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INSTRUMENTATION AND TRIP REPORT ON FLIGHT NUMBERS 14.79 UE THROUGH 14.82 UE

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NASA — GODDARD SPACE FLIGHT CENTER

GREENBELT, MARYLAND

INSTRUMENTATION AND TRIP REPORT

ON

FLIGHT NO'S 14.79 UE THROUGH 14.82 UE

By

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National Aeronautics and Space Administration
Goddard Space Flight Center

SUMMARY

19268

This report is one of a series issued by the Sounding Rocket Instrumentation Section. It contains all pertinent engineering data on actual flight instrumentation, and documents the flight results of Flight Nos. 14.79 UE through 14.82 UE. These rockets were fired from the Thumba Equatorial Rocket Launching Station (TERLS), located near Trivandrum in southern India. In addition, this report contains a collection of practical and useful information relating to travel, business, and diplomatic needs.

This report is intended to illustrate the function and performance of instrumentation and/or telemeter equipment supplied by the Sounding Rocket Instrumentation Section, and not to present an analysis of either data or performance of the vehicle.

AUTHOR

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INSTRUMENTATION AND TRIP REPORT ON FLIGHT NOS. 14.79 UE THROUGH 14.82 UE

INTRODUCTION

The purpose of these flights is to determine the altitude and intensity of electric current systems in the ionosphere near the magnetic equator where it crosses the southern tip of India. Altitude determination was made by means of densitometer and a baroswitch.

In addition, this report includes information on the facilities of the Thumba Equatorial Rocket Launching Station (TERLS) and such general information on India as travel, transportation, accommodations, necessary travel documents, weather, etc.

ATTENDING NASA PERSONNEL

Mr. Jack Holtz, NASA Headquarters, Observer

Mr. K. R. Medrow, Branch Head, Sounding Rocket Branch, Observer

Mr. R. W. Conrad, Sounding Rocket Branch, Adviser and Observer on Payload and Instrumentation

Mr. J. C. Modlin, Sounding Rocket Branch, Adviser and Observer on Mobile Telemetry Station F

COGNIZANT TERLS RANGE PERSONNEL

Mr. H. G. S. Murthy, Test Director

Mr. M. S. V. Rao, Chief of Met. Unit

Mr. D. John, Project Engineer

Mr. D. Easwardas, Vehicle Preparation Unit

Mr. A. P. J. Abdel Kalam, Range and Safety

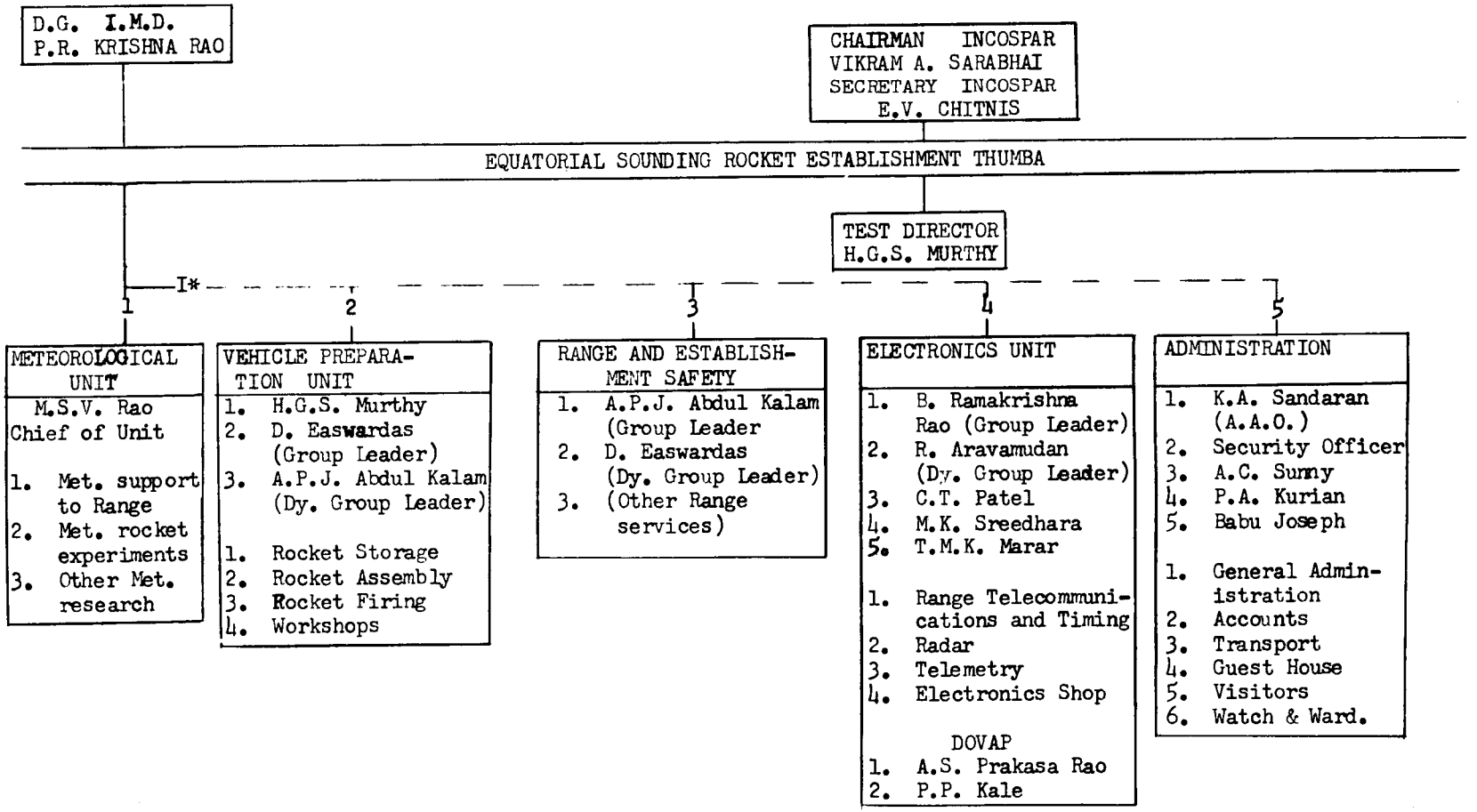
Mr. B. Ramakrishna Rao, Electronics Unit, Group Leader

