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HISTORY OF THE ITALIAN SAN MARCO EQUATORIAL MOBILE RANGE

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ABSTRACT

Events leading to the development of the San Marco Equatorial Range are presented. Included are background information leading to the cooperative space program between the United States and Italy, conceptual planning, training activities, equipment design and fabrication, and range utilization. The technical support provided the San Marco Program by Scout Project Office, its Prime Contractor, and other NASA installations is described.

FOREWORD

This document was written under the direction of Mr. L. R. Foster, Scout Project Office, Langley Research Center, by the Vought Missiles and Space Company, LTV Aerospace Corporation in compliance with Task J of NASA Contract NAS1-10000. The purpose of this report is to record the events of the San Marco Project and the history of the San Marco Equatorial Mobile Range.

The report was prepared from data found in official letters, memoranda, reports, photographs, and other historical documents at the Scout Project Office and Vought Missiles and Space Company. Additional data was obtained in conversations with personnel from the Centro Ricerche Aerospaziali, the National Aeronautics and Space Administration, and LTV Aerospace Corporation. The events recorded in this edition occurred prior to 1 May 1971.

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SAN MARCO EQUATORIAL MOBILE RANGE

1.0 SUMMARY

The San Marco Equatorial Mobile Range, a fully equipped operational range, was established in Formosa Bay of the Indian Ocean off the east coast of Kenya, Africa for the purpose of placing small to medium sized satellites in orbits about the equator. The establishment of the range was accomplished through a joint and cooperative project, the San Marco Project, undertaken in 1962 by the Italian Space Commission of the National Council of Research and the United States National Aeronautics and Space Administration. The responsibility for the development and operation of the range was given to the Centro Ricerche Aerospaziali of the University of Rome.

To meet the objectives of the San Marco Project, activities were implemented which would train spacecraft engineers and range operational personnel, develop and test scientific spacecrafts, and acquire and activate the range. The objectives were achieved with the launching of the San Marco B spacecraft on 26 April 1967; successfully placing the first satellite into equatorial orbit and establishing the range as a complete operational launch facility.

The Italian Space Commission and the United States National Aeronautics and Space Administration entered into a second cooperative satellite project, San Marco C, in November 1967. The San Marco C spacecraft was placed in equatorial orbit on 24 April 1971.

On August 21, 1970, the United States National Aeronautics and Space Administration contracted the University of Rome to provide launch services at the San Marco Equatorial Mobile Range. Under terms of the contract, the Centro Ricerche Aerospaziali would launch three NASA Small Astronomy Satellites (SAS-A, B and C) and one NASA Small Scientific Satellite (SSS-A).

The NASA spacecraft SAS-A was placed in equatorial orbit on 12 December 1970; the first time that a United States satellite had been launched by another nation.

The San Marco Equatorial Mobile Range is available for use by any nation or group of nations interested in conducting peaceful scientific investigations of space and the upper atmosphere for peaceful purposes and within the framework of international cooperation.

The purpose of this report is to document the historical events of the San Marco Project and the development of the San Marco Equatorial Mobile Range.

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2.0 INTRODUCTION

Scientific space research for the United States is the responsibility of the National Aeronautics and Space Administration (NASA). The authority for NASA's international activities rests in Public Law 85-568 [Section 102 (C)] of July 29, 1958, which states that:

> "The aeronautical and space activities of the United States shall be conducted so as to contribute materially to . . ."
>
> "(7) Cooperation by United States with other nations and groups of nations in work done pursuant to this act and in the peaceful application of the results thereof . . ."

NASA's international activities are planned to provide opportunities for the participation of scientists and agencies of other countries in the task of increasing man's understanding and use of his spatial environment. The activities follow guidelines which establish a basis for sound programs of mutual value and contribute to the objectives of international cooperation.

Scientific space research for Italy is the responsibility of the Italian Space Commission of the National Council of Research. The development of scientific satellites and their launching is the prime responsibility of the Centro Ricerche Aerospaziali (CRA) of the University of Rome, a specialized laboratory in the field of aerospace research and technology.

Professor Luigi Broglio was the chairman of the Italian Space Commission and Director of the CRA during the inception and development of the San Marco Project. He remains the Director of the CRA.

The Italian Space Commission, after successfully accomplishing an Italian Space Program in 1960 and 1961, desired to further scientific research and technology in such a way as to train people and to prepare the Italian National industries for future and more ambitious programs. To achieve these goals, the Italian Space Commission formulated and proposed the "San Marco Project".

The Italian Space Commission in the San Marco Project proposed to make continuous measurements of atmospheric properties at altitudes around 125 nautical miles at the equator. This not only would provide information of a type not previously available but would provide study in a new geographical area. Very little data had been obtained on air density and molecular temperature in this region as no satellite had previously been placed in equatorial orbit.

To insert a satellite into equatorial orbit without a performance costing dog-leg maneuver, the launch site must be located near the equator. Since there were no equatorial ranges in existance, it was necessary to develop a new launch site. The only large land masses on the equator are in South America and Africa. There were potential problems associated with the acquisition of land for a new launch site in countries located near the equator. The launch technique proposed by the CRA envisioned a sea borne mobile launch system operating in international waters free from local problems of land based systems.

The San Marco Project involved both short and long term objectives with the ultimate objective being that of providing an operational launch system capable of accomplishing direct equatorial orbit in the most efficient and economical manner.

The historical events described herein have been grouped into four sections.

The first section describes the events which led to the establishment of the project, the project objectives and responsibilities, the development of personnel and procedures, and the development of the spacecrafts.

The second section describes the development of the San Marco Equatorial Mobile Range into a fully equipped operating range by tracing the facility and equipment from concept through first launch.

The third section concerns the range in operation and describes events that occurred following the first launch through the end of April 1971.

A fourth section covers the events planned for the future.

Appendix A is the 1962 Memorandum of Understanding, Appendix B is the Agreement notes, Appendix C summarizes the major milestones and Appendix D summarizes the support provided by Vought Missiles and Space Company and the Scout Project Office, Langley Research Center.

At some future date, additional sections may be added and the Appendices revised to include the events from subsequent time periods to perpetuate this historical record.

3.0 A PROJECT IS BORN

3.1 OBJECTIVES AND RESPONSIBILITIES

In October 1961 a group from the Italian Space Commission presented the San Marco Project proposal to the United States National Aeronautics and Space Administration at Langley Research Center Headquarters. Photographs of the Italian and NASA personnel at Langley Research Center in 1961 and again in 1962 are shown in Figure 1.

In a report (Reference 1) prepared by the University of Rome describing the San Marco Project, the objective of the project was stated as follows:

> "The project San Marco will be performed under the cooperation between the NASA and the Italian Space Committee, and it will have as objective the launching of a scientific satellite in an equatorial orbit by means of a Scout vehicle launched from a mobile base consisting of two floating platforms with movable legs."

The proposed project actually encompassed two objectives; a short range scientific objective and a long range operational objective with goals in future space work. The scientific objective was to obtain information on the atmosphere in the equatorial region, 200 to 300 Km high. Prior to San Marco, the available data regarding the density variation versus altitude had been obtained by sounding rockets (maximum altitudes about 200 Km) and by satellites (at altitudes generally above 300 Km). Under the F_2 layer, (300 to 400 Km) a considerable amount of data on the electrons total content was already available; however, daily and longitudinal variations were of special interest particularly in the area where the geographic equator and the magnetic equator coincide and at altitudes between 150 and 300 Km.

The operational objective was to establish a launch capability in an equatorial area for launching small to medium sized payloads. The new launch test facility would be available to any nation or group of nations interested in space research and exploration for peaceful purposes.

The San Marco Project was formalized on May 31, 1962 with the signing of a memorandum of understanding by the Italian Space Commission and the United States National Aeronautics and Space Administration providing for a joint and cooperative project. The memorandum (Appendix A) defined the goals and constraints of the project and the commitments of the cooperating agencies. The project consisted of three phases:

Phase I

- Train Italian space engineers.

- Train launch and range safety crews for Shotput vehicle.

- Flight test the principal elements of the scientific payload utilizing Shotput vehicle launched from Wallops Island and/or from an Italian platform located near the equator.

- Begin initial design of the equatorial launch complex.

Phase II

- Train launch teams for Scout vehicle assembly, checkout and launch and range operations.

- Place a prototype of the ultimate satellite in orbit utilizing a Scout booster launched from Wallops Island.

Phase III

- Place the proposed payload into equatorial orbit utilizing a Scout booster launched from a platform located in equatorial waters.

- Establish a fully qualified operational launch test facility.

