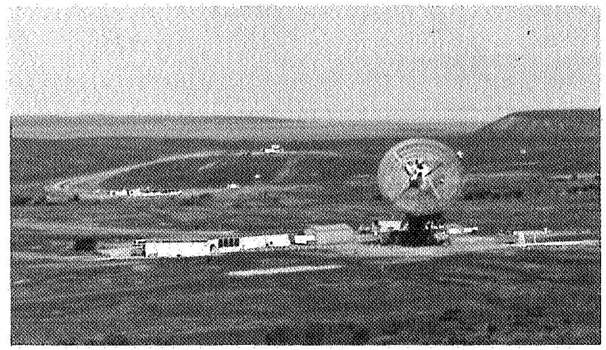

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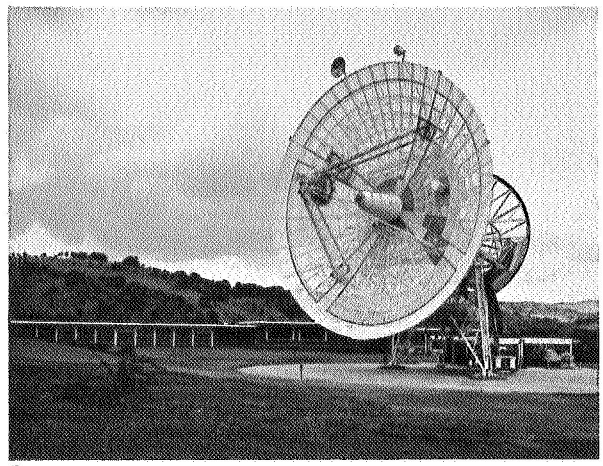

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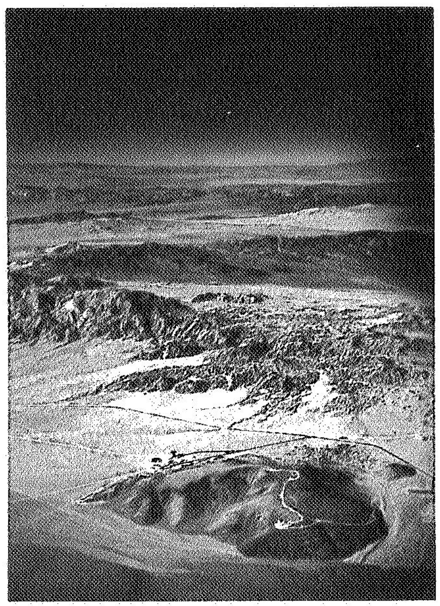

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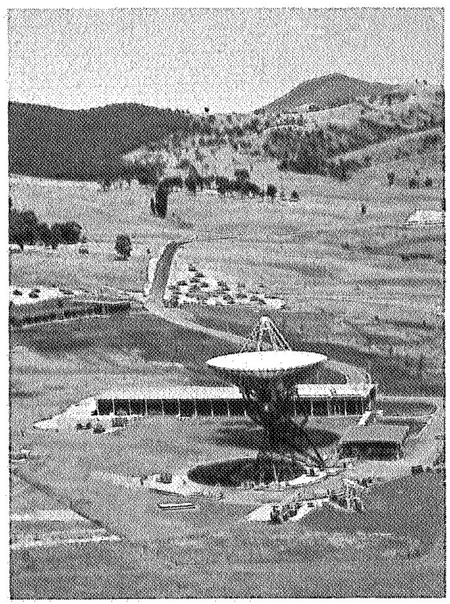

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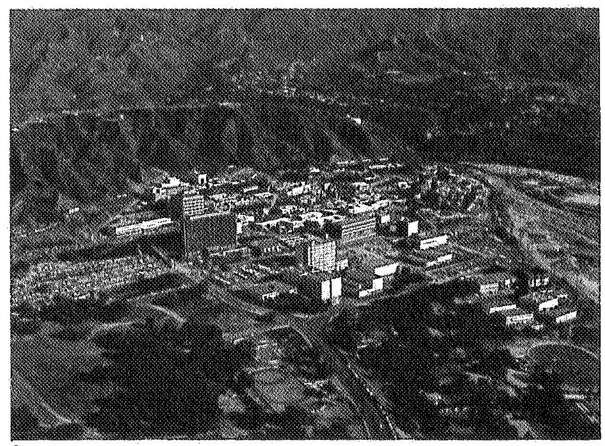

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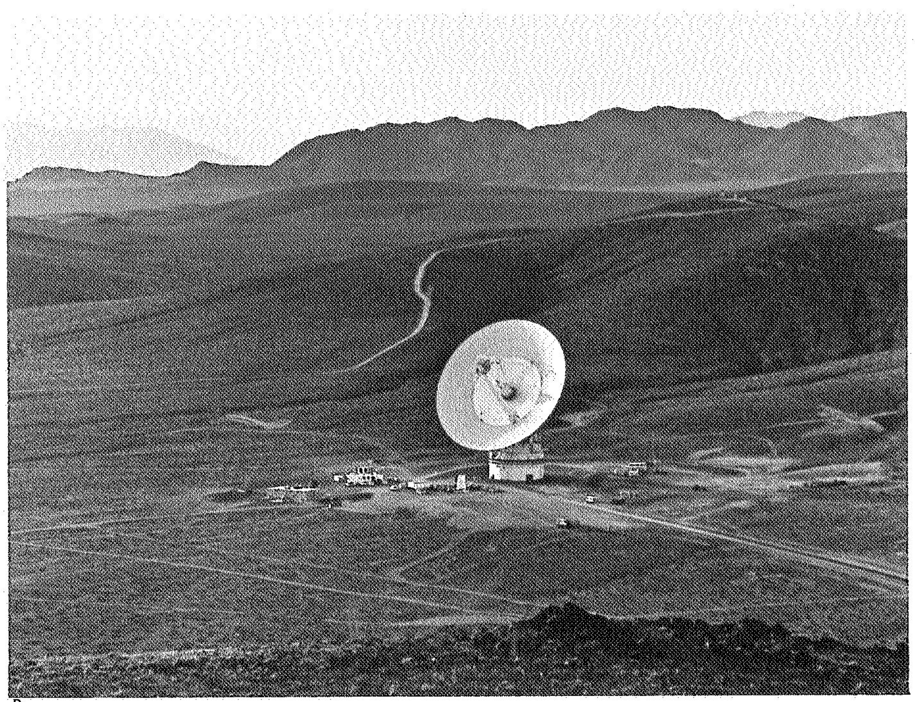


D.