Mr. R. Aravamudan, Electronics Unit, Dy. Group Leader

Mr.. A. S. Prakasa Rao, Electronics Unit, Dovap

Mr. P. P. Kale, Electronics Unit, Dovap

(Figure 1 presents the organizational structure of TERLS.)



* In relation to the Met. Support for rocket firings, this signifies a solid line. For other programmes and for administration, the unit operates directly under Director General, I.M.D.

Figure 1. TERLS Organizational Chart

TERLS RANGE AIDE

Mr. V. J. Talati, Publicity Division, Department of Atomic Energy, Bombay, India

ROCKET VEHICLES

Vehicles used were standard Nike Apache, two-stage, unguided, sounding rockets supplied by NASA under an international collaboration agreement with the Indian Department of Atomic Energy (see Appendix A).

PAYLOADS

Payloads were supplied by Dr. L. J. Cahill, Jr., Chief Scientist, New Hampshire University. The instrumentation included:

1. A magnetometer to measure the earth's magnetic field.
2. Langmuir Probe to measure electron density.
3. Densitometer and Baroswitch for altitude determination.
4. Aspect Sensor to measure magnetic aspect.

The payload block diagram is shown in Figure 2.

TELEMETRY

A five-channel FM/FM telemetry system was used on these experiments, transmitting on a carrier frequency of 240.2 mcs. The transmitter provided two watts of RF power into a set of four turnstile antennas, swept back at 45° to the longitudinal axis, and fed to give circular polarization.

GSFC Telemetry Ground Station F (Figures 3 and 4) was supplied to India on a loan basis. It includes two eight-turn, right-hand circular helix antennas; a pair of telemetry receivers; eleven sub-carrier discriminators, with channel selectors and low-pass filters for all standard IRIG channels; a 12-inch magnetic oscillograph, and a 4-channel tape recorder. Calibration, test and service equipment, and a paper record processor, complete the installation. The ground station (GSFC Sounding Rocket Branch Station F), is housed in an air-conditioned, 28-foot, semi-trailer. It was operated by Indian range personnel, previously trained at GSFC.