The Italian Space Commission was to provide the range equipped with a Scout launch complex, the launch crew, and the scientific satellite. The National Aeronautics and Space Administration was to provide the Scout launch vehicle, the training services for the Italian launch crew and the tracking network.

The memorandum of understanding was confirmed by an official agreement between Italian Foreign Minister, Pietro Piccioni and Vice President Lyndon B. Johnson dated 5 September 1962. (Appendix B)

Thus, with a plan, a memorandum of understanding with the United States and a few determined scientists; the first complete space program undertaken by the Italians began to materialize. To meet the objectives of the project, activities were implemented along three lines with the activities extending across the United States and Italy to the East Coast of Africa.

Sufficient qualified personnel were not available to man such a complex and widely diversified undertaking; and because of this, the most important line of development concentrated on the training of personnel.

Another line of development entailed the spacecraft and its design, manufacture and flight qualification.

The third and perhaps most complicated line of development encompassed the acquisition and activation of a launch test facility with its launch complex and support facilities.

Figure 2 summarizes the development of the San Marco Project.

3.2 PERSONNEL AND PROCEDURE DEVELOPMENT

The San Marco Project was the first full-fledged space program to be undertaken by Italy. Since it included the building of a launch range as well as maintaining a launch capability, it became necessary to train Italian personnel for a variety of functions. Training programs were implemented in several locations to transfer the necessary knowledge within the required time frame to Italian personnel for them to effectively accomplish the objectives of the San Marco Project. In summary, the training was conducted as follows:

a. Goddard Space Flight Center, Greenbelt, Maryland, trained CRA engineers in all facets of spacecraft design and operation, data reduction systems, and dynamic balancing and testing.

b. Langley Research Center, Hampton, Virginia, provided instructions on assembly and checkout of the Shotput vehicle.

c. Wallops Station, Wallops Island, Virginia, provided information on range procedures and range safety practices and trained CRA personnel during the NASA launch operations.

d. LTV Aerospace Corporation, Vought Missiles and Space Company - Texas conducted classroom and on-the-job training in assembly, checkout, and launch operations of the Scout vehicle.

In this manner, there was developed an operational organization with the capability to man and operate a range and a highly proficient cohesive team through which the knowledge and skill could be applied to receive, checkout, and launch a booster vehicle and spacecraft.

3.2.1 Training Programs

The training programs for the CRA personnel included both formal classroom presentations and on-the-job training.

The training presented by Goddard, Langley, and Wallops Station encompassed a large amount of organizational philosophy and operational methodology rather than pure technical training as the CRA personnel possessed excellent technical backgrounds. Training was not accomplished through formal classroom presentations to a prescribed curriculum. Instead the

CRA engineers were integrated into the existing organizations working directly with their counterparts. Due to the nature and type training presented at these locations, training records were not documented.

Training was conducted by LTV Aerospace Corporation, Vought Missiles and Space Company - Texas at its Dallas facility between August 19, 1963 and October 11, 1963. Approximately 35 members of the CRA were trained in the operational requirements of processing and launching a Scout vehicle. The training included 3 weeks of formal classroom work in the function and operation of the systems of the Scout vehicle and 5 weeks of on-the-job training with vehicle S-137 in the areas of factory manufacturing, quality control, vehicle processing and prelaunch checkout.

Subsequent to the training at the factory, field operational training was scheduled to be conducted by Vought Missiles and Space Company, Wallops Island field personnel, at Wallops Island. Unfortunately, this field training effort did not materialize as scheduled. The Scout vehicle was undergoing a series of design improvements which prevented vehicles from being delivered and processed in the field. In addition, range facilities and requirements had not been resolved. However, in spite of these conditions, some training was accomplished through informal lectures, shop demonstrations, observation and on-the-job training.

A new training plan (Reference 2) was prepared and a formal field operational training program was implemented 1 August 1964. Advantage was taken of every opportunity for training and available hardware was utilized to the fullest extent possible. CRA personnel participated by observation or personal performance in almost every phase of the receipt-through-launch cycle of five Scout vehicles at Wallops Island.

Vehicle S-137R could conceivably be called the final examination of the San Marco Training program. A team of Vought Missiles and Space Company - Wallops Island personnel was formed to monitor and assess the CRA performance. The vehicle arrived at Wallops Island on 3 November 1964 and was successfully launched 15 December 1964. This launch was an all-Italian endeavor and gave Italy the distinction of becoming the third nation to place a satellite in orbit following Russia and the United States. For the record, Great Britain and France had satellites in orbit, but they had been placed there by United States launch teams.

3.3 SPACECRAFT DEVELOPMENT

Not only did the San Marco project involve a new area of spacecraft operation, it also included a new concept in spacecraft design. For this reason, it was proposed that the experiment concept be validated utilizing a smaller booster before committing to launch with a Scout booster and to flight qualify the spacecraft before committing to launch from the San Marco Range. The approach then was to flight qualify the air density experiment utilizing Shotput vehicles and to flight qualify the spacecraft

utilizing a Scout vehicle. Three Shotput launches were planned with the first two to be from Wallops Island. The third Shotput launch would be from a platform in equatorial waters off the coast of Kenya, Africa, if practical. The spacecraft launch with Scout would be from Wallops Island.

3.3.1 Shotput Launches

The experiments and flight qualification test spacecrafts were designed and fabricated in Rome by CRA personnel. Launch operations with the first flight unit were initiated early in 1963. The first unit was mated with the second stage of Shotput 6 vehicle at Langley and delivered to Wallops Island in April for final spin balancing. Shotput 6 vehicle was launched from Wallops Island 21 April 1963. All spacecraft systems functioned properly except for the yo-yo despin system. This system failed to reduce the spin rate as required in order to make atmospheric measurements with the drag balance experiment. The flight was considered a success despite the failure as valuable data were obtained from the associated subsystems.

Improvements were incorporated into the second flight unit by CRA personnel and Shotput 7 vehicle with flight unit 2 on board was successfully launched from Wallops Island 2 August 1963. Figure 3 is a photograph of a Shotput launch vehicle.

Based on the results of Shotput 6 and 7 launches, the air density experiments were considered satisfactorily flight qualified and required no further tests. However, by mutual agreement of CRA and NASA, the decision was made to launch the third flight unit from the Santa Rita platform located in Formosa Bay off the coast of Kenya, Africa. It was felt that a launch from the proposed range site at the earliest opportunity would serve several very desirable purposes. In addition to verifying the compatibility of the spacecraft and ground station equipment, the launch would establish a base of operations and test the concept of launching from a mobile platform with its peculiar logistic problems. All of this could be accomplished with the smaller less expensive vehicle prior to committing to the larger Scout vehicle.

Due to a combination of late arriving balancing equipment at Rome and a predicted early monsoon season at the launch site, the proposed launch was cancelled and the Shotput 8 vehicle placed in storage. In light of the circumstances, the CRA decided that the Shotput 8 launch objectives could be achieved by using Nike-Apache vehicles. A series of Nike-Apache launches from the Santa Rita platform followed with launches on March 25, March 30, and April 2, 1964.

3.3.2 San Marco A Spacecraft

Both the prototype and flight units of the San Marco A spacecraft were designed and fabricated in Rome at the CRA facilities. Operational

and environmental tests were also conducted in Rome, with the prototype being integrated and electrically tested early in August 1964. Mechanical fit checks and radio-frequency-interference (RFI) tests were conducted at Vought Missiles and Space Company, Dallas, Texas in October 1964 with the prototype spacecraft. In November 1964, the prototype spacecraft was moved to Blossom Point, on the Eastern shore of Maryland, where compatibility tests were conducted to assure that all tracking, telemetry, and command links between the San Marco spacecraft and the NASA Satellite Tracking and Data Acquisition Network (STADAN) were compatible. Meanwhile, the flight spacecraft arrived at Goddard Space Flight Center (GSFC) from Rome on 20 October 1964 for dynamic balancing. On 17 November, the spacecraft was mated to the Scout vehicle fourth stage at Wallops Island and the assembly spin-balanced.

It was December 15, 1964 that Scout vehicle S-137 was successfully launched from Wallops Island to place the San Marco A spacecraft, a 250 pound 26 inch sphere, into orbit. The spacecraft, designed and fabricated by CRA personnel in Rome, was launched with CRA personnel handling all phases of the launch and climaxed two years of intensive training for about 75 Italian technicians and engineers. The San Marco A launch marked the first time in the NASA international cooperative program that a satellite launch operation had been conducted by a team of foreign nationals and the first use of a satellite fully designed and built in Western Europe. Figure 4 is a picture of the San Marco A launch from Wallops Island. The results of the mission were reviewed and it was the mutual decision of the CRA and NASA to proceed with the next phase of the San Marco Project. The San Marco A spacecraft decayed from orbit September 13, 1965.

