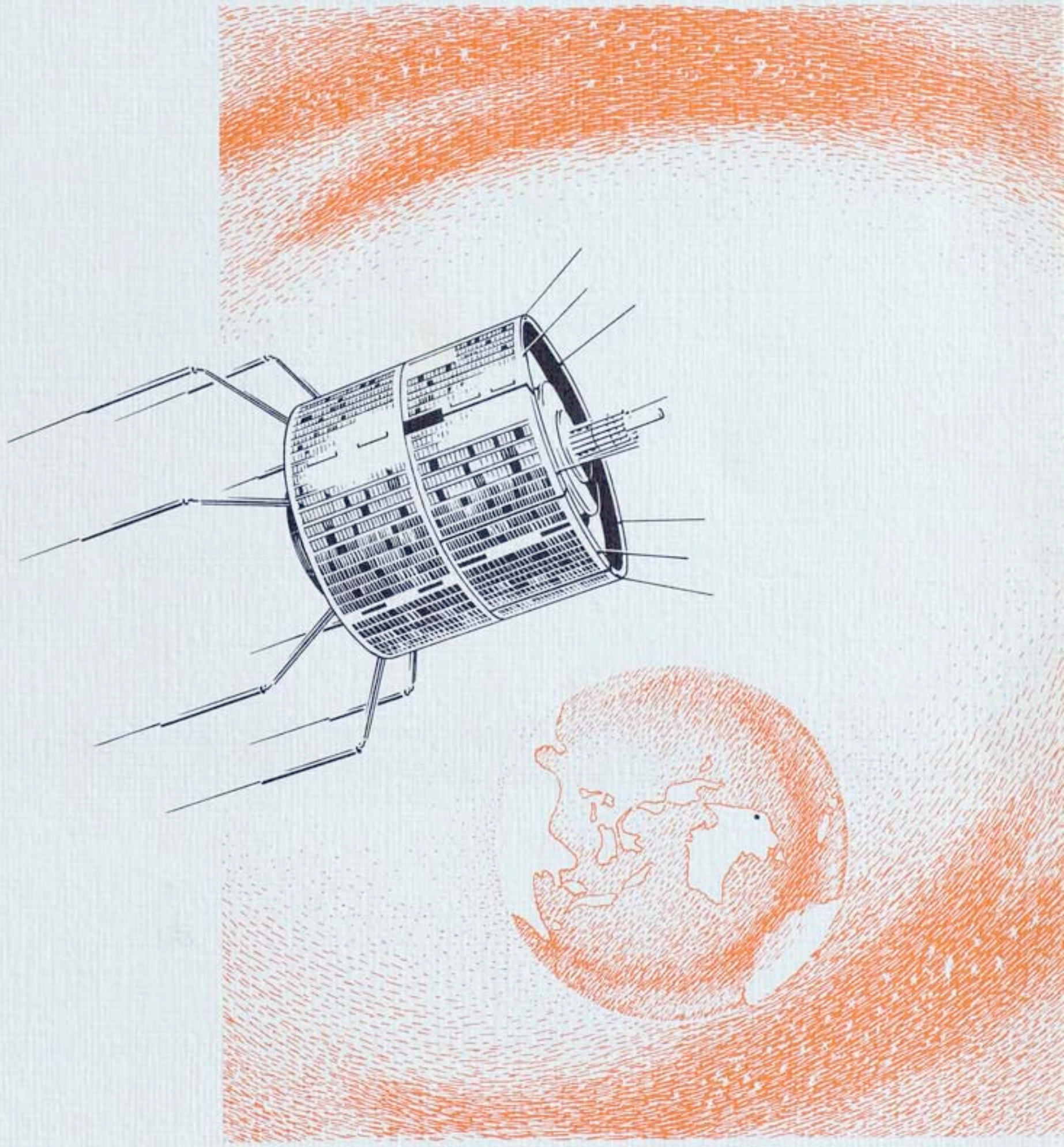
ATS station



COOBY CREEK
QUEENSLAND

COMMONWEALTH OF AUSTRALIA
DEPARTMENT OF SUPPLY

UNITED STATES OF AMERICA
NATIONAL AERONAUTICS
AND SPACE ADMINISTRATION

OPERATIONS AND MAINTENANCE CONTRACTOR
AMALGAMATED WIRELESS (AUSTRALASIA) LTD.

APPLICATIONS TECHNOLOGY SATELLITE (ATS) STATION,

COOBYCREEK, DARLING DOWNS, QUEENSLAND.

INFORMATION BROCHURE

Issued with the compliments
of the Department of Supply

POSTAL ADDRESS: The Secretary, Department of Supply
339 Swanston St., Melbourne, C 1
(or Box No. 2288U, G.P.O. Melbourne C 1, Vic.)

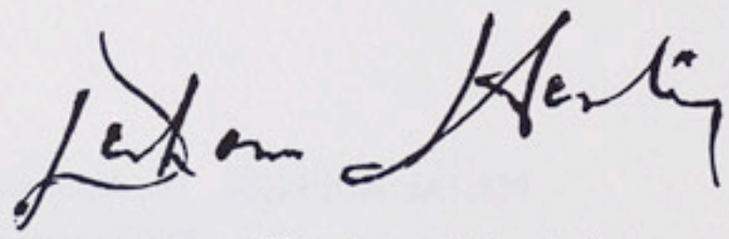
Cooby Creek Tracking Station is the sixth space tracking station to be established in Australia by the National Aeronautics and Space Administration. There are now more NASA space tracking stations in Australia than in any country other than the U. S. A.

Cooperation between Australia and America in space activities has gained strength year by year since the International Geophysical Year in 1957-58 when Australia was first asked to allow satellite-tracking facilities to be installed at Woomera. This continued and increasing cooperation is a measure of the confidence of NASA and the American Government in the technical skills and reliability to be found in Australia.