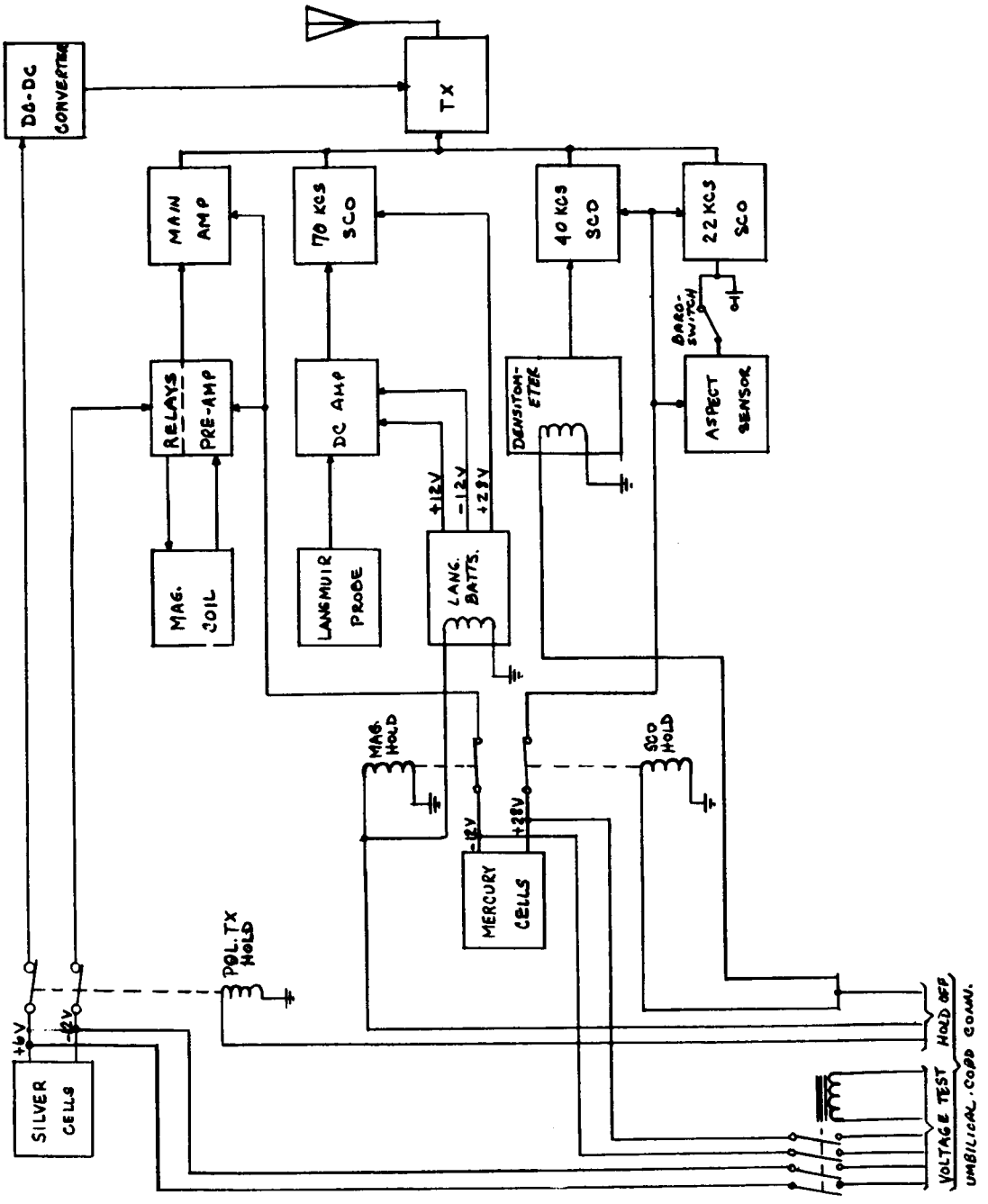


Figure 2. Rocket Payload Block Diagram

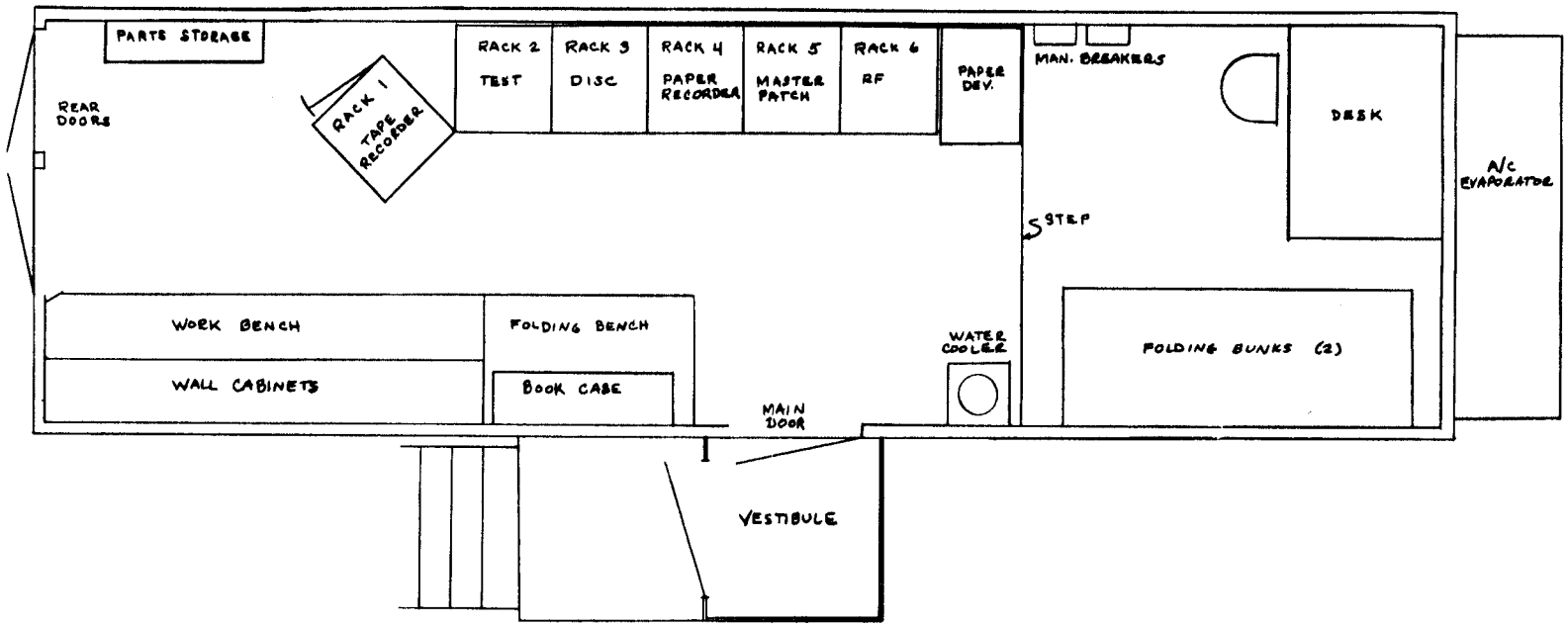


Figure 3. Goddard Telemetry Trailer F, Layout

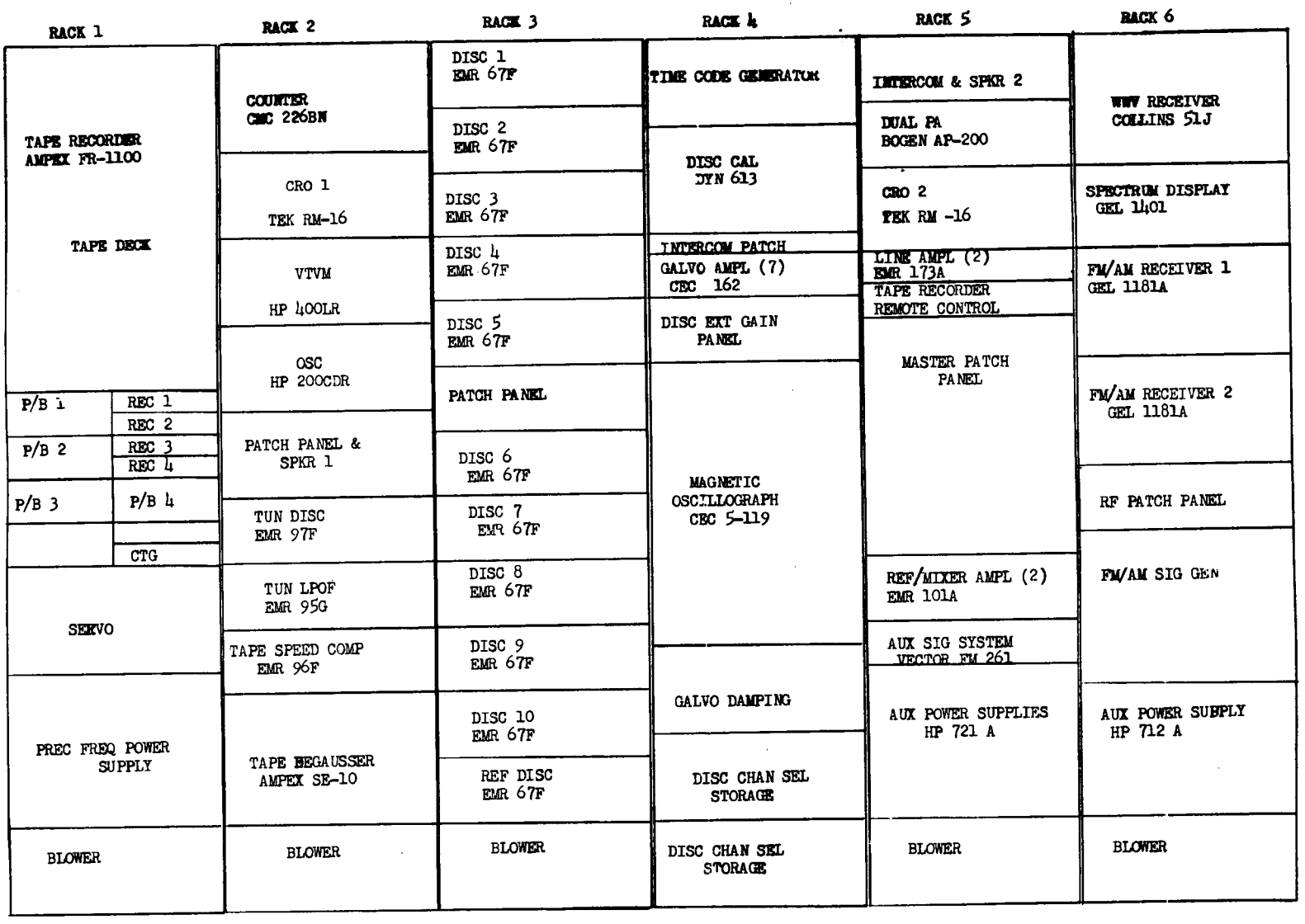


Figure 4. Goddard Telemetry Trailer F, Equipment

The magnetometer modulates the transmitter directly at 1.5 KCS with a 10 percent deviation. Standard sub-carrier oscillators modulate the transmitter as follows:

1. Densitometer, 70 KCS (±7.5%)

2. Aspect Sensor, 40 KCS (±7.5%)

3. Langmuir Probe, 22 KCS (±7.5%)

FIRING DATA

Launch times are as follows:

Flight	Date	Time
14.79 UE	25 January 1964	0514Z
14.80 UE	27 January 1964	0430Z
14.81 UE	29 January 1964	1000Z
14.82 UE	31 January 1964	1330Z

CONCLUSION

All rockets performed normally and Dr. Cahill reported that the experiments worked satisfactorily. Each successive rocket gained altitude over its predecessor. Data was collected and stored on magnetic tape and real-time records. Instrumentation performance was good and the experiments appear to have been successful. All telemetry signals were received as follows and good data are expected in all cases:

Flight 14.79 UE, 395 seconds of telemetry

Flight 14.80 UE, 394 seconds of telemetry

Flight 14.81 UE, 404 seconds of telemetry

Flight 14.82 UE, 406 seconds of telemetry

GENERAL INFORMATION

FACILITY INSPECTION AND RANGE MEETINGS

An inspection tour was made of the range soon after arrival to acquaint ourselves with the range and its operational facilities. We (Goddard employees) were amazed at the work the Indians had done in making TERLS an up-and-coming rocket range. Their method of doing things is entirely different than ours, but the end result is one of which they can be proud. Minor problems were encountered and alleviated in the GSFC telemetry trailer. The air conditioning system, which had been inoperative, was repaired and recharged, putting the trailer in tip-top condition for the Indians to operate during these and subsequent launchings.