3.3.3 San Marco B Spacecraft

The San Marco B spacecraft was also designed and fabricated by CRA personnel at Rome. The basic design of the San Marco B was the same as San Marco A with improvements in operation and reliability. Two spacecraft were fabricated; a primary flight unit and a back-up unit.

Integration and environmental tests were conducted in Italy at the CRA facilities on both the flight unit and the back-up unit. The back-up unit was shipped to Vought Missiles and Space Company at Dallas, Texas in 1966 where a mechanical fit check with the Scout vehicle and radio-frequency-interference tests were conducted. As with the earlier spacecraft, STADAN compatibility tests were conducted at Blossom Point on the Eastern shore of Maryland during 1966 using the back-up unit.

Dynamic balancing of the spacecraft/Scout fourth-stage combination posed a problem. In the past in Scout vehicle processing, the spacecraft/fourth-stage assembly was dynamically balanced at the launch site and then mated as an assembly with the rest of the Scout vehicle at the launch emplacement. With the San Marco B spacecraft, things were not quite so simple because the spacecraft was in Italy, the spin facilities were in

the United States and the launch site was off the east coast of Africa. To follow the established routine would have added 8000 miles of transportation to the spacecraft and would have created a difficult shipping situation for the spacecraft/fourth-stage assembly. Based on the Scout fourth-stage interchangeability study (Reference 4) which had just recently been completed, the decision was made to balance the spacecraft and the fourth stage separately, ship them to the range, and then assemble them. As a result, the spacecrafts were balanced in Rome, the fourth stage was balanced at Wallops Island and the mating of the flight spacecraft with the fourth stage was performed aboard the San Marco platform at the range. The flight spacecraft and the back-up were shipped in March 1967 from Rome through Nairobi to Malindi by commercial air where they were moved by motor truck to Base Camp and to the platform by motor launch.

The San Marco B spacecraft was successfully launched with Scout vehicle S-153C on April 26, 1967 to become the first satellite to be placed in equatorial orbit. All systems performed normally from launch until mid-August 1967 when the loss of power supply voltage prevented further command of the satellite. Re-entry occurred on October 14, 1967, during orbit 2680. The satellite had been in orbit for 171 days.

Since the launching of San Marco B spacecraft, development has continued on other spacecraft for launches from the San Marco Range. The San Marco C spacecraft was launched in April of 1971 and is described later in the section - The Range In Operation. The San Marco D spacecraft is in the conceptual development stage and other experiments are in a development stage. The San Marco B and C spacecrafts are shown in Figure 5.

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4.0 A RANGE IS BUILT

4.1 CONCEPT OF THE RANGE

As mentioned in the introduction, a new launch site was required near the equator if equatorial orbit was to be achieved without a performance costing dog-leg maneuver. Selection of a site near the equator was complicated in that the large land masses on the equator were in South America and Africa and some of the countries located near the equator were having political adjustments. To achieve the short range scientific objective of launching a satellite in an equatorial orbit as well as the long range operational objective of establishing a launch capability in an equatorial area, the Centro Ricerche Aerospaziali proposed launching from a mobile base consisting of two floatable platforms equipped with movable legs which could be extended downward to rest on the ocean floor. (Reference 1)

This launching technique provided several technical advantages; e.g.,

a. A firing range for satellite launches for countries which are not in a suitable geographical location to install such a launch site.

b. The capability of launching satellites from most any point of the world, while in most cases remaining in international waters.

c. The satisfaction of the needs of launches where a particular orbit must be accomplished, such as with an equatorial satellite.

d. An economic solution, through the use of the movable legs, to obtain a stabilization system for a floatable platform on the sea.

The type of platform envisioned for use was a modified off-shore oil drilling platform. This type platform, manufactured in Italy and in the United Stated had been widely used throughout the world for off-shore oil drilling. From this experience, indications were that this type platform could be readily adapted to a launch platform.

The concept presented in 1962 by the CRA is depicted in Figure 6. One platform, designated SM-1, was to be the launch platform on which the vehicle would be assembled, checked out, and launched. The other platform, designated SM-2, was to be the control platform on which the range support equipment and accommodations for technical and scientific personnel would be located. Supporting the mobile launching base would be a supply ship, a helicopter, and two tugboats to tow the platforms to the launching point.

In operation, the platforms would be towed to the selected launch location, the legs lowered to the ocean bottom and the hull structure self-elevated on the legs to the desired height above the water surface for launch operations. To move off location, the procedure would be reversed.

The choice of location for the San Marco Project launch site was narrowed to three areas off the coast of Kenya, Africa: the Manda Roads/ Lamu Bay area, the Formosa Bay area and the Malindi area. These areas were considered prime areas for the following reasons:

a. The areas lay between latitude 2° 15' S and 3° 20' S; therefore, the launch area could be considered as quasi-equatorial;

b. The territorial limits of Kenya extended only 3 miles out, which could allow the platforms to be supported on the sea floor outside this limit and be in international waters; and

c. Reasonably quick connections to prominent harbors and towns could be established.

The harbor at Mombasa offered excellent port facilities for year round loading and unloading operations. In addition, the airport at Mombasa provided air connections to Nairobi and thence to most parts of the world. For these reasons, Mombasa became a contributing factor in the selection of a launch site. The geophysical characteristics of the individual sites being considered were also contributing factors to the final selection.

Of the three sites considered, a launch site located in the Manda Roads/Lamu Bay area extending between latitude 2° 15' S and latitude 2° 25' S would be nearer the equator than either of the other sites; the Lamu Harbor would be within 15 miles of any acceptable location; refuge could be taken behind the Lamu, Manda, or Patta Island in the event of extremely bad weather conditions; and the distance to Mombasa Harbor would be no more than 120 nautical miles.

The Formosa Bay area between latitude 2° 30' S and latitude 3° S offered many good launching sites, the geophysical configuration would provide protection from winds from several directions, the distance to Lamu Harbor would be no more than 45 nautical miles, the distance to Malindi no more than 40 nautical miles and the distance to Mombasa Harbor no more than 90 nautical miles.

The Malindi area between latitude 3° 15' S and latitude 3° 20' S would be less than 10 nautical miles from Malindi and no more than 55 nautical miles from Mombasa.

These considerations coupled with the ocean bed condition at each area resulted in the selection of Formosa Bay as the best area. However,

the other two areas were deemed suitable and could be used if Formosa Bay should become unavailable for some unforseen reason. The exact location would be determined later.

The design concept of the platforms followed very closely the design of existing off-shore oil drilling platforms. Corrugated steel plates formed the sides and bottom of the platform structure. The hull and inner bottom were arranged into water tight compartments for installation of equipment and operational facilities as well as storage of hardware and consumables.

The elevating mechanism (movable legs) was to have the capacity to raise a platform with a maximum load at the rage of approximately one foot per minute. The maximum water depth in which an operational setup would be attempted was specified as 100 feet; and in addition, operations would be confined to soil bottoms having a shear value of 0.25 tons per square foot or more.

The platforms were to be designed for maximum wind velocity of 100 mph including gusts. The wave forces were assumed to be associated with storm waves of a maximum height of 25 feet above mean sea level.

The general plan for the launch platform, SM-1, is shown in Figure 7. The design length of the platform was 185 feet with a maximum width of 152 feet. Hull depth was 22 feet. The vehicle assembly checkout area would be located in a compartment below deck measuring 20 feet wide by 85 feet long. For launch operations, the deck forming the roof portion of the assembly area would be removed and the assembled vehicle raised on its assembly platform to mate with the launcher in a horizontal position. With vehicle attached to the launcher, the vehicle assembly platform would then be lowered back into the assembly area and the deck repositioned. The launcher would now be elevated and rotated approximately 180° to the desired launch azimuth. As shown in Figure 7, the Blockhouse was to be located in a compartment below deck forward of the assembly area. Personnel inside the Blockhouse would be protected by a blast wall.

The general plan for the range support and crew quarters platform SM-2 is shown in Figure 8. The design length of this platform was 120 feet with a maximum width of 115 feet. Depth of hull was 13 feet. The platform was to contain all the range support equipment such as radar, telemetry, command destruct, communications, etc. as well as accommodations for the personnel required to operate and maintain the equipment. Crew quarters would be located on the first deck of the platform building with the range support equipment located on the second deck. Extensive plans were made for personnel comfort and logistics support.

A 4500 HP and 1600 HP tugboat would be used to tow the platforms to the launching area. The support ship was to be supplied by the Italian Navy and would be used as an escort to the convoy. The dimensions of the platforms would allow the convoy to pass through the Suez Canal.