A. *Robledo Station, one of two Spanish DSIF facilities, is situated in a valley near the village of Robledo de Chavela, about 40 miles west of Madrid.*

B. *Echo Station serves as the administration center and operations headquarters for the four-station complex at Goldstone, California.*

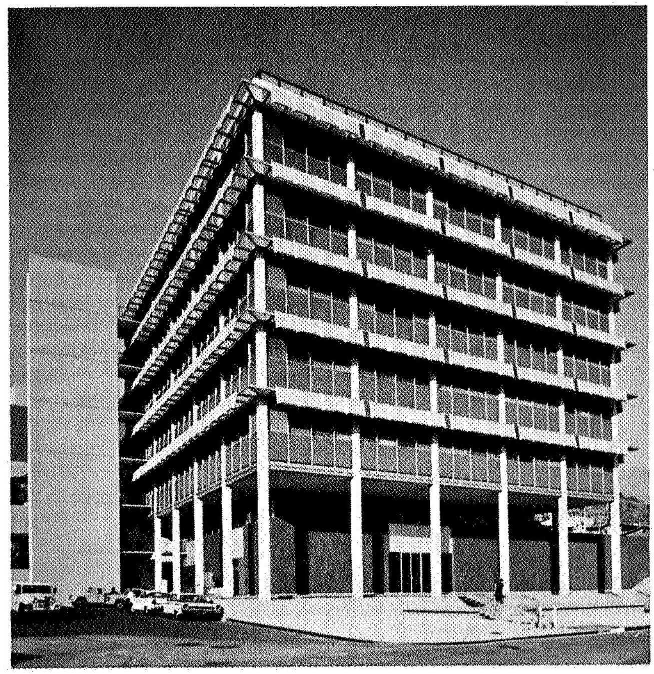
C. *One of two Australian DSIF stations, Tidbinbilla is named for the valley in which it is located, about 25 miles from Canberra, the capital city.*

D. *The 210-foot-diameter antenna at the Goldstone Mars Station – the first to become operational in the Deep Space Network – extends U.S. tracking capabilities to the limits of our solar system. It stands 240 feet tall and weighs about 16 million pounds.*

E. *Woomera Station in Australia was built near the shores of Island Lagoon dry lake close to the village of Woomera.*

F. *The Johannesburg Station, one of the original links in the DSIF, is about 40 miles north of Johannesburg, the largest city in South Africa.*

G. *Jet Propulsion Laboratory, Pasadena, California.*



Telecommunications Laboratory at the Jet Propulsion Laboratory.

The Deep Space Instrumentation Facility

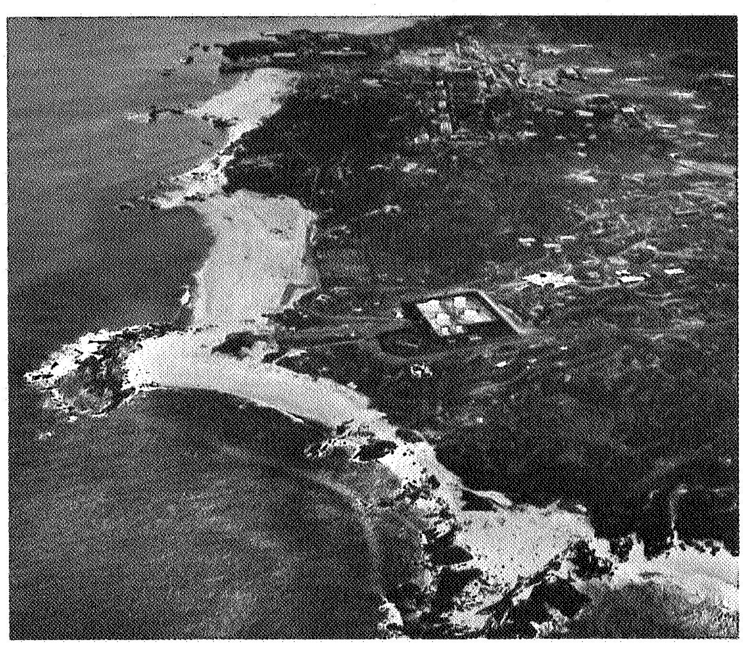
The Deep Space Instrumentation Facility provides the radio-frequency links that tie the spacecraft to the Earth. Radio contact begins when the spacecraft is poised on the launch pad and continues essentially without interruption throughout the mission as the spacecraft passes over one station to another. The Spacecraft Monitoring Station at Cape Kennedy monitors the spacecraft during and immediately after launch. The Ascension Island Station then picks up the signal during the launch trajectory while the spacecraft is relatively low in altitude. Once the spacecraft is in orbit, the deep space stations spotted around the world take over radio communications and follow the spacecraft to its destination.

Mission functions of the DSIF are tracking the spacecraft to determine its position and velocity; sending commands to the in-flight spacecraft; receiving scientific and engineering data transmitted from the spacecraft; and recording and relaying these data to the Space Flight Operations Facility in Pasadena, where it is processed by computers for analysis and interpretation by scientists and engineers.

The DSIF stations are located in regions where man-made electrical and commercial radio and television interference is at a minimum, and where bowl-shaped terrain offers natural shielding. Station facilities are standardized as much as possible, yet must be adaptable for use in a variety of missions.

One of the chief problems in deep space radio communications is the loss of signal strength over the great distances of transmission. To overcome this loss, huge antennas are used to pick up the weak signal from the spacecraft and separate it from competing noises in and outside of the Earth's atmosphere. The standard antenna in use at the deep space stations has a perforated metal paraboloidal (dish-shaped) reflector, 85 feet in diameter, which is polar-mounted on two axes so that the antenna can be pointed in any direction to follow the spacecraft. With the aid of highly sensitive receivers, ultra-low-noise amplifiers, and powerful transmitters, the DSIF is capable of two-way communications with spacecraft traveling hundreds of millions of miles from Earth.

In anticipation of tomorrow's more complex deep space missions, the telecommunications systems of the DSIF are constantly being improved. Among the newest advances introduced in the DSIF is the 210-foot-diameter antenna at the Goldstone Mars Station, which has more than six and one-half times the transmitting and receiving capacity of the 85-foot antennas. This advanced antenna extends America's deep space communications and tracking capabilities to the limits of our solar system.



FACING, TOP: *Facilities at the Ascension Island Station are shared by the Deep Space Network and the Manned Space Flight Network.*

FACING, BOTTOM LEFT: *Wideawake Airfield at AFETR main base.*

FACING, BOTTOM RIGHT: *British settlement at Georgetown.*

Ascension Island Deep Space Station

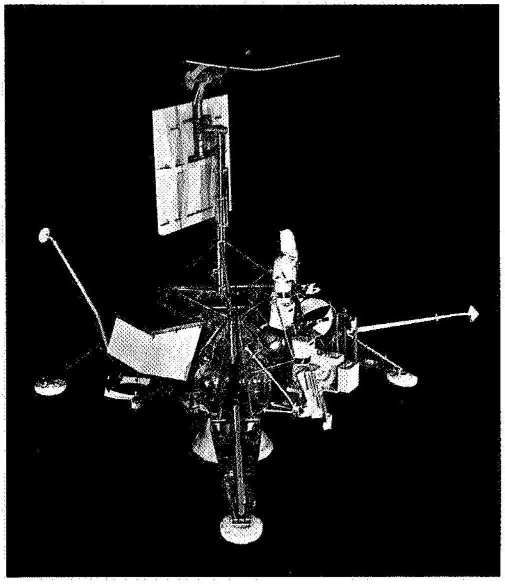
The Governments of the United Kingdom and the United States have entered into a cooperative agreement permitting the National Aeronautics and Space Administration to establish and operate an Integrated Apollo and Deep Space Station on Ascension Island. The station will form a common link in two NASA world-wide data acquisition and tracking networks: the Apollo Unified S-Band Network and the Deep Space Network. This site was chosen because of its geographical location, which is approximately 5,000 statute miles down the Air Force Eastern Test Range (AFETR) and roughly centered in the normal launch corridor from Cape Kennedy. It is in this corridor that many of the critical functions and operations of the spacecraft are performed during its launch and injection phases.