Two important range meetings were held. The first was held at the Range Guest House where Dr. Cahill gave a lecture on his experiment, explaining what information he would like to obtain and the method to be used. Following this lecture, Mr. Medrow presented Mr. Murthy and members of his crew who had completed NASA training, with certificates of completion. This gesture was appreciated very much.

The second meeting was called by Mr. Medrow at the end of the rocket series and was held in the Test Director's Office. Each person was asked to outline any problem encountered in launching and preparing for launching of the rockets. Mr. Murthy seemed most grateful for the suggested remedies. Mr. Medrow then commended Mr. Murthy and his crew for the outstanding job that they had done. The following morning, we started the trip home.

In summation, I think that the successful operations during these rocket launchings were due to the close co-operation between Indian and NASA personnel. With continued co-operation of this kind, I see no difficulties ahead with future launchings at TERLS.

THE TERLS RANGE

TERLS Rocket Launching Facility (Figure 5) is located only a few miles from Trivandrum along the Malabar Coast. It faces the Arabian Sea and the village of Attipura. The present site was selected by a survey team consisting of Indian and American personnel as the best compromise of all locations near the magnetic equator.

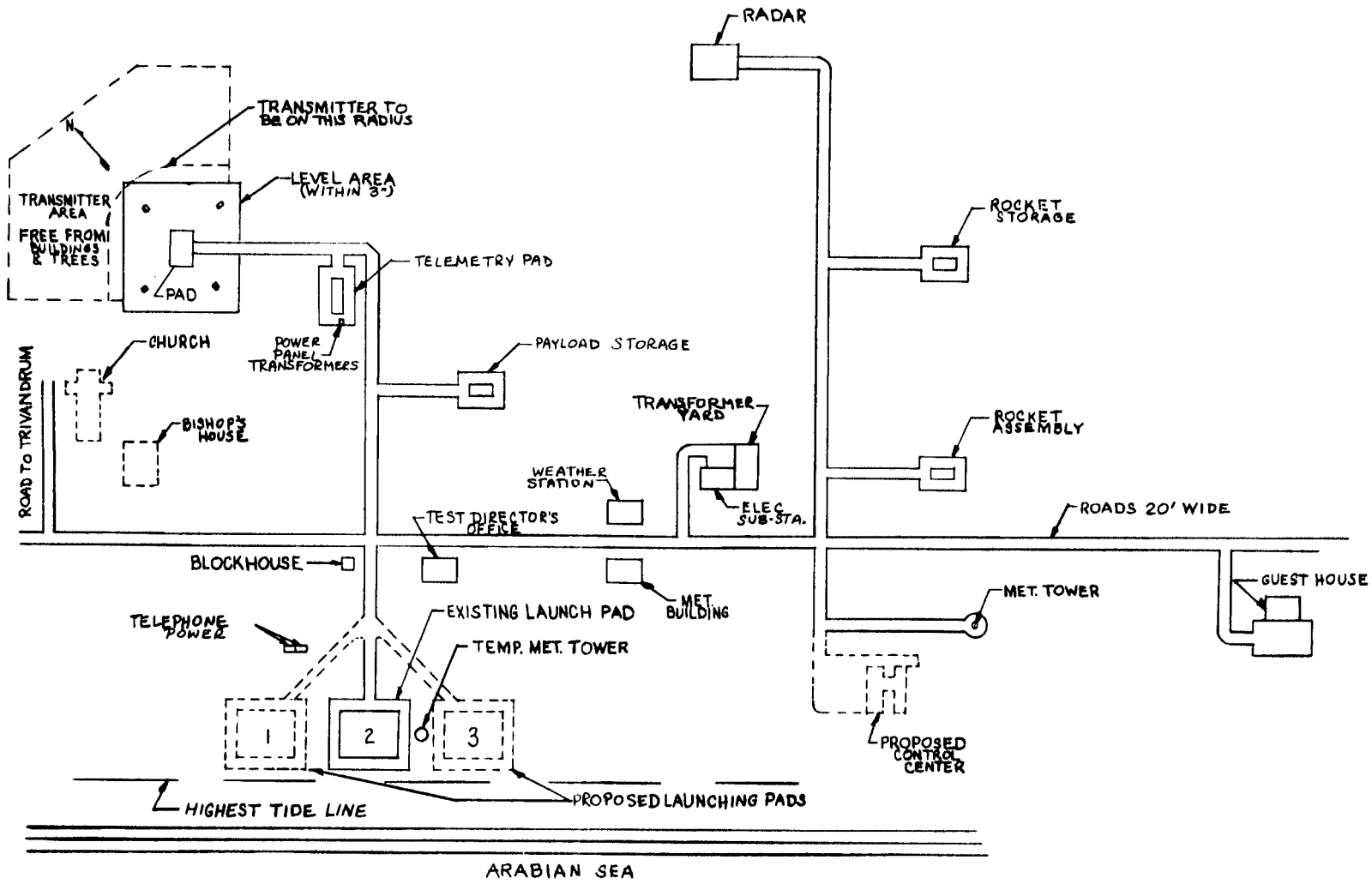


Figure 5. Rocket Launching Facility, Thumba Site Plan

The entire Malabar Coast is thickly populated, creating the problem of displacing a large population adjoining a rocket launching site, which involves great time and expense. Relatively few people had to be displaced however, and these were relocated nearby in a new village that was established. The new homes and environmental conditions are much better than those the people relinquished. Considering all factors involved in the selection of a rocket launching range, the site seems to be an excellent choice.