Mombasa, with its harbor and airport, was considered the most suitable support center. Transportation between Mombasa and the platform would be by helicopter (90 minutes) or open sea motor boat (3 hours 30 minutes). Other motor boats would be used for transportation between platforms.

The San Marco Project as proposed in 1962 included sounding rocket launches in connection with the Scout vehicle launch. Two multi-purpose rail launchers were to be located on the stern of SM-1 platform. Vehicle control panels would be located in the Blockhouse. Photographic stations would be established in Kisimayo, Nairobi, and Mombasa. The project as first proposed was estimated to require 22 months to accomplish.

4.1.1 Environmental and Motion Studies

Since the Scout vehicle and its Ground Support Equipment were not specifically designed to operate from a water based platform, two studies were conducted to determine the feasibility of such launches. The two studies were an Environmental Study and a Platform Motion Study.

The San Marco Environmental Study Report (Reference 5) was prepared for NASA to establish the feasibility of launching a Scout vehicle from a water based platform located in the Formosa Bay area off the east coast of Kenya, Africa, with respect to the total environment encountered. The total environment included the normal ambient conditions encountered as well as those parameters which are induced as a result of transportation and launch platform characteristics. Each component and subsystem of the vehicle was evaluated in light of the total environment in order to establish the adequacy of the total Scout system. The degree of reliability attainable for an operation of this type was assessed. The study began in December 1962 and was completed in May 1963. The results of the study clearly showed that the concept was sound and feasible.

The San Marco Launch Platform Motion Study Report (Reference 6) followed the environmental study and was performed to determine the motion environment experienced while on the launch platform due to the action of the waves on the platform. Several sea conditions were investigated in order to determine the platform motion under the most adverse conditions expected to occur. The principal variables computed in the analysis were launch platform motion, Scout vehicle motion at the gyro location (Vehicle station 115), and envelopes of maximum loads imparted to the Scout Vehicle and Mark II Launcher by the platform motion. Results of the analyses indicated that the proposed platform would be quite stable throughout the range of sea conditions which were considered likely to occur at the launch site.

4.2 FACILITIES AND EQUIPMENT ACQUISITION

The development of the operating range progressed through the conceptual stage and feasibility studies and entered into the task of acquiring

and accumulating hardware to be assembled into what was to become the San Marco Equatorial Mobile Range.

4.2.1 Santa Rita and San Marco Platforms

The first significant piece of the San Marco Range to be acquired by the CRA was a 1,500 ton off-shore oil drilling platform. The platform was built in the United States in 1959 as Mobile Tender - Assisted Platform Number 9. The platform was delivered to the Italian oil exploration organization S.A.I.P.E.M. and was named "Scarabeo". The CRA obtained the Scarabeo from the Italian National Oil Company early in 1963.

For economic reasons and expediency in setting up a launch platform, it was decided that this platform should be converted into a launch platform. This created what might be considered the first iteration of the layout and general arrangement of the dual platform concept. The most significant changes from the original concept were the employment of a smaller platform than the proposed SM-1 launch platform and the relocating of the Blockhouse equipment to the SM-2 launch control platform. At the same time, changes were made in the platform names. The newly acquired oil drilling platform Scarabeo, to be converted to SM-1, was christened "Santa Rita" after the Patron Saint for things impossible. The SM-2 platform, yet to be obtained, was given the name "San Marco" after the Patron Saint for navigators. The configuration of the range envisioned for this iteration is shown in Figure 9.

Subsequent to the Shotput 7 launch in August 1963, the CRA and NASA had mutually agreed to launch a third spacecraft using a Shotput vehicle from the Santa Rita platform at the equatorial launch site off the coast of Kenya. As mentioned earlier, the Shotput launch was cancelled, but Nike-Apache launches were scheduled instead. Early launches from the Santa Rita at the equatorial site were highly desirable. It was felt that in addition to verifying the compatibility of the ground-station equipment and the vehicle telemetry equipment; the launches would serve to establish precedence for an operational base in the area, obtain the reaction of the local constituents toward spacecraft launches, and checkout the logistic problems associated with platform operations.

The Santa Rita platform was located in the harbor of Taranto, Italy in the early part of 1963 where refurbishment and conversion began in preparation for the forthcoming sounding rocket launches. A multipurpose launcher was purchased in the United States by the CRA and installed on the stern of the Santa Rita platform. The launcher was the same type used for the Shotput launches. A small shelter was constructed on the main deck to be used for vehicle assembly and checkout operations.

The Santa Rita platform departed Taranto, Italy December 21, 1963 in tow of a tugboat headed for Mombasa, Africa. Enroute, while sailing in the Indian Ocean, a storm was encountered and the platform had to be

cut loose from the tug. The platform remained adrift for several days until the storm subsided and the platform could be found and again taken in tow. After arrival at Mombasa on January 29, 1964, additional outfitting was accomplished in preparation for the Nike-Apache launches at the proposed range launch site.

Difficulties were encountered hindering the procurement of the San Marco platform, and as a result, a second iteration of the dual platform configuration was created. For the Nike-Apache launches at least, launch control would be located on board the support ship with underwater cabling connecting it electrically to the Santa Rita platform. This configuration is shown in Figure 10.

The platform and support ship were positioned at the range launch site on March 1, 1964. Nike-Apache rockets were launched from the platform on 25 March, 30 March, and 2 April 1964. At the conclusion of the sounding rocket launches, a study (Reference 7) was conducted by the CRA to evaluate the sounding rocket operational experience to assure that the plans being made for the operations with the Scout vehicle were still valid. The results of the study were published 12 May 1964. The platform was returned to Mombasa where the multipurpose launcher was removed and preparations started to convert the platform into a Scout launch complex.

During the time of the Nike-Apache launches, a design which would modify a Scout Mark II complex for installation on the Santa Rita platform was being prepared. Space limitations on the platform would not allow the entire shelter to be moved to permit erection of the launcher as is done with land-based installations. To accommodate this condition, the shelter included an accordian type retractable roof of French design. The proposed configuration of the platform is shown in Figure 11.

In this configuration, the vehicle would be assembled on a transporter in the shelter on the main deck. To get the transporter into and out of the shelter, the transporter would be built in three segments. The proposed sequence for unloading motors from the support ship and assembling the vehicle in the shelter was restrictive and required extra handling operations involving the transporter segments. Rails on the platform deck would guide the transporter segments laterally through the side doorway as well as fore and aft within the shelter.

The major steps of the proposed handling sequence included the following:

a. Load first stage of the vehicle onto the first segment of the transporter; move laterally into shelter and then aft to the rear of the shelter.

b. Load third stage of the vehicle onto the third segment of the transporter; move laterally into shelter and then forward to the front of the shelter.

c. Load second stage of the vehicle onto the second segment of the transporter and move laterally into shelter.

d. Mate fourth stage with third stage while on the third segment of the transporter inside the shelter.

e. Join the three segments of the transporter and complete the vehicle assembly.

A 1/20 scale model of the platform, shelter, vehicle and transporter segments was built by NASA to demonstrate the ability to bring each segment of the transporter, with motor installed, into the shelter with launch beam in the down position and complete the vehicle assembly.

Plans moved ahead for the design of the equipment to make up the proposed configuration. A cost proposal for the launcher was submitted to the CRA in May 1964 by Vought Missiles and Space Company, and in November of that year CRA asked NASA to act as procurement agent for the launcher.

About this time, a chance conversation between a member of NASA and a member of the CRA led to the ultimate solution of the dilemma that resulted in an unexpected turn of events. In the conversation, it was brought out that the U.S. Army had in its inventory floatable steel barges normally used to establish quick docking facilities at advanced operational sites. Furthermore, several barges were thought to be in surplus storage in the United States. A letter to the U.S. Army Materiel was initiated July 7, 1964, to determine the availability of one of these barges. A surplus barge with deck area approximately 90 feet by 300 feet, was located in a Naval Facility in the United States where it had been "mothballed" for about 7 years.

When the existence of the barge became known in October 1964, a study was conducted by the CRA to evaluate various combinations of platforms (Reference 8). The typical San Marco Range configuration used for the study consisted of the following elements:

a. A launch platform

b. A control platform (containing radar tracking equipment, telemetry system and logistical support facilities)

c. One or more auxiliary platforms

d. One or more cargo and support ships

e. Transportation system

f. Support equipment

Seven configurations were considered with each configuration composed of these elements. The variables consisted of the following:

a. Platform types (Off-shore oil drilling and self-elevating barge)

b. Distances between the various range components

c. Scout system support equipment modification and related procedures

d. Platform modification requirements

e. Hydrographic survey characteristics

f. Transport systems characteristics (including platform tugs)

g. Electrical connections between the various range components

h. Personnel lodging on the range (ships, trailers, or regular housing)

i. Possible utilization of equipment never used before

j. Physical location of telemetry and launch control equipment

k. Possible utilization of launch and/or control equipment that must be manned during the firing sequence

l. Usableness, set up capability and economic considerations

The study concluded that the preferable configuration consisted of one self-elevating pier barge for a launch platform and one off-shore oil drilling platform for a control platform.