Ascension Island, a mere dot in the middle of the South Atlantic Ocean, was discovered on Ascension Day in 1501 by the Portuguese navigator Juan de Nova Castella. Ascension Island is now a dependency of the British Crown Colony of St. Helena, which has been under direct government of the Crown since 1834. Both islands are volcanic peaks of an immense submarine mountain range known as the Mid-Atlantic Rise.

Ascension Island lies about half-way between South America and Africa, and about 700 miles northwest of St. Helena. It is approximately 5 miles wide and 7 miles long, with an area of 34 square miles. The terrain is basically lava flows and pumice cinder and is sprinkled with conical mounds of extinct volcanoes. The peaks of several of these cones have been graded off to provide areas for instrumentation sites.

The major population areas are on the western end of the island. Approximately 400 men are stationed at AFETR Station 12, which is based near Wideawake Airfield in the southwest section and is operated for the Air Force by Pan American Airways. The base provides housing quarters, messing facilities, a base exchange, theater, dispensary, recreational activities, and other services such as transportation for personnel engaged in operations and management of the various tracking sites on the island. Georgetown, in the northwest corner, is the major British settlement, with a population of approximately 300 British and St. Helenians.

Because the local economy is not sufficient to support U.S. activities on the island, all logistics support is provided by the AFETR. Transportation to the island for personnel, supplies, and most of the equipment is provided by the Military Airlift Command operating out of Patrick Air Force Base, Florida. The flight to the island takes two days, with an overnight stop at Recife, Brazil. The 13,000-foot runway at Wideawake Airfield is capable of handling all types of conventional and jet aircraft. Heavy equipment is shipped to the island, where it is off-loaded from ships that anchor approximately a mile off shore. Sea conditions and the lack of any natural harbor prevent large ships from docking close-in.



LEFT: *Surveyor spacecraft: The Ascension Island DSIF station tracked Surveyor I during the critical transfer trajectory/injection phase of its journey to the Moon.*

FACING, TOP: *Map of major U.S. and British facilities on Ascension Island.*

FACING, BOTTOM: *Site plan of Integrated Apollo and Deep Space Station.*

Ascension DSIF Station

The station site near Devil's Ashpit in the southeast section of the island was selected for its horizon mask, which allows visibility almost to the horizon in the direction of normal spacecraft approach from Cape Kennedy, and also because Green Mountain, with a peak elevation of 2817 feet, and other relatively high surrounding volcanic peaks offer natural shielding against radar and other types of radio-frequency interference from the AFETR main base to the west and the British Broadcasting Company facilities in the northwest. The station is connected to the AFETR main base, where the personnel live, by a paved road approximately eight and one-half miles long.

The DSN installation at Ascension is an integral part of the DSIF, the world-wide chain of stations that operates in the Deep Space Network. The station was designed to fill the gap in coverage that existed in the line of launch between the Cape Kennedy spacecraft monitoring station and first acquisition by the Johannesburg, South Africa, deep space station. This period varies for parking-orbit-type injections, depending upon the launch azimuth. For direct-ascent trajectory injections such as the initial *Surveyor* launchings, in which the spacecraft is injected directly into its lunar trajectory at the first burn of the second-stage *Centaur* instead of coasting for a time in a parking orbit, this period is longer and includes some of the most critical phases of the flight. For this reason, the Ascension DSIF was constructed and completed in time to participate in the early portion of the *Surveyor* program. While *Surveyor* is its primary support mission, the station will support most other deep space programs, and plans have been formulated to supply backup support to the *Apollo* program.