A good portion of the range is studded with coconut palms, making it very picturesque (see the photographs at the end of this report). Although not entirely completed as yet, it has excellent potential. All of the permanent buildings are now under construction and should be completed in the near future. Only one launch pad is now in operation; two others are planned. The range can handle Nike Apache and similar types of vehicles.

At present, the facilities are located in an abandoned mission with new roads being built over the entire range. The range will soon have Radar and Dovap stations. Also planned, or under construction, are a control center, rocket assembly building, a balloon launcher, and a new road to Trivandrum that will reduce the traveling distance considerably. In the not-so-near future, a Physical Science Laboratory is planned for location on or adjoining the present range.

At the moment, there is no public transportation between Trivandrum and the range. Mr. Murthy, the Test Director, can arrange transportation. These requirements should be made known to him. Public transportation is planned for the future. If on-range during lunch periods, Mr. Murthy can also arrange to provide food.

Because of the large number of coast-wide fishing boats and ships which operate within the impact areas, range clearances must be obtained at TERLS, as at any other range. Clearance normally consists of notifying air lines and shipping interests a day or so in advance of the intended firing. However, these notices are not always heeded, and numerous small fishing craft may be unaware of impending firings. This problem occurred during one launch, and caused a short delay in firing.

WEATHER AT TERLS

When planning rocket launchings at Thumba, the 75 inches of rainfall should be taken into consideration. Most of it comes during the monsoon season from June through October. At all other times, TERLS should be fine for experiments designed for studies around the equator.

Weather during the assigned launchings was ideal for rocket firings, with only scattered showers one morning.

TRAVEL SCHEDULE

We departed Friendship International Airport, Baltimore, Maryland on 17 January 1964, boarding National Airlines Flight 292 at 1908 EST for New York City, arriving there some 45 minutes later. At 2200 EST, we departed New York City on Air India Flight 110 for Bombay, via London, Paris, Geneva, and Cairo. On 19 January 1964, at 0650 IST, we arrived at Bombay's Santa Cruz Airport. At 1145 IST (all of India is on Indian Standard Time (IST), which is GMT plus 5.5 hours or EST plus 10.5 hours), on 20 January, we arrived at Trivandrum and were driven to the Mascot Hotel. On 1 February at 0930 IST, we departed Trivandrum for Bombay and at 0110 IST on 2 February, we departed Bombay for the return trip home, terminating at FIA Baltimore 2 February at 2030 EST.

LANGUAGES

In addition to English, which is widely spoken, there are 14 major languages and about 250 regional dialects. A person from one region normally can not understand a person from a different region. Under these circumstances, English is usually the common language, although it is not the national language.

TRAVEL DOCUMENTS

Priority should be given to obtaining a passport. U.S. residents must apply in person to the U.S. Passport Agency in either New York, Chicago, Boston, Miami, New Orleans, San Francisco, or Washington, D.C. Applicants should be prepared to present such documents as proof of citizenship, birth certificate, etc. and two recent photographs, full face, 2 1/2 x 2 1/2. Charges for passports are $1 for official and $6 for tourists.

Citizens of the U.S. require a visa for India. Visa costs are free for official visas and $2.50 for tourist visas, and can be obtained by applying to:

1. Embassy of India, Consular Division
   2107 Massachusetts Avenue, N.W.
   Washington 8, D.C.

2. Consulate General of India
   417 Montgomery Street
   San Francisco 4, California

3. Consulate General of India, Visa Section
   3 East 64th Street
   New York 21, N.Y.

Tourist Introduction Cards may be obtained from the visa issuing authority. It enables you to receive assistance in many ways, such as: customs clearance, liquor permit, tourist coupons for the purchase of various items at reduced rates, and finally it serves as an introduction to social and sport clubs.

Health Cards or Certificates

Health cards or certificates may be required by countries along the route to India. In India, only persons arriving from Yellow Fever infected areas in Africa or Latin America are required to produce a valid vaccination certificate. It is advisable to be inocculated and vaccinated against cholera, smallpox, yellow fever, typhoid, typhus, and tetanus, and have these vaccinations and inocculations marked on your health certificate. Without this precaution, difficulty may be encountered in returning to the U.S.

Customs Documents

Prior notification of expected time of arrival in Bombay, along with a list of equipment, tools, etc., will avail personnel from the Atomic Energy Commission to assist you through Customs with a minimum of red tape. A certified list of all major articles should be obtained from the Customs Officer so that there will be no question of duty on departure from India. The following baggage allowance, duty free, is allowed:

1. Wearing apparel
2. Personal jewelery
3. Two cameras (8 mm and 16 mm for cine cameras only; any size for still cameras; 8 reels of film per camera)
4. One pair of binoculars
5. One portable musical instrument
6. One tape recorder
7. One transistor radio
8. One typewriter
9. Two watches
10. Consumable items: reasonable quantity of cigarettes, cigars, and tobacco; one regular size bottle of wine and 1/4 liter of liquor (or 1 qt. of liquor); small quantity of perfume; and a reasonable quantity of medicines.