Through the efforts of NASA Headquarters, a long term lease was arranged with the U.S. Army for the use of a barge. The barge was inspected on April 19 and 20, 1965 by CRA, NASA, and Vought Missiles and Space Company personnel. The barge is a floatable 3,000 ton self-elevating pier which can be raised above sea level by means of a lifting system consisting of 22 pneumatically operated cylindrical legs 6 feet in diameter and 100 feet long. The deck plan size is 90 feet by 300 feet. The depth of the hull is 13 feet. The barge, BPL 6665-F, departed from Charleston, South Carolina on 30 May 1965 in tow of an Italian tugboat bound for La Spezia, Italy, to become the "San Marco" platform. The acquisition resulted in a redirection of plans and established the third iteration of the dual platform concept.

The plan now was to virtually duplicate the Wallops Island Scout Mark II Standard Launch Complex (SLC) and the Standard Scout Systems Test (S^3T) equipment on the deck of the San Marco platform. Identical equipment and installations of the launcher, transporter, rails, shelter and winch would be utilized. The Scout vehicle would be assembled on the transporter in the shelter rather than in a separate assembly building as was done at Wallops Island. Functionally, the San Marco complex would

be identical to the Wallops Island Scout complex. Along with this redirection came the decision to house as much equipment as possible in trailer vans rather than in compartments of the platforms. This arrangement would not only provide a better utilization of space on the platforms, but would allow the equipment to be set up at a land base with a minimum of effort.

Since the launch and range control had already been planned to be on a platform like the Santa Rita, the change in plans posed no problem and work got underway converting the Santa Rita. Modifications were performed at Mombasa, Africa and required about 12 months to complete. During this time, the Santa Rita took on a new look -- that of a combined range control, blockhouse, and logistic facility. The layout and general arrangement of the platform is shown in Figure 12. Photographs of the Santa Rita Platform at Mombasa Harbor are shown in Figure 13.

Nine portable trailer vans were positioned on the main deck to house the launch support and blockhouse equipment. Built onto the main deck and rising above these vans were crew quarters which comprised the first deck. The second deck located directly above the crew quarters became the dining area. The Range Control Center and the Communication Center were installed in two adjacent compartments below the main deck.

Four of the vans positioned on the main deck contained the vehicle control equipment. Vans number one and number two were joined along one side to form the Vehicle Control Center (Blockhouse). Installed inside these vans were the launch control consoles manufactured by CRA personnel in Rome. The relay racks and power supplies for the vehicle control equipment were installed in van number three. Installed in van number four were the terminal racks and junction boxes to electrically interconnect the vehicle control equipment.

The equipment installed in the Communication van was primarily for on-board interplatform communications and included such items as the telephone switchboard and intercom main station.

The AN/MPS-19 radar system was housed in two trailer vans that were located on the stern of the Santa Rita platform. The antenna was mounted on the starboard van which contained the transmitting and receiving portions of the system. The computer portion was installed in the port van. The radar system was acquired from the Sardinia Range and had been used in conjunction with the Jupiter program. Two plotboards on which to display the radar were installed in the Range Control Center below deck.

The trailer van housing the Telemetry System was located on the forward center of the main deck. The auto tracking antenna was installed on top of the starboard leg of the Santa Rita platform. The Telemetry System was also acquired from the Jupiter Program.

The trailer van housing the Command Destruct System was positioned on the port side of the platform main deck.

Installed in the Range Control Center were the Radar and T/M Plotboards, TV monitors and range safety and control consoles. The equipment for platform-to-shore type communications was located in the Communications Center adjacent to Range Control Center.

A tower with five anemometer transmitters was installed atop the port leg of the Santa Rita platform and connected to readout instruments in the below deck Communication Center. This installation formed a part of the meteorological data gathering facilities for the range.

Other range support facilities that were installed aboard the Santa Rita included fire fighting and emergency equipment, camera stations, and camera control, sky screens, and a Mark 51 modified optical tracker.

Frequencies assigned for the command destruct receiver, the telemetry transmitter and the radar beacon required certain coordination before the operational phase began as the San Marco Project would be operating in Region I of the Radio Frequency Allocation Table.

The international aspect of the San Marco Project required United States State Department cognizance of the frequency assignments and allocations. NASA was to perform all the coordination and assign specific frequencies. It was decided that the frequencies to be used by the onboard RF systems in the San Marco Scout would be the same as those used for Scout launches at Wallops Island. The NASA coordinated the frequency assignments with the State Department and the foreign governments involved.

Modifications to the Santa Rita were completed and by August 28, 1966, all the trailer vans had been positioned on the main deck and checkout of system segments was being performed. By November, the platform was ready to tow to the launch site.

Meanwhile, the San Marco platform arrived at La Spezia, Italy in June 1965 and refurbishment and modification work was initiated immediately. Platform support utilities such as electrical systems, fresh water systems, fuel oil systems, salt water systems, and fire fighting systems were either refurbished, modified, or installed new as required. An opening was made through the platform hull beneath the launcher location to allow a free discharge path for the vehicle exhaust gases. The transporter rails and shelter rails were installed as well as the shelter winch. On March 4, 1966, the Scout Mark II launcher arrived by ship from the United States and was transferred on board the San Marco platform.

March 25, 1966, the platform departed La Spezia, Italy under tow of an Italian tugboat bound for Mombasa, Africa. The platform was tied up in the Mombasa Harbor on 6 May 1966 where modification work and installation of equipment was resumed. The layout and general arrangement of the platform is shown in Figure 14. Photographs of the platform at Mombasa Harbor are shown in Figure 15.

The shelter parts, arriving at Mombasa by ship, were assembled on the deck of the San Marco platform. Movable booms were installed in the shelter to duplicate the checkout area at Wallops Island.

The S.S. Australian Gulf arrived in Mombasa August 29, 1966, to deliver the S^3T equipment for the San Marco platform. The S^3T checkout consoles which had been manufactured by CRA personnel at Wallops Island were installed in two mobile trailer vans positioned alongside the shelter and connected to junction boxes in the shelter by means of flexible cables. Thus the checkout setup was made functionally identical to that at Wallops Island and the Vought Missiles and Space Company - Texas factory.

Two other trailer vans were placed aboard the platform. The Operations trailer van provided on-deck office space for the platform supervisor. The other van housed the machine tool equipment used for maintenance and repair operations. The small metal shelter used on the Santa Rita for vehicle assembly during the sounding rocket operation was transferred to the San Marco and placed on the port side, bow end of the platform. Air conditioning was added to the structure to provide environmental controlled storage for the solid propellant rocket motors. Eight 100 KW diesel motor generators were installed on the deck to provide electrical power for the platform. These generators were obtained from the Italian Jupiter Program. The vehicle transporter, a Standard Scout transporter, arrived at Mombasa on the same ship with the shelter. The transporter was transferred on board the platform late in 1966. The hydrogen peroxide servicing equipment was installed in a compartment below deck on the starboard side near the stern end of the platform.

One vital piece of equipment located on the deck of the San Marco platform is a 35-ton mobile crane. (Figure 16) This crane was manufactured in the United States and had seen about 25 years service with the U.S. Army. During the negotiations with the Army for the San Marco platform, CRA personnel discovered the crane as surplus equipment and immediately began proceedings to obtain it for the San Marco Project. The crane was placed aboard the San Marco before it departed the United States and has since remained on board to provide the means for handling equipment and material on the platform deck.

By November 1966 equipment installations and modifications had progressed to the point where both platforms were ready to be moved into position in Formosa Bay. There they would be electrically connected by underwater cables to complete the launch complex system.

4.2.2 Ground Support Equipment

The previous paragraphs centered on the acquisition of the platforms and only mentioned the major pieces of Ground Support Equipment as they became a part of the platforms. The following paragraphs document the acquisition of the Ground Support Equipment.

4.2.2.1 Launcher, Shelter, and Vehicle Handling Equipment - A sketch of the Scout Mark II launcher, transporter, and shelter is shown in Figure 17.

Although the final decision on the platform configuration had not been reached, acquisition of a Mark II Scout launcher was initiated. The launcher is a hinged structure which can be used in a horizontal position for launch preparations and then with shelter rolled back, elevated to any position up to vertical for launch. The launcher can be rotated on its base to permit azimuth control.