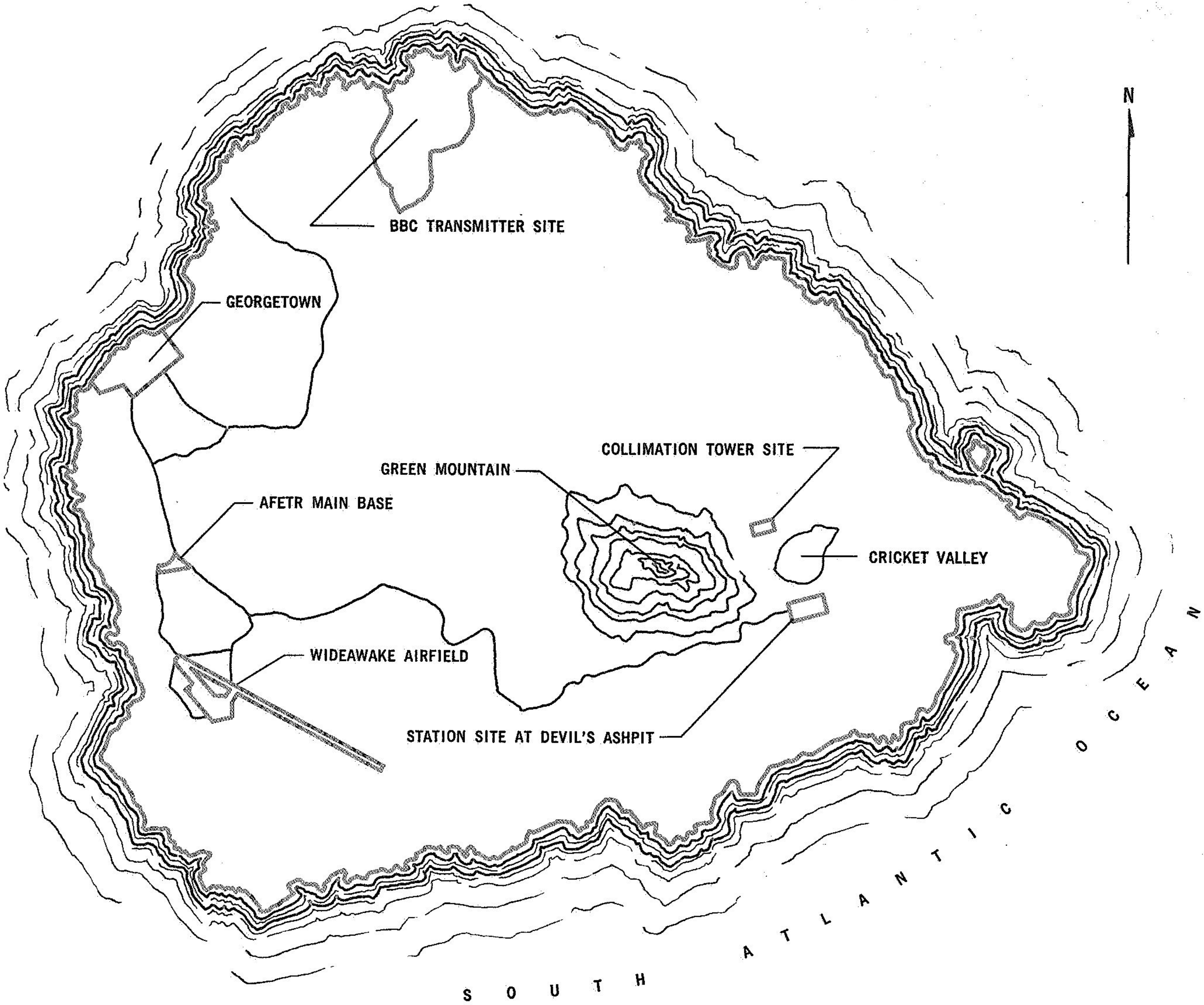
Mission Support Functions

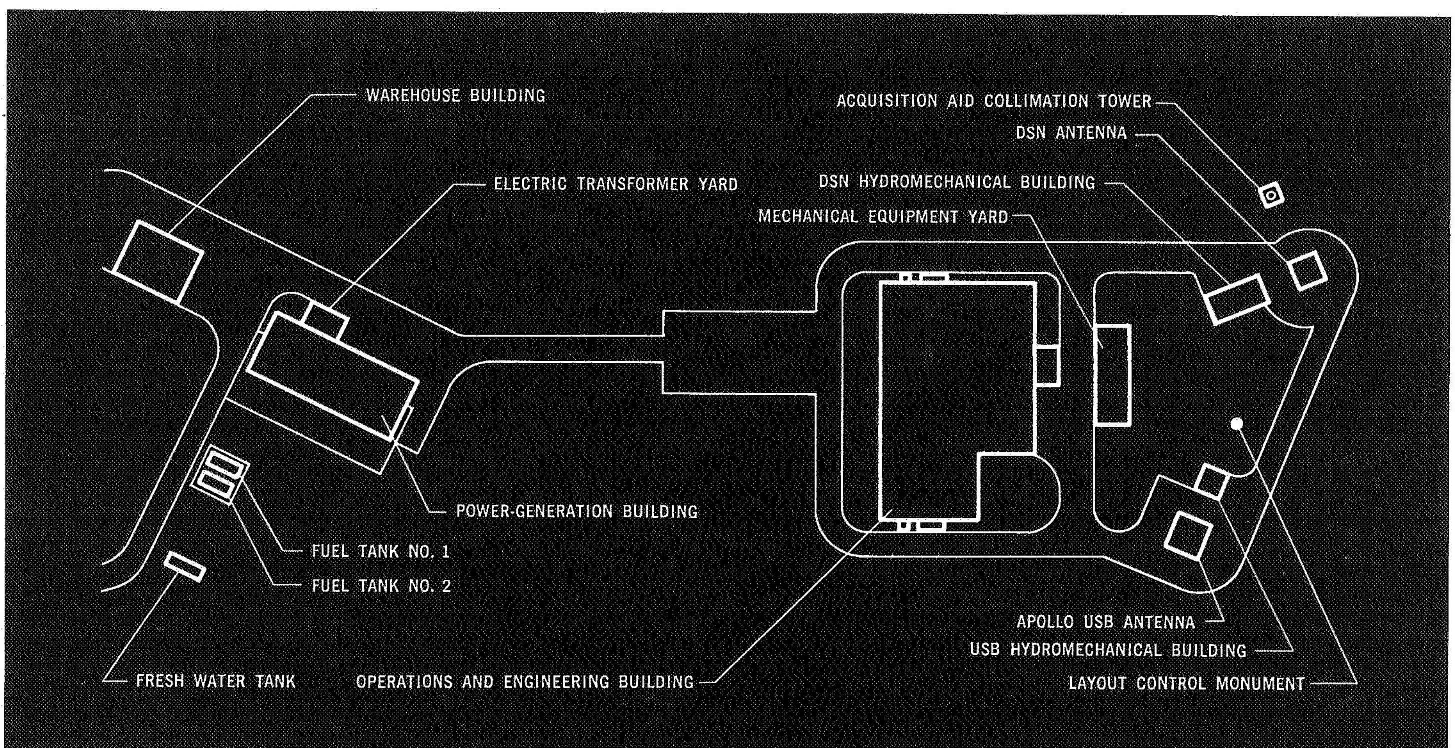
As the first station to view a spacecraft after it has been launched from Cape Kennedy, the Ascension DSIF performs the following spacecraft guidance and command functions:

1. Acquiring and tracking the spacecraft, transmitting the tracking data to the SFOF in Pasadena for computation and generation of trajectory, and predicting information for the other DSIF stations.
2. Receiving spacecraft telemetry data to monitor the performance of the spacecraft.
3. Transmitting commands to the spacecraft to provide primary and backup control of the spacecraft during the critical transfer trajectory/injection phase of the mission.

In normal mission operations, the station maintains communications with the spacecraft during the initial portion of flight, ranging in time from a few minutes up to several hours, until the spacecraft reaches the maximum range capability of the station. Because of the high angular-tracking rates of a "close in" spacecraft, the Ascension DSIF uses a 30-foot-diameter antenna with an azimuth-elevation mount. This antenna is capable of much higher angular velocities and accelerations than the 85-foot-diameter antenna used at the standard DSIF stations. The nominal communication range of the 30-foot-diameter antenna with a spacecraft in the typical launch/injection conditions is approximately 37,500 miles. With the exception of the antenna and its associated microwave components, the station uses standard DSIF S-band equipment and facilities.

When required, the station can be operated 24 hours a day, seven days a week. In non-tracking periods, a minimum crew of five men is retained to maintain the station. Approximately two weeks prior to a scheduled launching,


N
BBC TRANSMITTER SITE
GEORGETOWN
COLLIMATION TOWER SITE
GREEN MOUNTAIN
AFETR MAIN BASE
CRICKET VALLEY
WIDEAWAKE AIRFIELD
STATION SITE AT DEVIL'S ASHPIT
SOUTH ATLANTIC OCEAN


WAREHOUSE BUILDING
ACQUISITION AID COLLIMATION TOWER
DSN ANTENNA
ELECTRIC TRANSFORMER YARD
DSN HYDROMECHANICAL BUILDING
MECHANICAL EQUIPMENT YARD
POWER-GENERATION BUILDING
FUEL TANK NO. 1
FUEL TANK NO. 2
APOLLO USB ANTENNA
USB HYDROMECHANICAL BUILDING
FRESH WATER TANK
OPERATIONS AND ENGINEERING BUILDING
LAYOUT CONTROL MONUMENT