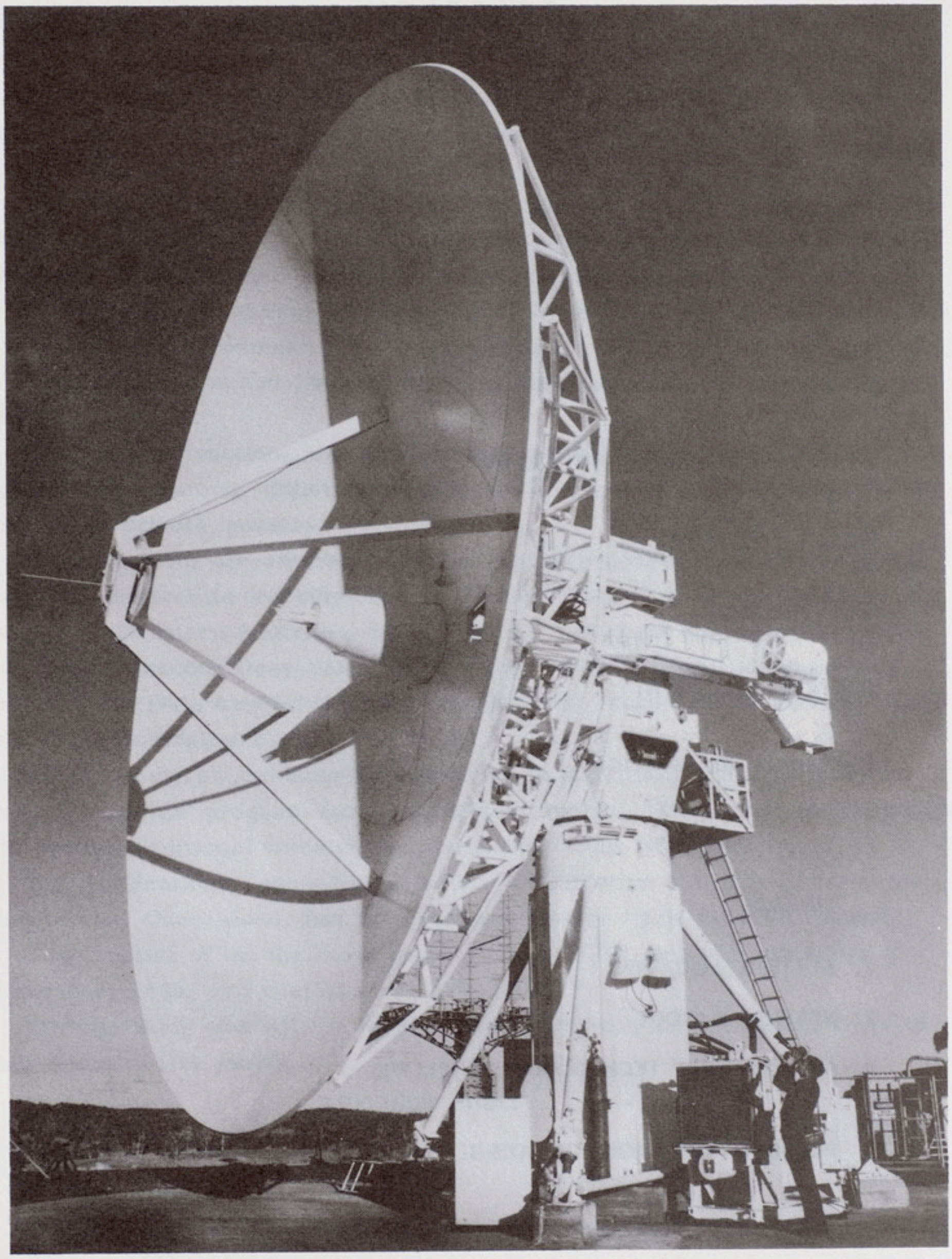
The Department of Supply is the organisation in Australia responsible for the construction, maintenance, operation and administration of the NASA space tracking stations. Only one of the Australian stations is operated entirely by Department of Supply Staff; the remainder are operated and maintained by private enterprise under contract to the Department.

Cooby Creek continued the Government's policy of encouraging private industry to play its part in Australia's space activities and to benefit from the new technologies brought by the space age. The operation of this latest station has been let to Amalgamated Wireless (Australasia) Ltd.

As Minister for Supply I welcome you to the Cooby Creek Tracking Station in Queensland; I commend the continuing cooperation within Australia between Government and private enterprise and internationally between Australia and the U. S. A.



(Denham Henty)
Minister of State for Supply



40FT ANTENNA COOBY CREEK

CONTENTS

AUSTRALIAN–AMERICAN COOPERATION IN SPACE EXPLORATION

In February, 1960, the Governments of Australia and the United States of America formally agreed to cooperate in space flight programs being conducted by the U.S.

Australia undertook to establish and operate a number of tracking stations which would form part of a world-wide network under the control of the U.S. National Aeronautics and Space Administration (NASA).

The Department of Supply is responsible for fulfilling the Australian commitment under this agreement.

The construction and operation of these tracking facilities in Australia is financed by NASA.

Design, construction, management and operations are provided from Australian resources, either directly by the Commonwealth Government or by contract to private industry.

Major stations already established are a Deep-Space Station (DSS 41) and Baker-Nunn satellite tracking camera, both at Woomera, South Australia; the Carnarvon (Western Australia) Station for manned space flights and scientific satellites; a second Deep-Space Station (DSS 42) at Tidbinbilla and a Space Tracking and Data Acquisition Network (STADAN) Station in the Orroral Valley, both in the Australian Capital Territory.

A further station, at Honeysuckle Creek in the A.C.T., will support the lunar space flight program known as Project Apollo. Extensions at Tidbinbilla will provide additional tracking support for the same program.

The Applications Technology Satellite (ATS) Station at Cooby Creek near Toowoomba, Queensland, has been established to support the ATS Project.

Construction of the facilities began in May, 1966, and was completed in September, 1966, at a cost of about $150 000.

The operating cost will be about $1 000 000 a year, for its expected life of about three to five years.

STATION LOCATION AND LAYOUT

The ATS Station overlooks the Cooby Creek Reservoir, about 14 miles (by road) north of Toowoomba, on the Darling Downs (see figure 1).

This site was selected because the high ground to the south and south-west screens the station from man-made radio-frequency interference, which could seriously jeopardise the reception of satellite signals, whereas, the lower

3. An electronically steered antenna to keep the transmission beamed towards the earth, automatically compensating for the spin of the spacecraft and thus increasing the signal at the receiving station.

V.H.F. frequency modulated transponder. This will be used for experimental transmissions between the ground and specially equipped aircraft, to study the possibility of using a satellite for aircraft control and navigation.

Meteorological T.V. camera. Coverage of about one quarter of the earth's surface will be provided, the spin of the satellite providing the scan, to determine the usefulness of meteorological TV from a synchronous satellite.

Ion engine thruster. A small electric jet engine will be tested as a means of keeping a satellite in a precise orbit.

Environment measuring equipment. A number of systems will be used to measure the environment of the spacecraft. These will include magnetometers, spectroscopes and particle detection systems.

STATION EQUIPMENT

Instrumentation

The station is transportable, most of the equipment being either mounted on trailers or easily dismantled so that it can be moved to a new site.

Because the station is designed to operate with only ATS satellites, much of the equipment is peculiar to this project.

The communications antenna is a 40 ft diameter parabolic antenna which can be transported and erected using two trailers.

It is fitted with a novel feed system, which consists of five plastic spikes, four for receiving and one for transmitting.

The weak signals from the satellite are amplified by a maser, a device maintained at extremely low temperatures by means of a closed-cycle helium refrigeration system, before being fed to the main receivers.

The antenna has several modes of operation:-

Search - Scan in a prearranged pattern to acquire the satellite.