A cost proposal for the design, manufacture and test of a Mark II Scout launcher was submitted to the CRA in May 1964 and in November of that year, CRA asked NASA to act as procurement agent for the launcher. Negotiations were completed March 3, 1965, and the launcher was fabricated under contract to NASA. In December 1965, the launcher was given a thorough structural test using a simulated Scout vehicle which matched the 20-ton launch weight of the actual vehicle. The launcher was elevated and rotated into launch position with the 72-foot simulated vehicle installed. Wiring circuits were checked, rocket retaining arms cycled and umbilicals pulled to simulate actual prelaunch procedures. Production and tests of the launcher were completed and the assembly accepted by NASA on 6 January 1966 with acceptance by CRA the following week. The launcher was transported to Houston, Texas where it was loaded aboard a ship on February 18, 1966 for shipment to La Spezia, Italy.

Also in Figure 17 are two photographs of the launcher taken during production and tests and one photograph of the launcher after it was installed on the San Marco platform.

Early in 1965 the CRA began to finalize equipment requirements and to place orders for material. The major pieces of equipment, in addition to the launcher, included the shelter, transporter, blockhouse equipment, checkout equipment and vehicle handling and servicing equipment.

In July 1965, the CRA contracted for the shelter, transporter, mechanical GSE and hydrogen peroxide service unit. Delivery to CRA was at the point of manufacture with CRA making arrangements for transportation to Mombasa.

The photographs in Figure 18 show the shelter being assembled on the San Marco platform at Mombasa.

The remainder of the vehicle handling equipment was manufactured in the United States and was delivered to Mombasa.

The launcher, shelter, and transporter under operational conditions are shown in Figure 19. In the upper photograph, the transporter is being removed from beneath the vehicle after the shelter was removed. The other photograph shows the launcher and vehicle raised to the vertical position.

4.2.2.2 Checkout and Blockhouse Equipment - Complete sets of drawings for Standard Scout System Test equipment (S^3T) and Blockhouse equipment were supplied to the CRA by Vought Missiles and Space Company, Texas through the NASA.

At Wallops Island a small building was made available to CRA personnel where they modified the design and built the S^3T checkout equipment. The modifications involved changing the mechanical aspects of the equipment to fit into trailer vans rather than an Assembly/Checkout Building. CRA personnel purchased the material and manufactured and assembled all of the S^3T equipment for the San Marco Range. Vought Missiles and Space Company provided technical support to the CRA from February 22, 1965 through April 22, 1966. The completed S^3T equipment was transported from Wallops Island 15 May 1966 to New York for further shipment to Mombasa on 23 July 1966.

Meanwhile, at the CRA facility in Rome, CRA personnel were modifying the basic design of the Scout blockhouse equipment for use with trailer vans and the underwater cables at the range. As with the S^3T equipment, CRA personnel acquired the material, manufactured and assembled the Blockhouse equipment. Vought Missiles and Space Company provided technical support to the CRA from 30 May 1966 to July 1966. The Blockhouse equipment was shipped from Rome to Mombasa on 18 July 1966.

Throughout the S^3T and Blockhouse equipment modification designs, the CRA maintained standard Scout configuration such that the San Marco installation is functionally identical with the Scout complexes at Wallops Island and Vandenberg Air Force Base, California.

4.2.3 Base Camp

The original concept of the range system included a landbased area from which logistic support could be provided to the platforms in Formosa Bay. Mombasa, with its harbor and airport, was considered to be the most suitable support center for transportation. As the project developed, it became apparent that a base camp located on the coast as near as possible to the platforms was very desirable as a staging area for platform operations.

A site was selected on the coast near the village of Ngomeni, about 20 miles north of Malindi and 90 miles north of Mombasa. A plot of land 75 meters by 126 meters was acquired on long term leases from the property owners and was sanctioned by the government of Kenya.

Ground was broken in September 1966 and by December 1966 the Base Camp was considered fully operational. Four tents had been erected on concrete slabs; one open building, i.e., a concrete slab with a roof, constructed; and a boat dock constructed. Some scenes at base camp and the general arrangement of the camp are shown in Figure 20.

The base camp would provide personnel accommodations in the form of barracks, kitchen and dining hall. A radio station was set up to provide communications with the platforms. The boat dock was sufficient to accommodate the shallow draft boats that would be used for transportation of personnel and equipment to and from the platform.

4.3 RANGE ACTIVATION AND VALIDATION

If a single date could be designated as the start of activation of the range, it would be November 10, 1966. On this date, the San Marco platform was towed to Formosa Bay and positioned with the launcher facing east. The San Marco was followed by the Santa Rita on 26 November 1966.

The platforms were positioned near the southern end of Formosa Bay about 3 miles off shore. The geographical location of the launcher on the San Marco platform was determined to be 40° 12' 45" East Longitude and 2° 56' 18" South Latitude. Figure 21 shows the general location of the launch site in relation to Kenya and the towns of Nairobi, Mombasa, Malindi, and the village of Ngomeni. Also shown is the relationship of the platforms with base camp as well as the relationship of the platforms with each other.

A small four-legged auxiliary platform was constructed close off the stern of the Santa Rita to provide a location for six 100 KW diesel driven motor generators. These generators were obtained from the Italian Jupiter Program and installation was started December 16, 1966. This power plant serves the Santa Rita platform equipment and the launch equipment on the San Marco platform during launching operations.

The first underwater cable which electrically ties the San Marco and Santa Rita platforms together was laid 20 December 1966. By January 17, 1967, a total of twenty-one underwater cables had been laid and terminated in junction boxes on each platform. Photographs of the cable laying operation are shown in Figure 22.

With both platforms now in position, electrically connected, and all equipment installed and checked out; the last task remaining before launching a vehicle was to demonstrate and validate the total range system. The platforms as they looked in Formosa Bay in 1967 are shown in Figures 23 and 24.

Demonstration and validation was accomplished by performing complete receipt, assembly, checkout and countdown cycles using Scout vehicle S-144. Dummy motors were utilized since the operation would not culminate in a launch. The mock countdowns exercised all facets of the range system including both short and long haul communication and STADAN. Except for the dummy motors, the vehicle configuration was in every respect a flight vehicle. The final mock countdown was performed with live pyrotechnics to validate safety procedures and equipment readouts.

Processing of the vehicle was performed in accordance with Scout Standard Procedures that had been modified to account for the unique conditions at the range. The processing of vehicle S-144 served as validation for the procedures which form a part of the total range system.

Processing of vehicle S-144 began with the receiving and inspection procedures on 23 January 1967. Vehicle buildup operations followed with the first three stages completed on the 28th of January. Mating of the first three stages was completed on 4 February. The fourth stage with the prototype payload was installed Wednesday, 15 February 1967, and on the following day the All Systems and RFI checks were performed. Checkout of the launcher was completed on the 19th and the vehicle loaded onto the launch pins the following day.

Prelaunch operations proceeded without major difficulties and on 24 February a practice fueling and defueling operation was conducted using deionized water. Countdown dress rehearsals began 25 February with the initial practice countdown completed Monday, 27 February 1967. The final dress rehearsal with live pyrotechnics was performed 7 March 1967 to complete the demonstration and validation of the total San Marco Range system. Vehicle S-144 was immediately removed from the launcher, disassembled and the sections returned to their shipping containers.

4.4 FIRST LAUNCH

Scout vehicle S-153 was selected to place the San Marco B payload into equatorial orbit from the San Marco Range. Vehicle S-153 was a standard "B" configuration Scout comprised of Algol II, Castor II, Antares II, and FW-4S motors. The vehicle transition sections were manufactured and checked out by Vought Missiles and Space Company - Texas. CRA personnel observed the checkout. The sections were shipped by air carrier to Kenya, Africa arriving in Nairobi 23 October 1966.

CRA and NASA personnel inspected the motors at Wallops Island and on 16 January 1967, the motors were shipped by truck to Earle NAD, New Jersey. The motors were loaded aboard a ship which departed the United States 22 January 1967 and arrived in Formosa Bay March 2, 1967. Off-loading was delayed until the following day. To transfer the cargo from ship to platform, the ship stood off from the platform about 15 feet. The ship's crane was used to hoist the vans to a position approximately midway between the ship and platform and about even with the platform deck. From this position, a mid-air transfer to the San Marco mobile crane was accomplished. A photograph of the transfer is shown in Figure 25. Off-loading operations required two days to complete.