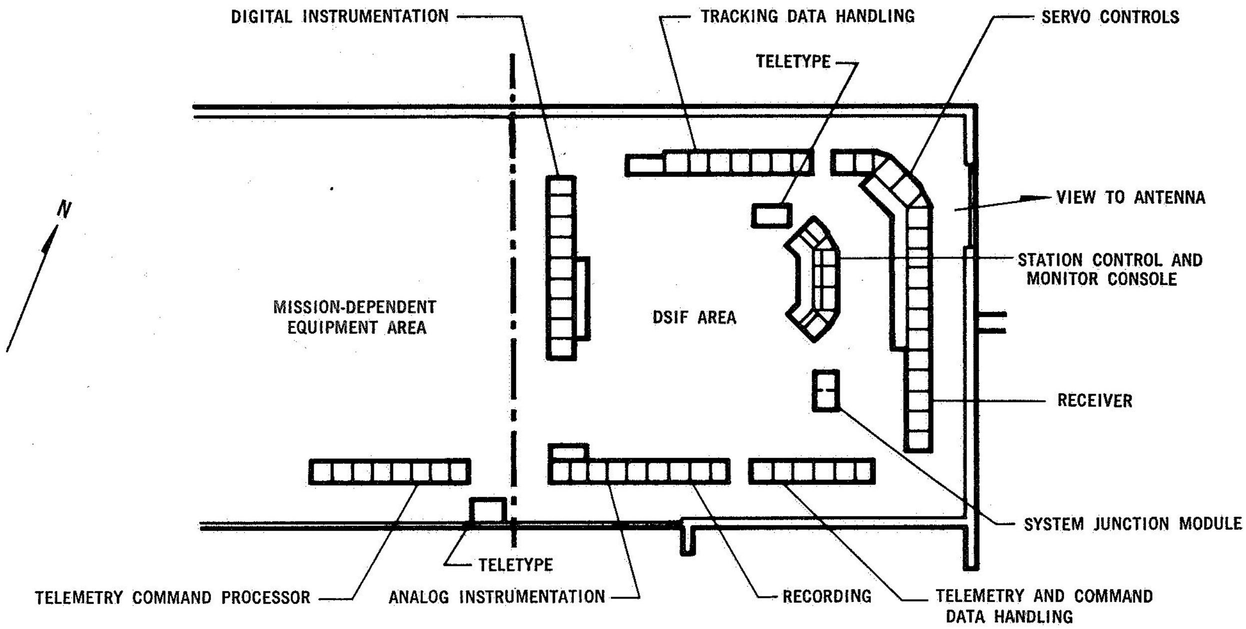


DIAGRAM OF TYPICAL ARRANGEMENT OF STANDARD S-BAND SUBSYSTEM EQUIPMENT IN THE DSN CONTROL ROOM, WITH MISSION-DEPENDENT AREA DESIGNATED FOR FLIGHT PROJECT SPECIAL REQUIREMENTS.

two to twelve additional men travel to the station to test and calibrate station equipment and to man the station during mission operations. The number of additional men needed depends upon the complexity of the station's role in supporting the mission.

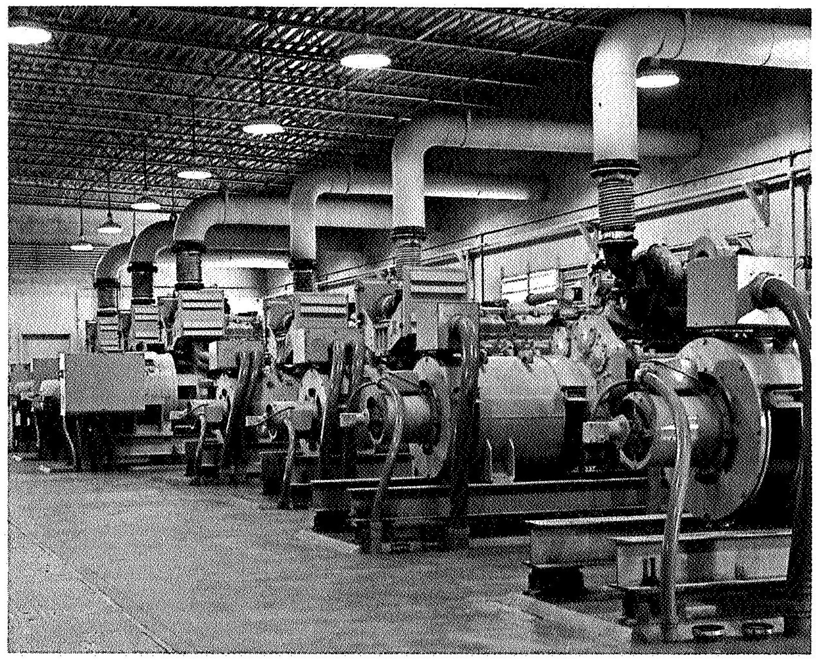
The station operates in the normal radio-frequency channels allocated to the DSIF. These frequencies are in the S-band region, ranging from 2110 to 2120 Mc (million cycles per second) for transmission of commands from Earth to the spacecraft, and from 2290 to 2300 Mc for receiving signals from the spacecraft. One-way or two-way communications can be maintained with any spacecraft having a normal S-band transponder on board, and data acquisition can be performed to the extent of recording video data received from the spacecraft.

Facilities

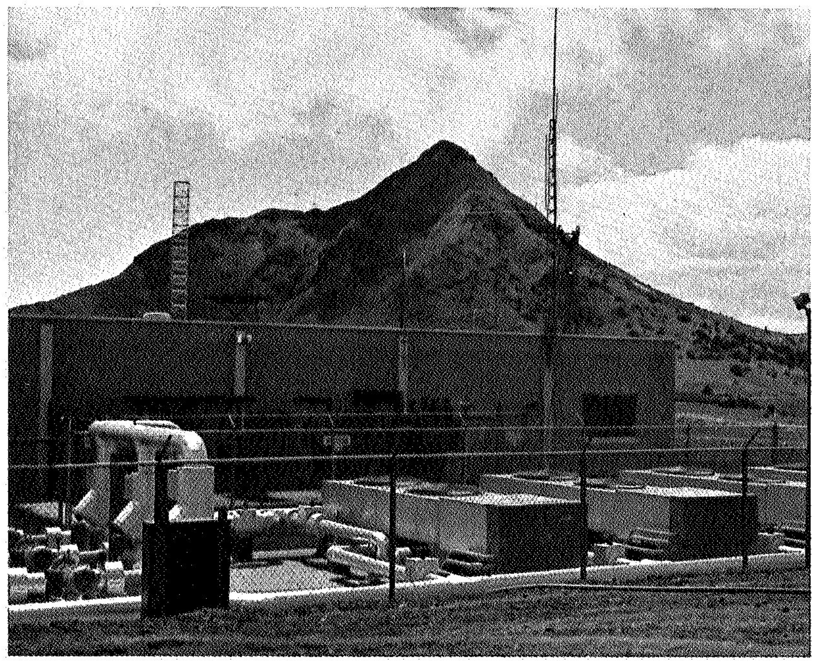
The major station facilities, which are shared by the DSIF and the Apollo Unified S-Band systems, are:

1. An operations and engineering building that houses the majority of the tracking, telemetry, and communications equipment, as well as laboratories and offices.
2. A power-generation and support building that houses the seven diesel generators and switching equipment to supply electric power to the entire site, and some workshop facilities.
3. A metal-construction storage building.
4. A 100-foot-high, far-field collimation tower, located about 4,000 feet northwest of the site on the slopes of Green Mountain. A source of radio energy mounted in the tower simulates spacecraft signals. A small building located at the base of the tower houses the electronics equipment. The collimation equipment is used to check the performance of the antenna and associated electronic systems, and to calibrate and adjust the boresight of the antenna.

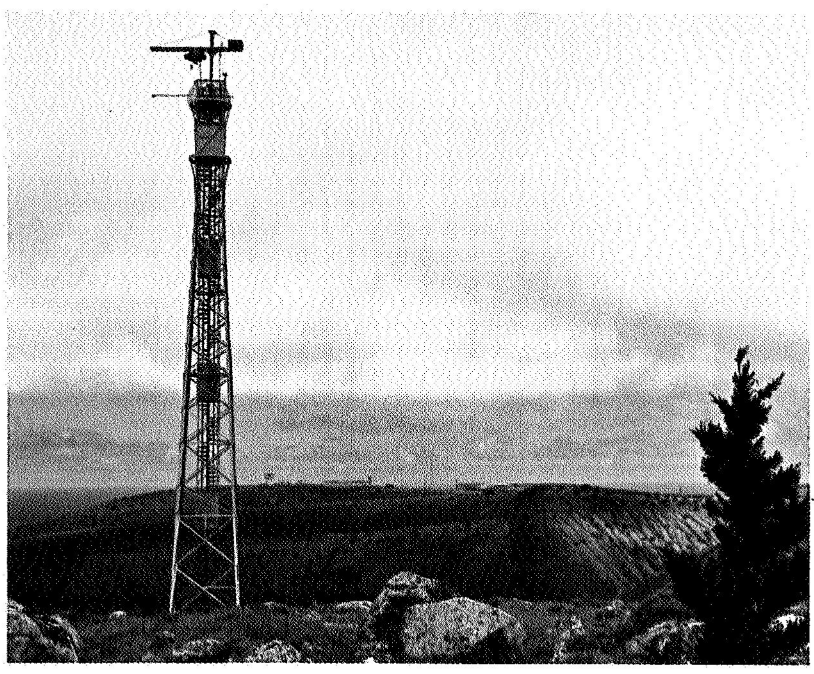
The DSIF and the Apollo Unified S-Band systems have separate antennas, each with its own hydromechanical support building. The DSIF hydromechanical building houses the servo hydraulic pumps that drive the antenna, and the power supply for the power amplifier of the radio transmitter. The far-field collimation tower serves both antennas. The DSIF antenna site has, in addition, a collapsible, 30-foot-high collimation tower that is used for calibrating the acquisition-aid antenna system.