CURRENCY

Every person arriving in India must fill out a Currency Declaration, and all transactions of monetary exchanges must be noted on this declaration. You are then able to exchange currency brought in and to take currency out on departure. Value of the Indian Rupee is approximately Rs. 4.75 to the U.S. dollar. India now uses the decimal system of coinage: The Indian Rupee consists of 100 Naya Paisa (NP).

Travelers Cheques are the best way to safeguard travel funds. Most universally accepted are those of American Express. All banks and most of the large hotels are authorized to exchange travelers cheques and U.S. dollars.

TRAVEL ITEMS

It is advisable to travel light and keep under the 44-pound limit. First class reservations may not be available for the entire route and the light weight simplifies going through Customs since registration and checking of baggage then becomes unnecessary. It is advisable to pack necessities in a separate bag on board the aircraft, in addition to the one large bag of bulk items, just in case your baggage is misplaced in transit (as was ours).

Clothing

Good, plain cotton clothing is excellent for any place in India with the exception of northern India. There, woolen clothing is necessary from the middle of November to the middle of February. Exotic fabrics are undesirable due to the difficulty of laundering. No difficulty should be encountered in having ordinary fabrics laundered at hotels. During the monsoon season, a raincoat, umbrella, and galoshes are needed. A raincoat serves very well as a topcoat during travels.

Climate

India's climate ranges from tropical to temperate. The TERLS area is within the tropical area, which undergoes a monsoon season for approximately three months of the year. Temperatures and humidity are high all year round.

Toiletries

Imported toilet articles and cosmetics are expensive, so favorite brands should be taken along. Getting medicine is not difficult, but prescription items may be, and a supply should be taken along. A thermos bottle, for boiled drinking water, is advisable. American-made electric razor can be used if some means of adapting it for use on 220 volts AC can be found.

TRAVEL

Air travel is best. India's internal air services are operated by Indian Airlines Corporation (IAC), the largest domestic airline in the world. Their safety record is unparalleled. The hop from Bombay to Cochin, India, was taken aboard a Fokker F-27 Friendship jet-prop. It is an excellent airplane for viewing the marvelous Indian scenery. The wing is above the windows so that there is no obstruction to the ground view, regardless of where you may be seated. Hardly a trip is made without running into the old standby, the DC-3, as happened on the Cochin-Trivandrum hop. Although not as smooth and modern as the Friendship, it is still a fine airplane.

Travel by train is available, although slow by Western standards. The Indian railroad system uses the broad, meter, and narrow gage tracks. Few cars are air conditioned and little or no first class travel is available in most areas. A slow moving meter-gage choo-choo is the only rail transportation between Cochin and Trivandrum.

Travel by automobile can be arranged in some areas, however, there are none for hire in the Trivandrum area. Most motoring is done by taxi or bus. Traffic keeps to the left and overtakes on the right. No general speed limit for cars exists apart from the 30 mph limit in some cities. The highway code means little to the Indian peasant who thinks in terms of years and not of minutes. Bullock carts, cyclists, and masses of pedestrians usually will be hogging the middle of the road, necessitating a constant beeping of the auto horn. An International Driving License is recognized and insurance is compulsory.

CITIES

Two cities of importance to you are Bombay and Trivandrum. Bombay will probably be your place of entry and departure. It is a blend of the East and the West and not quite representative of other parts of India. Some places that may be of interest while stopping over are: The Caves of Elephanta and its rock-cut temples, the view on Malabar Hill, and the Prince of Wales Museum. Other than these, Bombay has few sightseeing spots.

Trivandrum, located only a few miles from Thumba Range, will be much in your plans. One may think of it as only a small city, however, it has a population well over a million people. Trivandrum is quite pleasing to the eye, being a city built on hills overlooking quiet valleys. It will be well worth your time to pay a visit to the Trivandrum Museum where you will see a wide collection of paintings and a wonderful display of local arts and crafts. There is also a zoo, an excellent aquarium, a golf course, and a flying club. Should one desire some relaxation, one of the best beaches in India is available ten miles away at Kovalam.

HOTELS

The number of good hotels in India is limited. Hotel reservations should be made well in advance in order to avoid disappointment with a room taken on short notice. With few exceptions, service is excellent and accommodations good in all of the better hotels. In Bombay, the Taj Mahal and Ascot; in Cochin, the Malabar; in Trivandrum, the Mascot, are suggested. Tipping should be restricted until departure, leaving 10% of the bill. Individual tipping is impossible due to the great number of people at the hotels providing service.

FOOD

Generally, the food is excellent; but it is best to drink only boiled water, tea, or coffee. Boiled water is served in most good hotels. Avoid eating salads and raw vegetables, except in good restaurants. Should you try some of those innocent-looking Indian dishes, beware, you may have to reach at short intervals for your drink to bank the initial fire.

INDIAN PEOPLE

Indian people are very courteous. You are greeted with folded palms raised to the level of the chin. The Indians are mostly vegetarian.