The Telemetry van was declared operational after installation of the tracking antenna on the Northeast support leg of the Santa Rita platform. Checkout of the antenna was accomplished by carrying the T/M transmitter

from vehicle S-144 aloft in a light aircraft flying at various altitudes and positions.

Processing of the vehicle was performed in accordance with the Standard Scout Procedures which had been validated at the range with vehicle S-144.

The flight payload was brought aboard the San Marco platform 10 March 1967.

All vehicle and launcher prelaunch checks were completed and the vehicle loaded onto the launcher pins on Saturday, 15 April. Scout vehicle S-153 was launched 26 April 1967, placing the San Marco B payload into equatorial orbit and establishing the San Marco Equatorial Mobile Range as an operating range (Figure 26).

Technical assistance for the launch operation was provided by representatives of NASA and Vought Missiles and Space Company.

The San Marco B/Scout S-153 launch from the San Marco Equatorial Mobile Range completed the San Marco Project initiated by the signing of the Memorandum of Understanding in 1962. The short range scientific objectives as well as the long range operational objectives were achieved. The atmosphere was successfully investigated and a launch capability was established in an equatorial region. The range facility was now available for use by any nation or group of nations interested in conducting space research and exploration for peaceful purposes and within the framework of international cooperation.

Proud of its accomplishments but not content, the CRA instigated plans for improving the range and implemented plans for future use of the range.

5.0 THE RANGE IN OPERATION

(May 1967 thru April 1971)

This section encompasses the activities that occurred following the first launch in 1967 through April 1971.

Long before the first San Marco/Scout launch made history, plans were being made for other launches. Potential range users throughout Europe and other parts of the world were being advised of the capabilities of the San Marco Equatorial Mobile Range. Such projects as San Marco C, Small Astronomy Satellite (SAS), and Small Scientific Satellite (SSS) were already identified and in the formulating stages.

In order to provide the best services possible to potential range users, the CRA focused its attention on improving the range systems and maintaining launch readiness and crew proficiency.

5.1 IMPROVEMENTS IN RANGE SYSTEMS

Although the San Marco B/Scout S-153 launch achieved full success, deficiencies were noted in the operations and logistics areas of the range. The entire operation was reviewed by the major participants to identify problem areas and to determine improvements that could be made at the range. At the direction of NASA, a report (Reference 10) was prepared recommending improvements to the San Marco Launch Complex for future Scout operations. A meeting was held 19 September 1967 at NASA headquarters to review the San Marco B launch operation and to discuss future launch requirements for the range and recommended improvements to the range.

5.1.1 Communication Systems

The communication system, both short and long range, did not provide reliable uninterrupted communications. The system effectiveness was hampered by such things as radio transmission being dependent on atmospheric conditions, unreliable teletype machine at Mombasa, intermittent loss of contact between Mombasa and Tananarive, inadequate intercommunications between platforms and platforms to base camp, limited and very noisy hardline communications between platforms, and no communications available from base camp or platforms to the town of Malindi.

To eliminate these problems, the communication system was revamped and new equipment installed. The new system encompasses both internal and external communication networks. Figure 27 is a block diagram of the communication networks.

There are three independent external communication networks in operation which constitute a basic network, a spare network and an emergency network. These networks are used for voice or teletype transmissions of operating and administrative traffic.

The basic network is a Troposcatter System with radio links between Base Camp and the Santa Rita platform and between Kwale Station and the East African Post and Telecommunication (EAP&T) terminal in Mombasa. In addition, Mombasa radio is hardwire linked to the EAP&T terminal and the San Marco platform is linked to the Santa Rita platform through the underwater cables. This network provides the capability to connect the platforms and Base Camp directly to Mombasa EAP&T terminal through an automatic switchboard on the Santa Rita platform. The Mombasa EAP&T terminal has the capability to communicate with any other terminal in the world through East African External Communications Corporation (EXTELCOM). With this basic network and using telephones designated as "External" located on the platforms and at Base Camp, direct dial telephone service to local numbers in Mombasa is available. Other numbers in Kenya can be reached from these telephones by long distance through the Mombasa Operator. Numbers outside Kenya may be reached by long distance through the Mombasa Operator and the International Operator. The Troposcatter UHF Radio system is located on the Santa Rita platform. There are two continuous 30 watt channels in the troposcatter link with each having a capacity of 4 voice and 4 teletype channels. The radio link between Kwale and EAP&T is an HF system. The HF link is one channel operation with automatic switchover to a backup channel. The radio link between Base Camp and Santa Rita is a VHF radio system with a capacity of 3 voice and 3 teletype channels.

The spare network consists of CTR 43 VHF transmitter/receiver units located on the Santa Rita platform, at the Kwale station and at the CRA office in Mombasa. There are two units at each location operating on four predisposed channels in voice mode only. One channel is held open at all times and calls are made each day at prearranged times. Conversation can be originated at Kwale, but the repeater station is not regularly manned.

The emergency network consists of BC-610 HF transmitter/receiver units located on the Santa Rita platform, at Base Camp, and at Mombasa Radio Station. The network is voice mode only.

The internal communication network consists of inter-range radio systems, a telephone system and an intercom system.

The inter-range radio systems located on each platform and at Base Camp consist of CTR 44 transmitter/receiver units, TMC-703 ten channel transmitter/receiver units and nine pair of "Walkie Talkie" portable radio units.

The internal telephone system, platform to platform, uses an automatic switchboard located in the Communication Van on the Santa Rita

platform with dial telephones located on each platform. New equipment was installed in the telephone system to convert from a PBX system to a dial system. The system provides direct dial telephone service between the platforms. The system has a capacity for 10 pair of simultaneous telephone conversations and 100 dial telephone sets.

The operational intercom system provides 2 two-way voice intercommunication channels for use between individual stations and groups of stations. Each station consists of an end instrument connected to the channels as required. Improvements in this system primarily involved a cleanup of cable installation to reduce hash and cross-talk.

5.1.2 Radar and Tracking Equipment

Both "C" Band and "S" Band radar tracking systems were included in the original range concept, but due to procurement problems, the "C" Band system was not available for the S-153 launch. The MPS-19 "S" Band system, which was available, has limited range. To provide adequate range safety data for the S-153 launch, a Whittaker Roll Stabilized free gyro was incorporated into the vehicle to provide attitude information through the vehicle telemetry system. The obvious disadvantage is that of the telemetry signal being lost, or during normal signal blackouts, no vehicle position information is available. Another disadvantage is the accuracy capability of the system and the single source of information. In order to optimize the system, a telemetry auto track antenna system was installed, but the system still depended upon transmission of the telemetry transmitter. The Whittaker gyro information was very good during the flight of vehicle S-153 and was used as the prime safety of flight data. However, it was recommended that for continued operation as a complex, the "C" Band Radar system should be obtained to provide range safety data.

Activities were set in motion to obtain a "C" Band Radar system and it soon became apparent that a new system could not be procured, installed, and checked out in time to meet the next launch schedule. The NASA had an AN/MPS-26 radar system which it offered to the CRA on a temporary basis. The AN/MPS-26 radar system is a mobile system housed in a trailer van. The MPS-26 system has the capability to illuminate the vehicle with 250 KW of power at lift-off, can skin track to 75 miles, and can beacon track to 8000 miles.

A survey of the space available on the Santa Rita to set up the radar trailer indicated the need for some other location. It was also determined that if this additional weight were placed on the stern of the Santa Rita, the platform would not be as stable for towing should it become necessary to refloat the platform and move to a new location. The decision was made to construct a second auxiliary platform close off the stern of the Santa Rita and to place both the MPS-19 radar vans and the MPS-26 van on the new platform. The new platform, approximately 14 meters square, was constructed on the port side of the existing auxiliary platform.

Construction of the platform began March 1970. The MPS-26 van departed New York on 3 September 1970 on a ship and arrived in Mombasa on 7 October. The van was transferred to a lighter and towed to Base Camp. The van was towed out to the platform in the lighter and transferred into position on the auxiliary platform on 13 October 1970. The radar systems were operationally checked using balloons on 2 November. On the 9th, a geodetic survey was made to determine the geographic location of the MPS-26 radar antenna. On the 21st a light aircraft, carrying a Scout vehicle radar beacon and telemetry transmitter, made fly-bys to check the tracking operation of the systems. A new plotboard was installed in the Range Control Center to display the radar data. Both vertical and horizontal projections of the trajectory (Z vs Rxy and X vs Y) are displayed on the one plotboard. An identical plotboard is located in the MPS-26 trailer van. Figure 28 is a photograph of the Radar Trailer Vans on the auxiliary platform.