Programmed - Controlled by a computer, which calculates the pointing information from the orbital parameters of the satellite.

Manual - Moves under the control of an operator.

Automatic - Tracks the satellite automatically once the signal has been picked up.

Two 10 kW transmitters are mounted on the antenna structure, the power supplies and associated cooling equipment being mounted on a pad near the antenna.

The hydraulic power unit to drive the azimuth and elevation motors is located at the base of the antenna and is remotely controlled from the operations control complex.

This is made up of three 40 ft vans, interconnected to form the main equipment and control centre of the station.

The equipment comprises communications systems, exciters for the antenna transmitters, a range and range rate system (used to determine the satellite orbit), the antenna control and measuring equipment, and a computer to assist in the preparation and evaluation of data, and calculation of the antenna pointing directions from the satellite orbit.

The station transmits, receives and records voice, high-speed data, teletype and colour TV signals, the equipment including colour videotape recorders and monitoring equipment.

Associated with the operations control complex is the telemetry and command van, which contains the equipment used to transmit commands to and receive signals from the satellite via the nine-element hydraulically-controlled antenna.

The commands are used to change circuits or switch experiments in the satellite, and the receivers are used to obtain engineering or scientific data by telemetry from the spacecraft.

These data are recorded on magnetic tape or paper charts. The telemetry and command van also controls the gas jets used to maintain the satellite "on station" by means of a special control panel.

The telemetry data can be fed directly to the computer for processing in real time, thus producing an up-to-the-minute record of the satellite systems' performance.

A collimation tower with a remotely controlled spacecraft simulator is used for checking out and setting up the equipment before operations.

Communications

Permanently rented teletype and voice circuits are provided to connect the station with the ATS Operations Control Centre (ATSOCC) at the Goddard Space

Flight Centre, near Washington.

These circuits are routed through the main Australian NASA switching centre in Canberra.

The teletype system is used to send data to Goddard Space Flight Centre, in addition to being used for administrative and technical traffic.

The voice circuit enables ATSOCC to brief all the ATS ground stations simultaneously; during important phases of the project, stations will be controlled directly from the ATSOCC.

The Australian circuits are provided and maintained by the Postmaster-General's Department; those between Sydney and the U.S. are the responsibility of the Overseas Telecommunications Commission (Australia).

Power supplies

A reliable source of 60 c/s power is essential for station operation, as even a brief interruption could reduce efficiency and cause a loss of data, together with the possibility of damage to equipment.

The station will eventually be equipped with six generators - two 250 kW and two 150 kW gas turbine machines for primary power, and two 250 kW diesel generators to provide back-up power.

These are the first gas turbines to be used by NASA as a prime power source at a field installation, and their performance and reliability will here be tested under operational conditions.

For a transportable station they provide a compact and lightweight source of power, being much smaller than diesel machines with the same power outputs.

Two power systems are provided, one for electronic equipment, the other for air-conditioning, lighting, the antenna hydraulic system and other utilities.

A commercial 50 c/s supply is connected to the site to provide power to the Australian-supplied office and canteen trailers, external lights and the water and sewerage pumps.

STAFFING THE STATION

The Department of Supply is responsible for the establishment and operation of NASA tracking stations in Australia.

Initially, these were manned and operated entirely by Weapons Research Establishment personnel, but with an increase in the number of stations it was decided to supplement this with the resources of private industry.

Maintenance and operations services for the Carnarvon, Tidbinbilla, Orroral

Valley and Honeysuckle Creek Stations were contracted to private firms, and a similar contract has been arranged for the Cooby Creek Station.

The contractor for Cooby Creek is Amalgamated Wirless (Australasia) Ltd., operating under a Department of Supply Station Director. This company also holds the contract for the Carnarvon Station.

When fully operational, it is expected that about 100 professional, technical and administrative personnel will be employed.

Staff have been recruited throughout Australia and overseas, and a number of these have been to the U. S. for training.

A number of officers from Commonwealth departments and instrumentalities will also be attached to the station for duty in connection with experiments of special interest to their organisations.

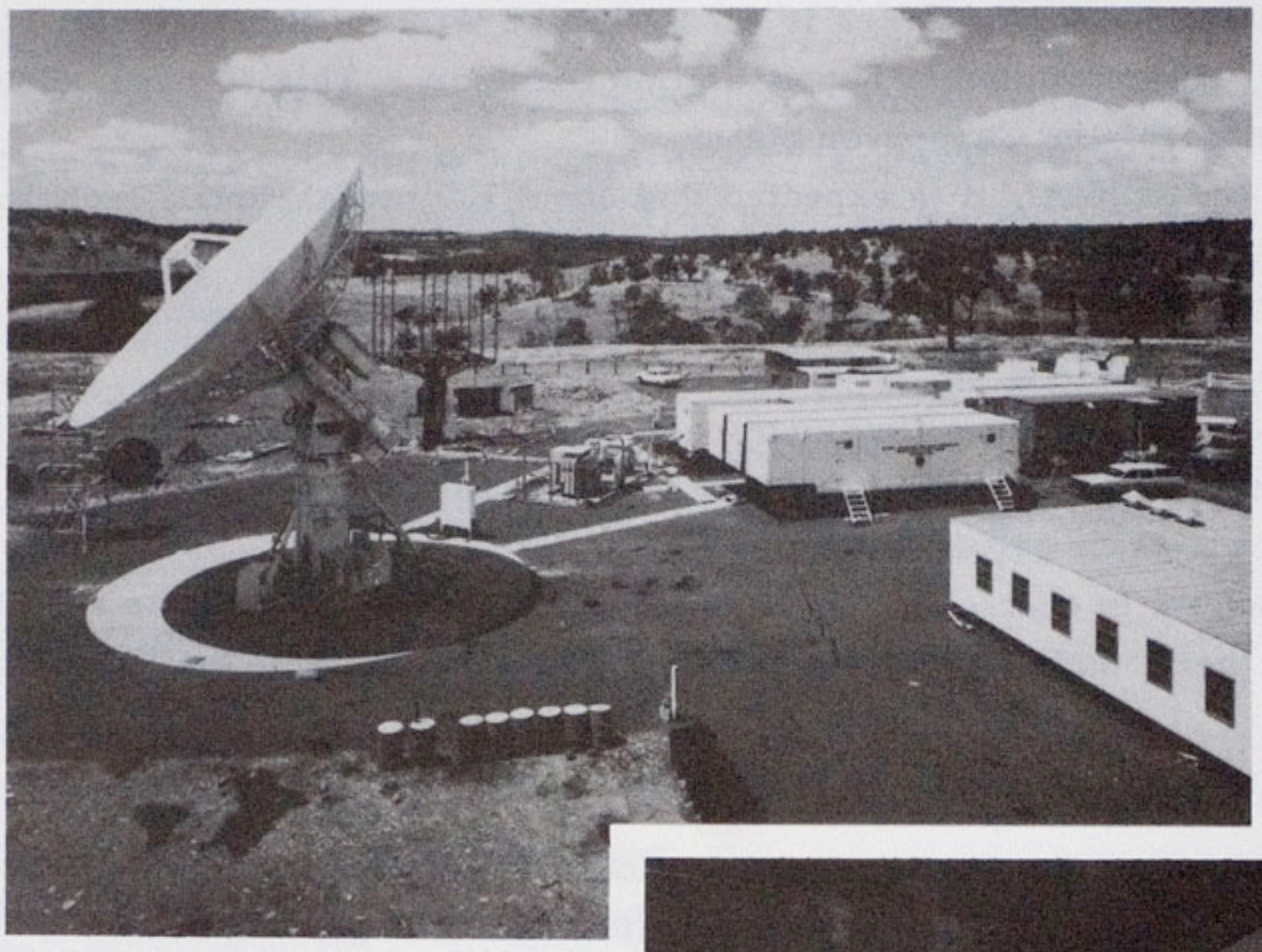
They will assist in controlling some experiments and evaluating the results obtained from them, and they will be responsible for liaison with their parent organisations.