PHOTOGRAPHY

Photography is permitted almost everywhere in India, except from the air and airports. There are many places of great beauty and historic interest. As a matter of courtesy, obtain permission to photograph people before doing so.

SIGHTSEEING

When time permits, side trips are advisable. One such weekend trip was made to Cape Comorin, southern part of India where, with a single glance, one can see the Bay of Bengal, the Arabian Sea, and the Indian Ocean.

Another weekend trip was made to Thekkady to visit the Periyar Game Sanctuary. The mountainous road to it passes through tea, rubber, cardamom, and pepper plantations. A man-made lake is the heart of this sanctuary. From a motor launch on the lake, one can observe herds of elephants, some bison, and deer. There are many such places to see, if time is available.

SOUVENIRS

India is most rewarding, with many irresistible objects. Street peddlers expect haggling over prices; therefore, the realistic price is about 1/3 the original quote. In Trivandrum, Mr. Murthy can get a 10% discount on most souvenirs. The state-run Emporium in Bombay was the best place to make purchases.

APPENDIX A

This section contains the Memorandum of Understanding between the Indian Department of Atomic Energy and the National Aeronautics and Space Administration.

MEMORANDUM OF UNDERSTANDING

BETWEEN

THE DEPARTMENT OF ATOMIC ENERGY

AND

THE UNITED STATES NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

The Department of Atomic Energy (DAE) and the United States National Aeronautics and Space Administration (NASA) affirm a desire to continue co-operation in space research of mutual interest for peaceful scientific purposes.

NASA and DAE accordingly agree to co-operate in two initial scientific experiments to be conducted by means of sounding rockets to be launched from a site in India near the geomagnetic equator. The two organizations also agree to continue discussions of additional experiments of mutual interest with a view to their future implementation. In addition, the two organizations agree to continue and expand a present program for the acquisition of satellite data.

(A)

The first experiment will be an investigation of upper atmosphere parameters by means of sodium vapor release payloads. It is anticipated that launchings of these experiments will take place beginning early in 1963, and that they will be carried out on a synoptic basis with launchings in other parts of the world.

To implement this project, DAE will use its best efforts to make available the following:

(1) Four sodium vapor release payloads.

(2) High speed cameras for photographing sodium release, and associated timing device. (Should these items not be available in India, NASA will attempt to make them available to DAE on loan.)

C O P Y

(3) An appropriate launching site near the geomagnetic equator in India.

(4) Launching site support facilities, including launching pad, buildings for control, assembly and testing of rockets and payloads, electrical power, and ground communications.

(5) Technical personnel for sounding rockets launching operations, and scientific personnel for data analysis.

(6) Meteorological data as required for launching operations.

NASA will use its best efforts to provide the following:

(1) Four Nike-Cajun (or equivalent) scientific sounding rockets with nose cones.

(2) An appropriate launching device on a loan basis.

(3) Training at NASA Centers for Indian personnel responsible for conducting launching operations.

(4) Necessary NASA advisory personnel to assist in launching operations.

(B)

The second experiment will be an investigation of the equatorial electrojet by means of sounding rockets carrying magnetometer instrumentation. It is anticipated that the first launching of this experiment will take place in 1963.

To implement this project, DAE will use its best efforts to make available the following:

(1) A sounding rocket launching site near the geomagnetic equator in India.

(2) Launching site support facilities, including launching pad, buildings for control, assembly, and testing of rockets and payloads, electrical power, and ground communications.

(3) Supplementary scientific experiment, for which room will be provided in the basic magnetometer payload housing.

(4) Magnetic ground observations from Indian stations.

(5) Meteorological data as required for launching operations.

(6) Personnel for sounding rocket launching operations, telemetry operations, and data analysis.

NASA will use its best efforts to make available the following:

(1) Nine Nike-Apache (or equivalent) sounding rockets with nose cones.

(2) Ground equipment and instrumentation on a loan basis, including an appropriate launching device, an instrumented telemetry trailer, and a Single Station Doppler or similar ground instrumentation for rocket tracking.

(3) Nine instrumented payloads for investigating the equatorial electrojet.

(4) Training at NASA Centers for Indian personnel responsible for telemetry, and any necessary additional training for Indian personnel responsible for launching operations.

(5) NASA advisory personnel for appropriate phases of the experiment.

(C)

NASA has made available on loan to the Physical Research Laboratory at Ahmedabad data acquisition equipment for satellites transmitting on 108mc, and the Laboratory has made available personnel to operate the equipment and participate in data reduction and analysis. In order to extend this co-operation NASA will make available on loan at Ahmedabad supplementary equipment to permit acquisition of data from satellites transmitting on a frequency of 136 mc. DAE will sponsor the continued staffing and operation of the facility as well as participation in data reduction and analysis.

No exchange of funds is contemplated in the above program.

NASA and DAE intend that the facilities to be established at the sounding rocket launching site near the geomagnetic equator will be made available for use by other countries for appropriate experiments in peaceful space research.

All experiments and experimental results will be open to the world scientific community.

(signed)

(Hugh L. Dryden)
Deputy Administrator
NASA

(signed)

(R. Shroff)
Deputy Secretary
DAE

RS:vva/1-10-62

C O P Y