Interior of power-generation building, with seven diesel generators that supply electric power to the entire site.

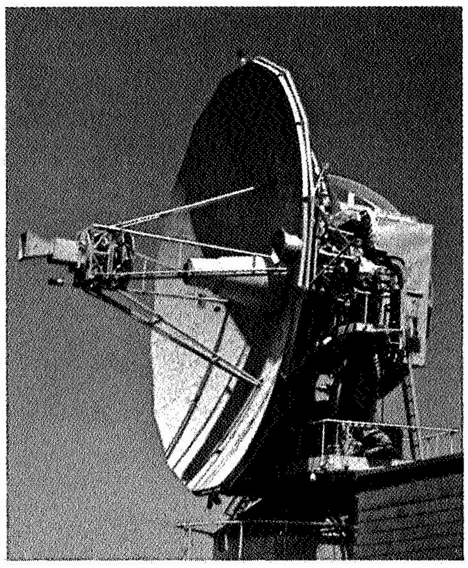
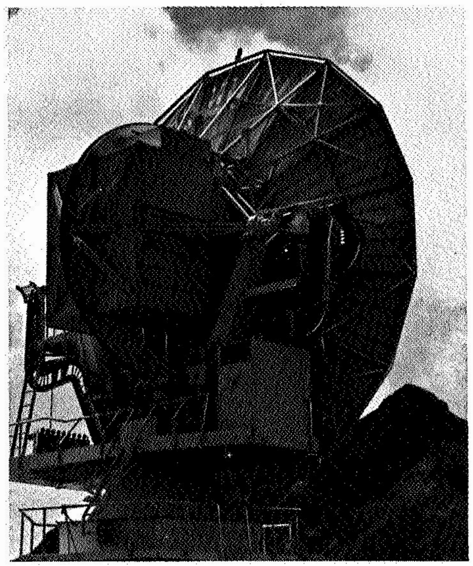
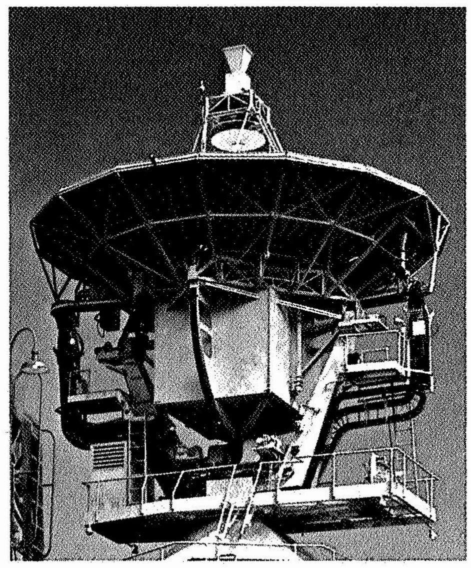


Airconditioning equipment in rear of operations and engineering building.



Far-field collimation tower, located on the slopes of Green Mountain.

The DSIF antenna at Ascension Island, which has a 30-foot-diameter paraboloidal reflector mounted on an azimuth-elevation axis system, is capable of high angular velocities and accelerations to track a "close in" spacecraft.

The two antennas are placed 200 feet apart to provide the required sky coverage for each and to minimize the possibility of mutual interference, and as close as possible to the operations building to minimize signal cable losses.

The operations building has movable interior partitions so that interior floor space can be adapted to future needs. In the DSIF operations and control room, four mission-dependent equipment areas of about 500 square feet each are provided for flight-project special requirements. Facilities are provided to interconnect such mission-dependent equipment with the DSIF standard equipment.

The DSIF Antenna

The antenna used in the Ascension Island DSIF operations has a 30-foot-diameter paraboloidal reflector, with an azimuth-elevation mount axis system. The reflector is a solid-surfaced metal mirror that looks like an inverted umbrella and is often called the "dish." The antenna and its supporting structure, which together with electronic and operating equipment weigh around 75,000 pounds, are mounted on a reinforced concrete foundation. The antenna is steerable; that is, its "beam" or major radiation pattern can be readily shifted in any direction to follow the spacecraft. It can be moved up and down 90 degrees in elevation between the horizon and zenith, and it also pivots 360 degrees around the vertical axis. The position angles of the spacecraft location relative to the antenna are measured in local azimuth and elevation coordinates.

The movement of the antenna is controlled by a servo system. Electric-motor-driven pumps in the hydromechanical building send high-pressure hydraulic fluid through stainless-steel tubing up to the driving motors (mounted on the antenna) that actuate the drive gears. The electronic control and readout equipment for the servo system is in the operations and control room. All parts of the antenna structure are so precisely balanced and aligned that, heavy as it is, the antenna can be rotated at rates up to 6 degrees per second in azimuth and 3 degrees per second in elevation.

The antenna is fitted with two separate feed systems: 1) a wide-beamwidth, moderate-gain acquisition aid system that is used to acquire the spacecraft when exact pointing angles are not known, and 2) a narrow-beamwidth, high-gain feed that utilizes Cassegrain optics. Both feed systems are capable of automatically providing steering signals to the servo antenna-pointing equipment through the receivers, and both feed systems are capable of transmitting to the spacecraft.

FACING, TOP: *Station control and monitor console, from which the JPL station manager directs and coordinates the station's activities during a mission.*

FACING, BOTTOM LEFT: *Receiver console in the control room.*

FACING, BOTTOM RIGHT: *Control room instrumentation and recording system.*

Receiver System

The Ascension DSIF is equipped with a standard dual-conversion superheterodyne phase-locked-loop receiver designed for reception of a continuous-wave signal in a narrow-frequency band. The receiver has two reference (or sum) channels, each of which provides reference signals for two orthogonal angle-error channels, an automatic gain-control channel, and a telemetry extraction channel. In addition, there is a ranging extractor and a doppler extractor. Distribution amplifiers in the receiver system disperse the information to proper destinations in the operations and control room.

Transmitter

The transmitter consists of a standard DSIF synthesizer-exciter and 10-kilowatt final amplifier. The exciter and controls of the transmitter are in the operations and control room; the high-voltage power supply is in the hydromechanical building, with the amplifier itself mounted up on the antenna. Provisions are made in the antenna microwave equipment to permit simultaneous transmission and reception in either the wide-beam acquisition mode or the narrow-beam Cassegrain mode. This permits the station to make two-way velocity and range measurements to very accurate tolerances, while concurrently receiving telemetry and transmitting commands.