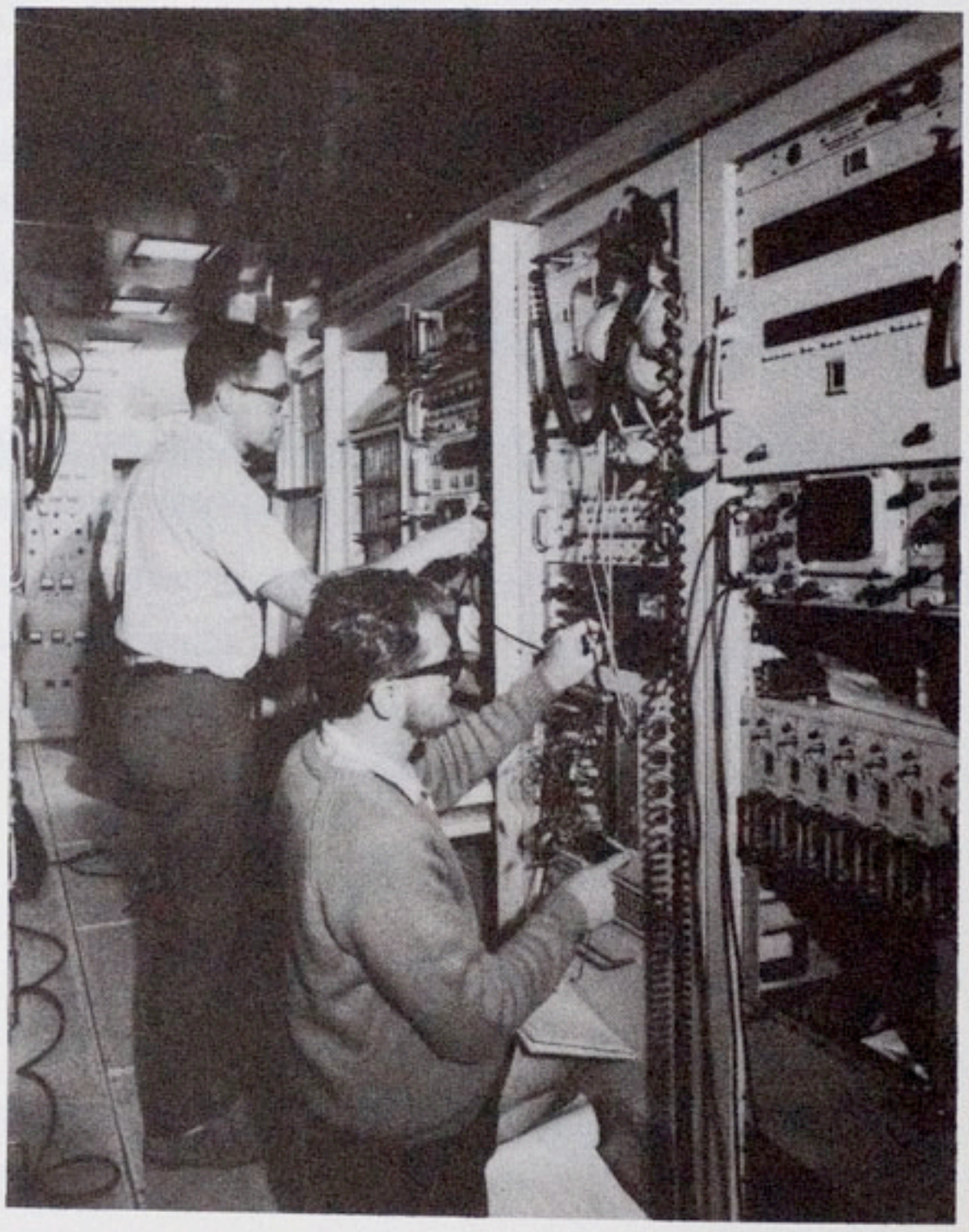
Officers will be attached from the following organisations:-

Postmaster-General's Department	-	Communications
Department of Civil Aviation	-	Aircraft communications and navigation
Bureau of Meteorology	-	Meteorological cameras and data transmission
Department of Supply	-	Communications

In addition there may be occasions on which additional staff from these and other organisations will be at the station to assist in specific aspects of experiments.

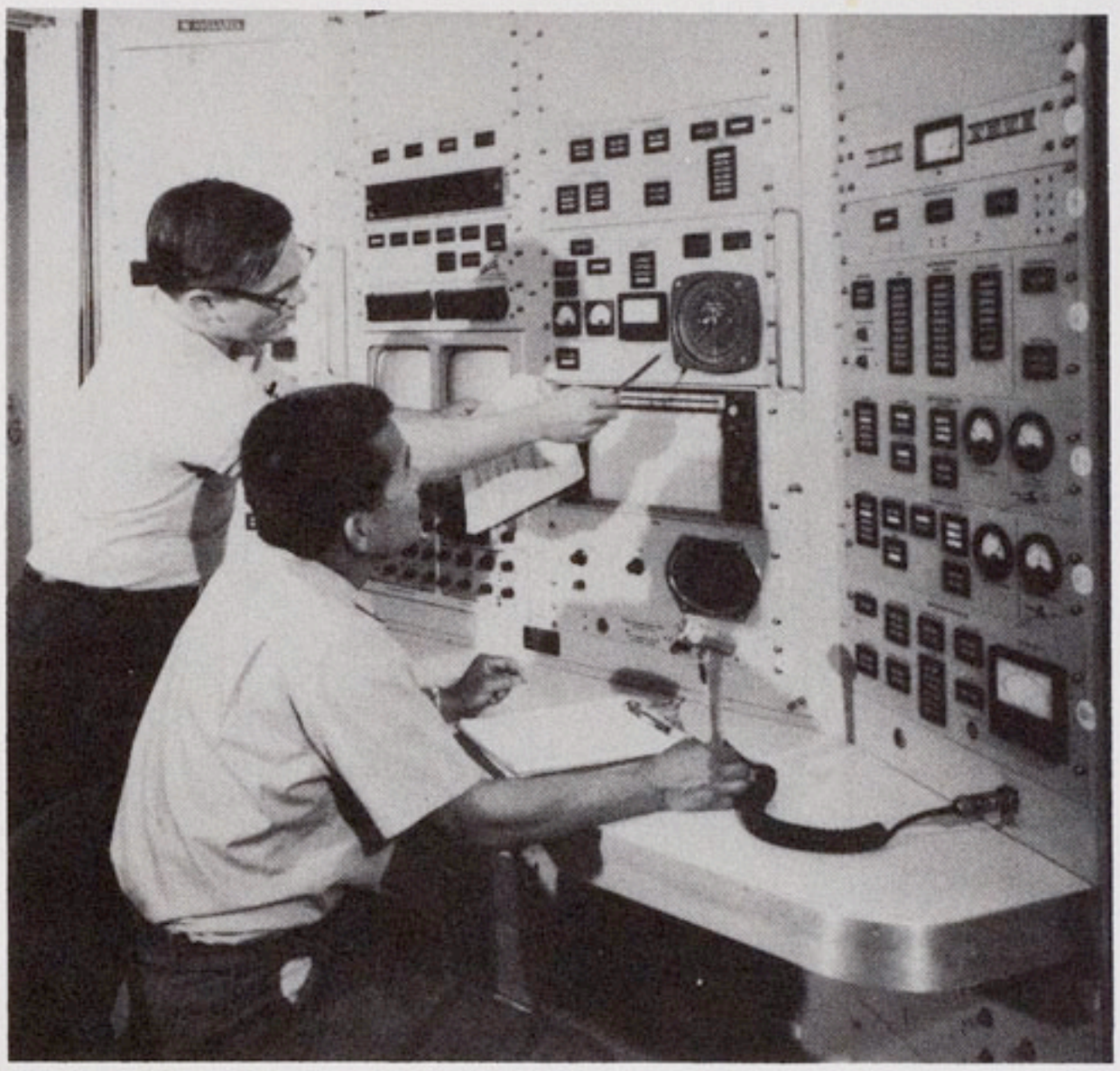
40FT. ANTENNA WITH O.C.C. COMPLEX

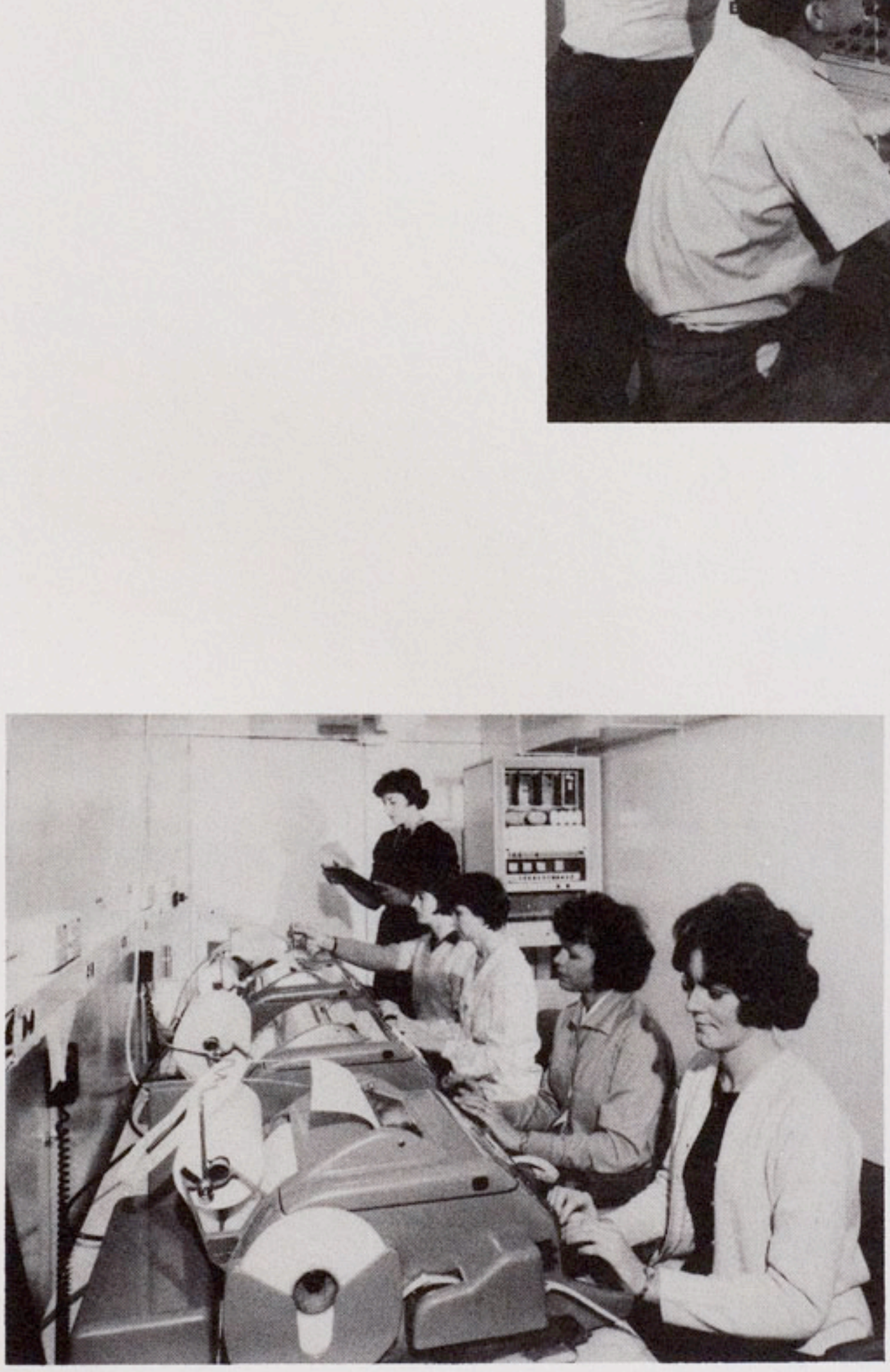




SPECIALISED EQUIPMENT
IN THE OPERATIONS
CONTROL COMPLEX

CONTROL CONSOLE





TELETYPE CENTRE

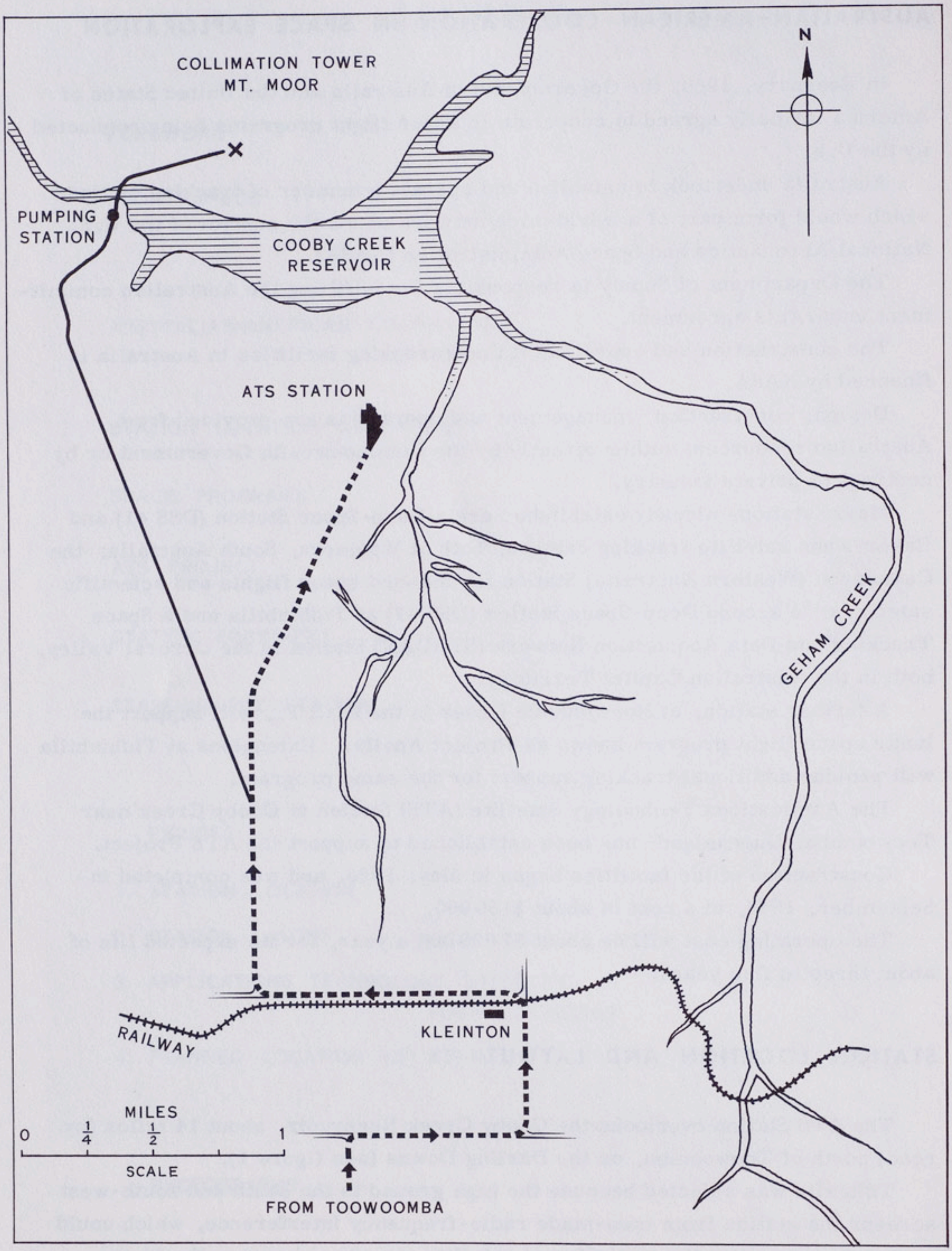


FIGURE 1. STATION LOCATION.

horizon in the north-east permits low-angle tracking in the more critical directions involving the ATS project.

To provide easy access for the establishment and operation of the station, a bitumen road was built from the site to the nearest existing sealed road to Toowoomba.

The ATS station (figure 2) is contained within an area of about 15 acres, and is arranged to give the antennas an unrestricted view from the west through north to east, all other station facilities being located to the south of the antennas.

The main structure is a transportable 40 ft diameter parabolic antenna which is used to track and communicate with the satellites.

A nine-element Yagi antenna is used to send commands to the spacecraft and to receive data from them.

An operating complex of three interconnected vans (the operations control complex) is the nerve centre of the station.

In conjunction with the adjacent telemetry and command van, this complex contains all the technical equipment required for communications, commands, telemetry and data analyses.

Additional vans are provided for stores, workshop, offices, canteen facilities and the generation of power.

A calibration system for the station is located on Mt. Moor, about two miles north-west of the station on the opposite side of the Cooby Creek Reservoir.

SPACE PROGRAMS

The present NASA program can be divided into three general groups:

- Manned space flights.
- Deep-space exploration.
- Near-earth scientific investigations.

Manned space flights

The two-man Gemini project, in 1965-66, was a logical successor to the original one-man Mercury project and has paved the way for the three-man Apollo Project, whose objective is manned exploration of the moon by the end of this decade.

The Carnarvon and Honeysuckle Creek Stations will be used to communicate with and track the manned lunar spacecraft and monitor the lunar excursion module, which the astronauts will use to reach and leave the moon.