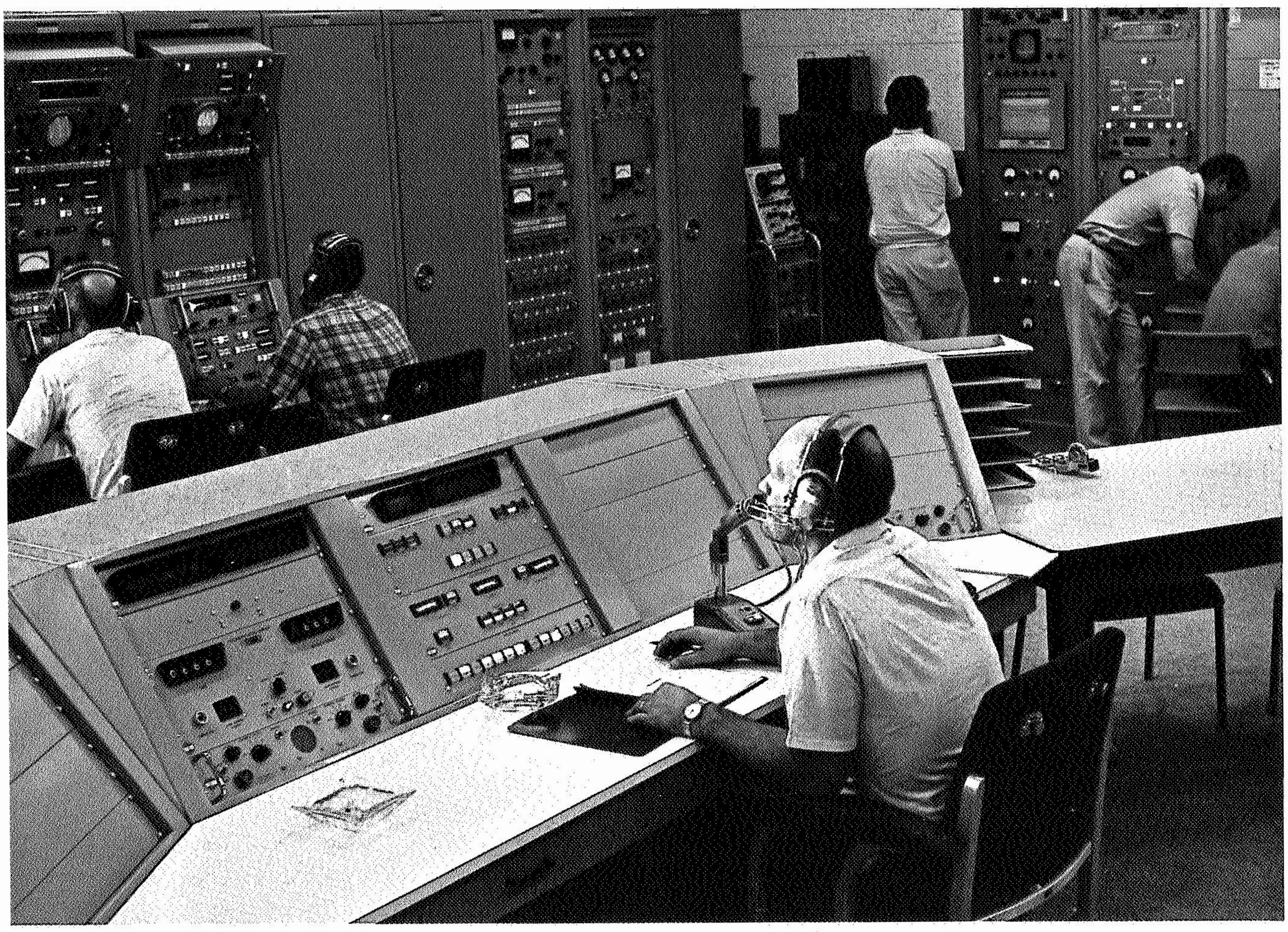
Instrumentation and Data Handling

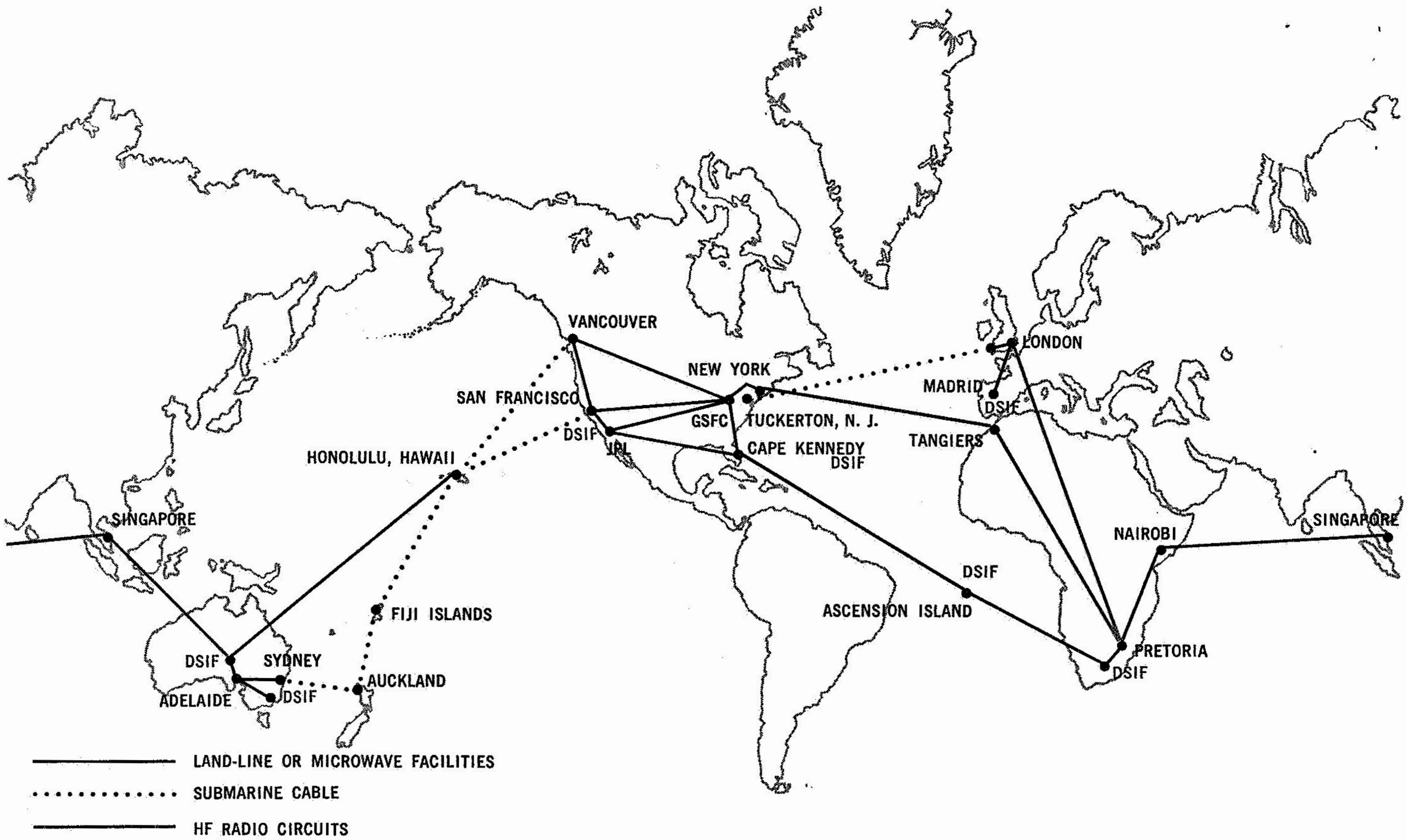
The signals from the receiver channels are processed and recorded by ground instrumentation and data-handling equipment in the operations and control room. The instrumentation system consists of standard DSIF analog and digital instrumentation and tracking-data-handling equipment. The recording equipment consists of two seven-track magnetic-tape recorders, paper-tape recorders, an ultraviolet oscillograph, and a hot-stylus recorder.