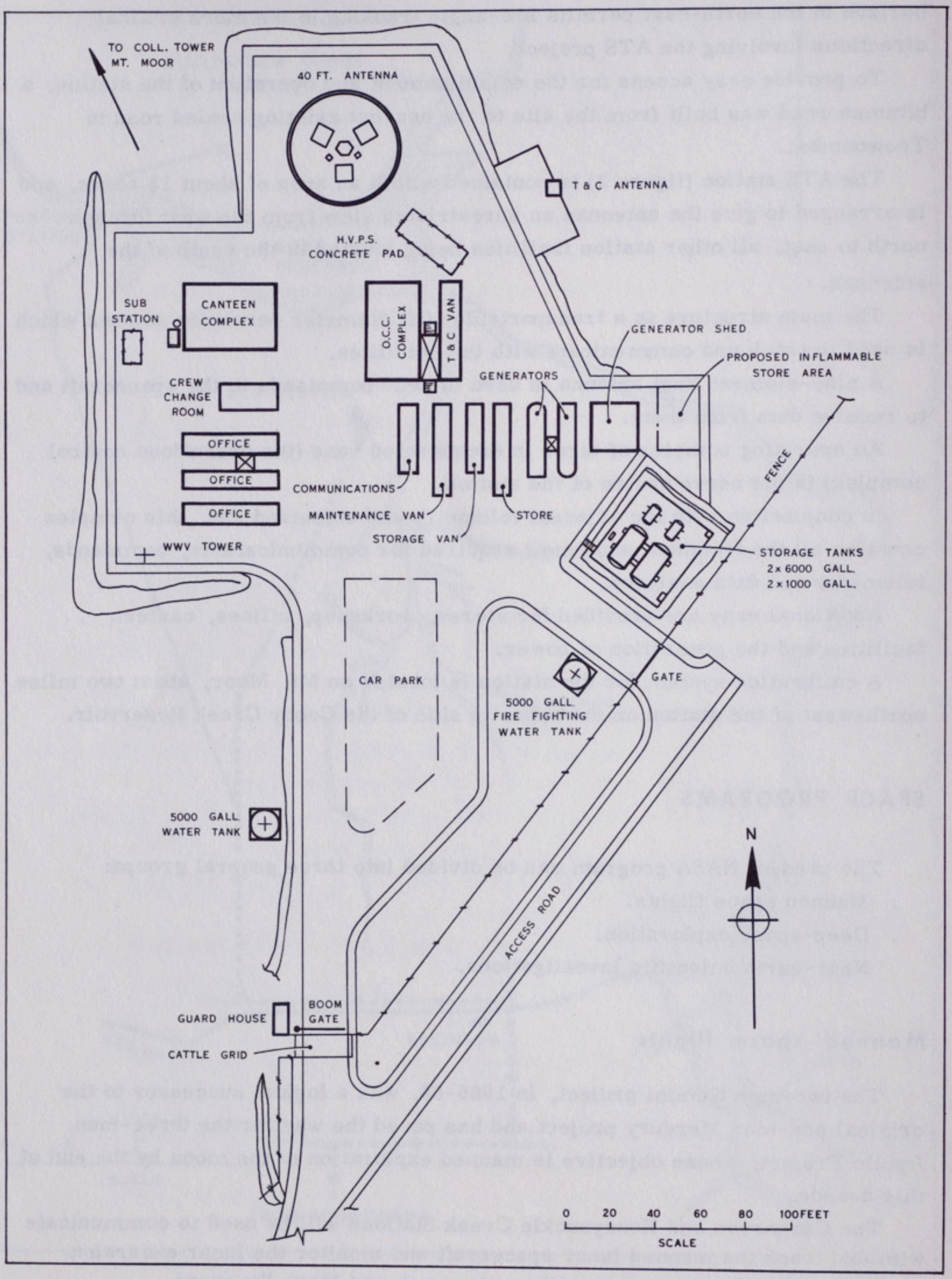


FIGURE 2. STATION LAYOUT.

Extensions to house new equipment at Tidbinbilla will permit it to share the Apollo task with Honeysuckle Creek.

Deep-space exploration

These projects are concerned with the exploration of the moon and the solar system, using unmanned spacecraft some of which travel up to hundreds of millions of miles out into space. Some of the projects are listed below.

Ranger carried TV cameras and returned pictures of the moon's surface before crash-landing on the moon. The project, which was the forerunner to Surveyor, was completed in 1965.

Surveyor aims to land spacecraft on the moon and to use them to send back TV pictures and data about the moon.

Surveyor I made a successful soft landing on the moon in June, 1966, and transmitted some 11 000 TV pictures of the moon. Unfortunately, Surveyor II, launched in September, 1966, was unsuccessful.

Lunar Orbiter 1 was placed in orbit around the moon in August, 1966, returning many photographs taken by its two cameras to aid in the selection of suitable landing sites for the Apollo Project. After completing its mission the space-craft remains in orbit around the moon, until it finally crashes on the moon's surface. There are five spacecraft in the Lunar Orbiter Series.

Mariner spacecraft were launched to fly past the planets and return data on the conditions in their immediate vicinity. Mariner II was used to study Venus.

Mariner IV flew past Mars in July, 1965, some eight months after launching, and returned much valuable information, including TV pictures about that planet.

Mariner IV then went into orbit about the sun, where it will stay indefinitely. After 18 months of flight, data were received from it at a record distance of about 200 million miles.

Pioneer spacecraft are used to send telemetry data on conditions in inter-planetary space, away from the influence of the planets. Pioneer VI and VII were launched in 1965 and 1966, respectively.

Near-earth scientific investigations

Earth satellites are unmanned vehicles which orbit the earth and return scientific data about its environments.

Along with other stations in the NASA network, the Orroral Station tracks

these satellites and acquires data for many purposes.

The ATS Project is an extension of this work, but, because of the different nature of the experiments and the spacecraft, specially equipped ground stations are required.

ATS PROJECT

The main objectives of the ATS project are:-

(a) To conduct experiments with gravity gradient oriented spacecraft. This system uses the force of gravity acting on long booms deployed from the vehicle to enable it to maintain its attitude in space relative to the earth. The studies will include the techniques required for both medium (6 000 miles high) and synchronous (22 300 miles high) orbits, to determine the feasibility and usefulness of the system for stabilising communications and meteorological satellites, regardless of disturbing effects generated within the satellite or caused by its environment.

(b) To flight-test experiments for various satellite applications (such as meteorological, navigational and communications applications), materials research, and attitude determination and control.

(c) To investigate and test systems common to a number of satellite applications, including experiments to:-

- Evaluate the use of multiple-access communications (simultaneous use of communications equipment by a number of stations) and meteorological equipment on spin-stabilised spacecraft.
- Test various types of spacecraft antennas and communication systems.
- Determine the sensors required for this class of satellite.
- Obtain data on high-energy particles at medium and synchronous altitudes.

(d) To investigate and test the technology for stationary orbits by:-

- Developing methods for correcting large errors in orbital injection, for precise station-keeping for long periods, and for spinning up a spacecraft after separation from its booster.
- Checking the feasibility of v.h.f. communications via a transponder in a spin-stabilised synchronous satellite.

For long-distance communications using satellites, there are many advantages in using spacecraft in synchronous equatorial orbits, the main one being that they are usable over about one-quarter of the earth's surface at the same time.

A synchronous equatorial orbit is one in which a satellite is placed above the equator at a height of about 22 300 miles.

At this height, the satellite orbits the earth at the same rate as the earth rotates, and the satellite therefore appears to remain stationary over a point on the equator.

This system was successfully demonstrated in 1964, using a communications satellite, Syncom III, which was used to relay TV pictures of the Olympic Games from Tokyo to California.

Schedules and experiments

The program will consist of five satellites, in three types of mission:

- Spin-stabilised in a stationary equatorial orbit.
- Gravity-stabilised in a medium-altitude orbit.
- Gravity-stabilised in a stationary equatorial orbit.

Details of the flight schedules are given in figure 3.

The first spacecraft, ATS-B, will be launched in the last quarter of 1966, aboard an Atlas/Agena D launch vehicle and manoeuvred into a synchronous orbit on the equator at about 151 deg. west longitude.

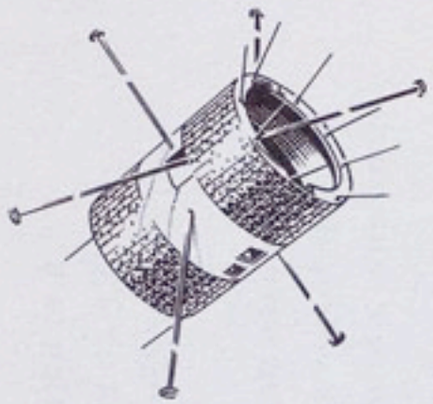
The spacecraft will be able to be tracked at the same time by the stations at Rosman and Mojave in the U.S. and the station at Cooby Creek.

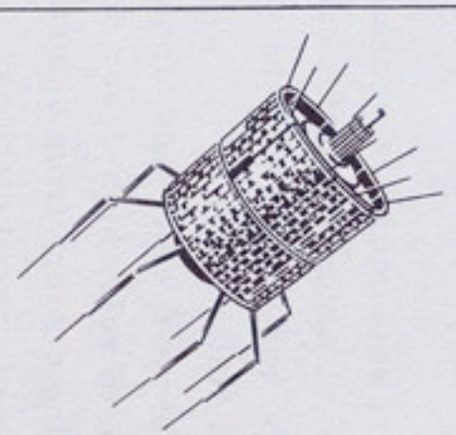
If it were bright enough to be seen, the satellite would be visible from any point shown on the area of visibility on figure 4.

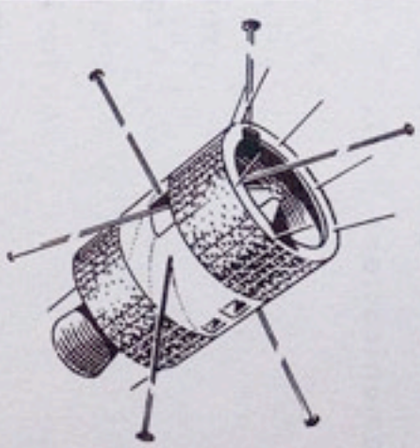
The ATS-B satellite will carry the following equipment:

Communications

1. A microwave multiple-access single-sideband system to conduct simultaneous voice, data or teletype communications between several ground stations.
2. A microwave wide-band frequency modulated system to relay high-speed data or TV, including colour, from one station to a number of ground stations.







FLIGHT	ORBIT	STABILIZATION	SCHEDULE
ATS-A	6,000 NAUTICAL MILES CIRCULAR 28° INCLINATION	GRAVITY GRADIENT	1966 1967 1968
ATS-B, ATS-C	SYNCHRONOUS EQUATORIAL	SPIN	
ATS-D, ATS-E	SYNCHRONOUS EQUATORIAL	GRAVITY GRADIENT	

FIGURE 3. APPLICATIONS TECHNOLOGY SATELLITE FLIGHT SCHEDULE.

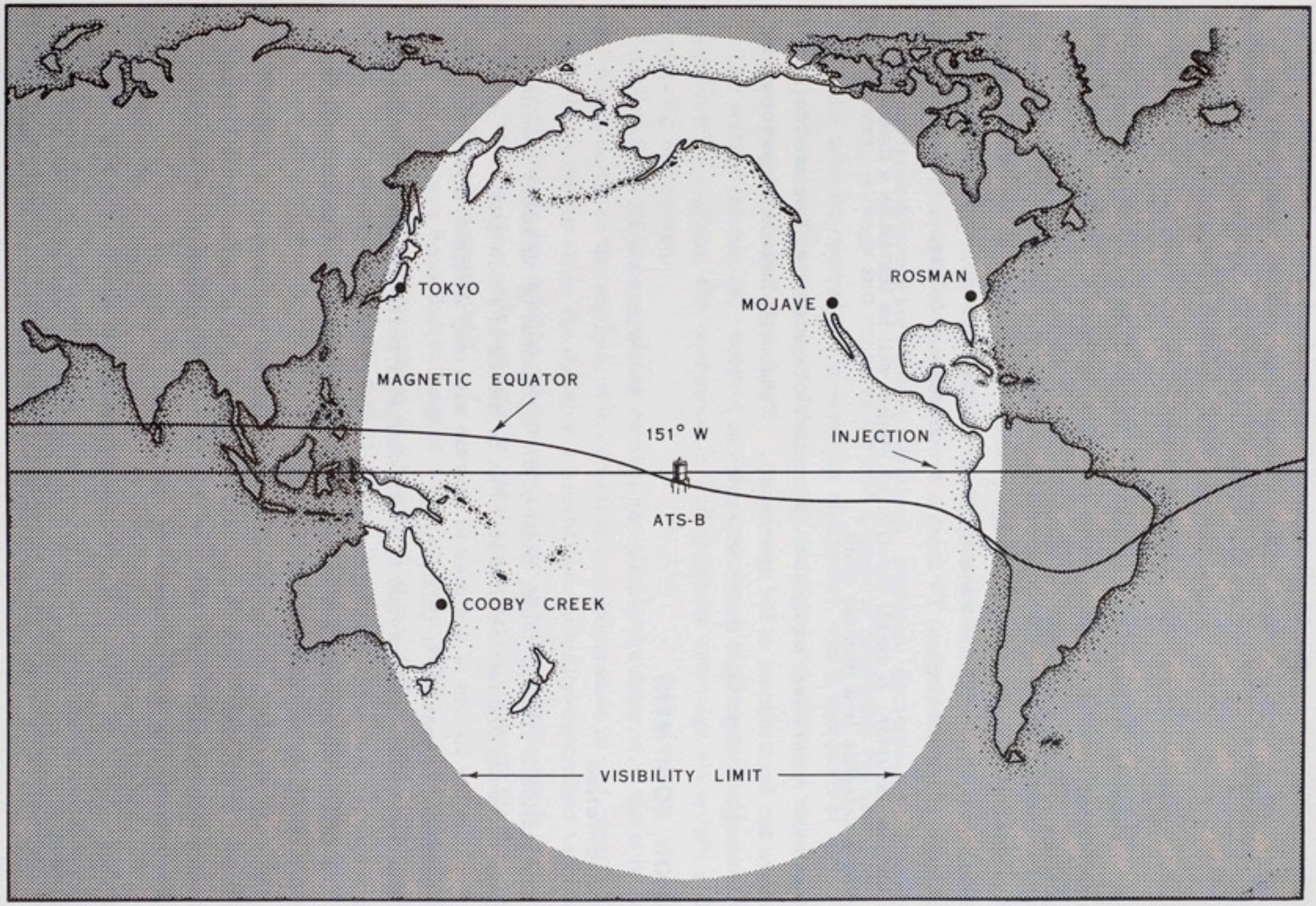


FIGURE 4. PLANNED LOCATION OF ATS-B.

DESIGNED AND PRINTED BY TECHNICAL SECRETARIAT GROUP, W.R.E.