Tracking-data-handling equipment records angle measurements of antenna position, doppler frequency measurements, range measurements, and time. These data are recorded on paper tape for immediate teletype transmission to the SFOF in Pasadena, California, for use in spacecraft orbit determination, calculation of maneuver parameters, and command decisions.

Telemetry signals from the spacecraft that come in on the receiver sum channels are either time- or frequency-multiplexed; that is, the signals from the various measuring instruments on the spacecraft are carried on one composite radio-frequency signal, either sequentially (time-multiplexed) or simultaneously on several subcarrier frequencies (frequency-multiplexed). This composite signal is "unscrambled" by decommutators in the telemetry and command processor subsystem. Analog or digital (or both) methods of signal modulation are used for transmission of data from the spacecraft to Earth.

The detected, unscrambled signals are recorded on magnetic tape so that complete recordings of all telemetry data from the spacecraft will be available for later data processing either by the SFOF at JPL or by the NASA Center responsible for the project. Certain selected spacecraft telemetry signals are displayed at the station as they are received for the use of operating personnel in maintaining contact with the spacecraft. The station is also equipped with an on-site data processing system, which provides real-time spacecraft telemetry for supplementary evaluation of communication system status.





GEOGRAPHIC ROUTINGS OF LAND LINES, SUBMARINE CABLES, MICROWAVE AND HIGH-FREQUENCY RADIO CIRCUITS IN A TYPICAL NETWORK OF THE DSN GROUND COMMUNICATION SYSTEM.

In addition to processing and recording spacecraft telemetered data, the station also processes and records data generated by the ground equipment, such as received signal strength, transmitted power, and condition of all station equipment. This information is processed by the digital instrumentation subsystem, which uses general-purpose digital computers that accept and process both analog and digital signals.

All taped information sent to JPL is labeled and identified by date, time received, station, and spacecraft number.

The control room, which is the center of operations during a mission, also contains the control consoles for the receiver, transmitter exciter, and antenna servo system; the ranging subsystem, which accurately measures range by use of an automatic coded signal in conjunction with doppler information; and the frequency and timing subsystem. Frequency references are accurate to one part in ten billion, and because time reference is a critical factor in tracking determinations and in other DSIF functions that depend upon timing of electronic phenomena, time reference is accurate to one hundredth of a second.

The telemetry and command data handling subsystem includes a special receiver for verifying commands before and after they are transmitted to the spacecraft, plus an interface panel for connection of mission-oriented telemetry and command equipment.

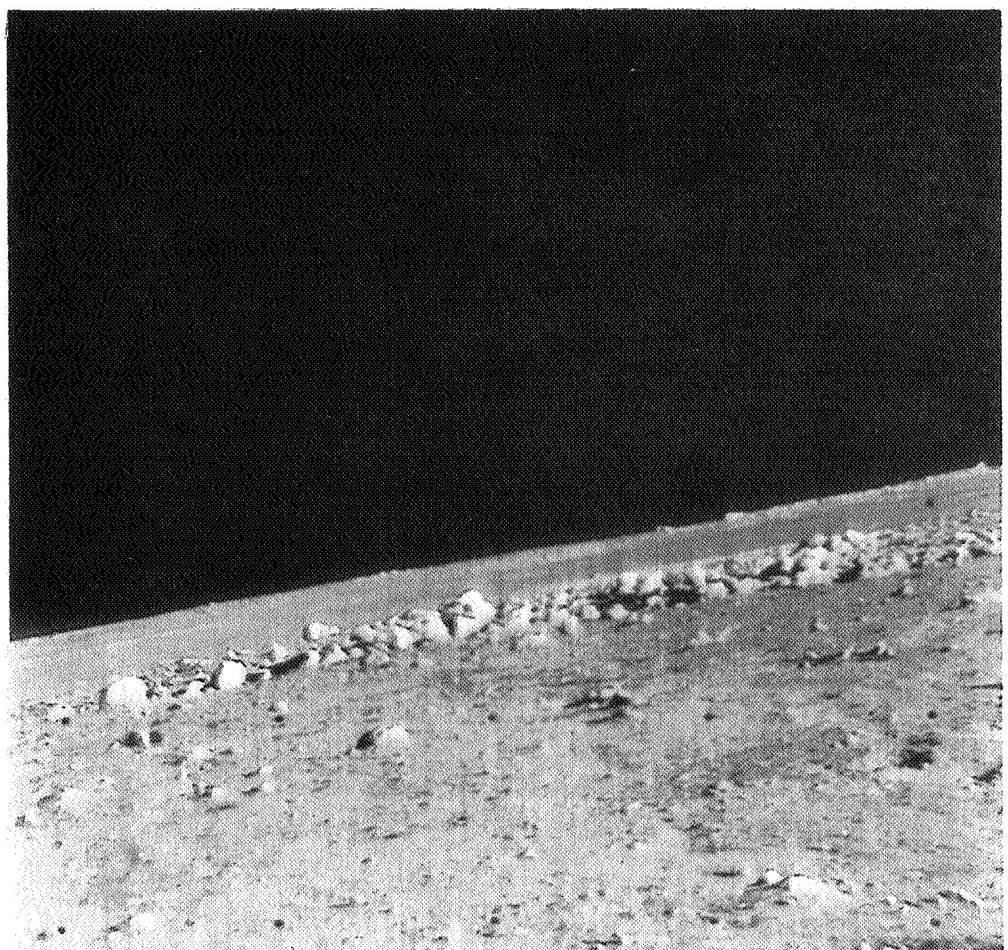
Overall coordination of the station's activities during a mission is directed by the JPL station manager from the station control and monitor console, which has special instruments and displays that keep him informed of the status of all operating systems. DSIF acquisition procedures, which include antenna pointing, receiver tuning, transmitter tuning, ranging lock, and telemetry decommutation, are so precisely timed and coordinated that it is possible to start recording data from 1 to 10 minutes after radio contact with the spacecraft is established, and to start transmitting data to the SFOF in Pasadena within 4 to 16 minutes.

Interstation Communications

The Ascension Island DSIF has communication with other DSIF stations by telephone and teletype through the DSN Ground Communication System (which uses facilities of the world-wide NASA Communication System), and is linked directly to the SFOF at JPL by high-speed teletype for digital data transmission. The station has three full-duplex teletype circuits, one high-speed data circuit, and two voice circuits. Communications to and from Ascension Island are handled by the AFETR through Cape Kennedy.

Teletype is the primary means used for transmitting tracking and telemetry data from the DSIF stations to the SFOF, and for sending predictions and other data to the stations. Analog and TV data channels may be available for some missions. Voice circuits are used for transmission of high-priority communications other than data.

Surveyor I photographs its own shadow on the Moon.



Close-up of rocky lunar landscape was one of the 11,150 TV pictures sent back by Surveyor I from the Ocean of Storms.