5.1.3 Command Destruct Equipment

The two command destruct transmitters were received at the range late in February 1967. Vendor drawings did not arrive until late in March. As a result, installation and checkout was being performed immediately prior to launch operations. A failure occurred in one transmitter's sealed crystal and was repaired. Small problems continued to occur with both transmitters making their reliability somewhat questionable. However, the general opinion was that since the equipment was basically of good design, a detailed inspection and rework of the faulty components should be sufficient to achieve reliable operation.

On 10 February 1969, representatives from the vendor and Vought Missiles and Space Company arrived at the San Marco Range to determine the cause of the difficulties and to provide recommendations to the system. In summary, the significant findings were that the schematics supplied with the units were incorrect; the instruction books on alignment, theory of operation on automatic switching, tone oscillator and audio limiter operation were incomplete or nonexistent; corrosion was evident in some mechanical components and although there was no apparent failure at the time due to corrosion, there were open type relays, open switches, and paper capacitors in the system which were not designed for high humidity conditions; and trouble-shooting of the system was hampered by lack of spares and test equipment.

Although every reported problem was not reconciled or verified, sufficient data was obtained to enable the CRA to continue trouble-shooting of the system. With the proper manuals, schematics, spares, test equipment, and environmental protective measures, the CRA was able to bring the system up to a satisfactory operating level for the next scheduled launch.

5.1.4 Telemetry Equipment

The telemetry ground station had been in use for some time. Although some modernization had been accomplished, the system had not been equipped with calibrators and the discriminators lacked sufficient output to drive the decommutators. Other equipment in the system such as the oscilloscope and counter were marginal in operational capability. The system was completely reworked. Several pieces of new equipment was installed including receivers, tape recorders, discriminators, oscillators, decommutators, oscilloscope, and counter.

5.1.5 Payload Processing Facilities

It was anticipated that future payloads would have the need for an environmentally controlled clean work area. To meet the needs of prospective range users and to provide the best services possible, an environmental controlled clean room was constructed on the main deck of the San Marco platform. The inside dimensions of the clean area are 25 feet long by 17 feet wide with a 13 foot ceiling. Entrance doorways are 5 feet 8 inches wide by 8 feet 5 inches high. The clean room is shown in Figure 29. The structure was located on the starboard side, bow end, of the platform.

The environment inside the clean room can be maintained at 67° to 77°F and 35% to 45% relative humidity at a positive pressure differential of 0.05 psi. Filters are capable of maintaining the contamination level at less than 8500 particles, between 0.3 and 10 micron, per cubic foot and 15,000 particles, greater than 10 micron, per cubic foot.

5.1.6 Santa Rita/San Marco Platforms

By early 1969 the Santa Rita platform had been exposed to several years of service as an oil drilling platform, a launch platform, and a control platform. In addition, the Santa Rita had covered numerous sea miles in its journeys from one location to another. The platform manufacturer was contracted to inspect and report on the integrity of the platform. The inspection was accomplished in April 1969. A report of the survey was published in May 1969 (Reference 10) pronouncing the platform sound and suitable for its intended use.

A similar thorough inspection was performed on the San Marco platform by the manufacturer's representatives. It too was pronounced sound and suitable for intended use.

Along with improvements in Range Systems came improvements in the basic platform logistics sytems. Some of the improvements which can readily be seen on the decks of the platforms are identified in Figure 30.

The following changes were made on the Santa Rita platform.

a. The rest rooms that were mounted along the port rail were removed and a new rest room built on the first deck.

b. A 500 Kg crane was installed at mid-platform on the port side.

c. A life boat was mounted on davits on the port side, bow end of the platform.

d. The tarpaulin wind break on the dining area sidewalls was replaced with moveable panels.

e. The first deck was rearranged to provide better quarters, offices spaces, and a conference room.

f. Emergency life rafts were installed on port and starboard side along the main deck rails.

The Santa Rita platform as photographed in December 1970 is shown in Figure 31.

The following changes were made on the San Marco platform:

a. The addition of the clean room on deck necessitated repositioning the Work Shop Trailer Van and Operations Trailer Van.

b. An Engineering office was established below deck allowing the Operations Trailer Van to be converted into the Battery Preparation and Pyrotechnic Checkout Trailer Van.

c. A 500 Kg crane was installed mid-platform on starboard side of the main deck.

d. A test rocket launcher was installed at the bow end, port side, of the main deck.

e. A life boat was mounted on davits on port side, bow end, of the platform.

f. Emergency life rafts were installed on port and starboard side along the main deck rail.

The San Marco platform as photographed in December 1970 is shown in Figure 32.

5.1.7 Base Camp

Base Camp improvements were quite extensive. The changes were aimed at more efficient operations, increasing capability and contributing to

the comfort and well being of personnel quartered there. Some of these changes were as follows:

a. Additional land was leased on the east side of Base Camp to nearly double the size of the camp area.

b. All the tent barracks were removed and replaced with concrete block structures.

c. A new jetty was built, including a rail system whereby cargo can be placed on a tram and moved along the jetty and a "A" frame hoist on the end of the jetty to transfer cargo to motor launch.

d. A Dispensary was constructed along with quarters for medical personnel.

e. A new water tower was constructed with quarters for the manager of Base Camp located in the tower base.

f. A large concrete slab was poured on which trailer vans can be parked.

g. The Mobile Italian Telemetry Station was moved from Nairobi and relocated on the concrete slab at Base Camp.

h. An observation stand was constructed on the beach to accommodate launch spectators.

i. An office building is to be constructed.

j. An Interferometer facility is under construction.

In general, Base Camp has taken on the appearance and atmosphere of a permanent settlement rather than a temporary outpost. Photographs taken at Base Camp since 1967 are shown in Figure 33 along with a plot plan of the camp. As shown in the photographs, a considerable amount of new construction has been accomplished since ground was broken for Base Camp in 1966.

5.2 RANGE READINESS

Having achieved a launch readiness condition for the range personnel and equipment during the launch of Scout S-153; the CRA now concerned itself with a means of maintaining launch readiness and crew proficiency.

Readiness of the equipment following the extensive rework incorporating the improvement modifications was achieved through individual checkout of each installation and then revalidating the systems in accordance with

standard procedures. For the equipment on which modifications were not performed, readiness was maintained through periodic maintenance operations in accordance with standard procedures.

To maintain personnel readiness, a refresher training program (Reference 11) was implemented. A training program was prepared by NASA and Vought Missiles and Space Company personnel at Wallops Station to include range safety, radar operations and general operations. The training was accomplished between March and July 1969. Approximately 25 CRA range personnel received training. Personnel skills included Engineering, Operations, Logistics, Shop technicians, and Quality Control.

The CRA range personnel were integrated into the existing operating groups at Wallops Station. Radar personnel received training from their counterparts at the Mod II radar complex on Wallops Island and Range Safety personnel were integrated with their counterparts in the Range Safety Branch. Range safety and operations support personnel operated out of the Flight Evaluation Center.

The Ground and Flight Safety Section and Range Safety Branch covered in detail such items as grounding, power switching, circuit restrictions, danger areas and times, ground safety plan, ground firing circuits, instrumentation, pyrotechnics, quantity-distance for explosives, specific vehicles, and personnel clothing. Additionally, items that were covered briefly included RF hazards, static electricity hazards, and building structures.

Flight safety items such as allowable impacts, overflight of land, methods to solve flight limits, plots and displays to monitor flight, flight terminations, flight safety plan, weather limitations, and wind weighting were covered during the refresher training.

Training was provided on specific items of equipment such as "S" Band Radar, "C" Band Radar (MPS-26), plotboards and time mark unit. The scope of the training encompassed general theory of operation, use of equipment, and maintenance trouble shooting.

Refresher training was provided in open site acquisition (skyscreens) technique and operational practice. General operational training was conducted at the Flight Evaluation Center at Wallops Island where the consoles, radar plotboard, TV displays and communication system were configured to simulate the San Marco Range Control Center.

5.3 SAS - A PROJECT

On 21 August 1970 the United States National Aeronautics and Space Administration signed a contract with the University of Rome for launch services at the San Marco Equatorial Mobile Range. The contract called for the University of Rome through the Centro Ricerche Aerospaziali to

provide personnel and equipment to launch NASA Scout vehicles with NASA payloads from the San Marco Range. A total of four launches have been proposed to occur during the next two years under this contract and are identified as SAS-A, B, and C and SSS-A.

The mission objective of the SAS-A launch was to place a satellite into a 300 nautical mile circular orbit at 2.9 degree inclination. The objective of the experiment was to study the position, strength, spectral composition, time variation, and correlation with optical and radio sources of known and new X-ray sources that the satellite may discover. The launch date for SAS-A spacecraft was set for early December 1970.

Scout vehicle S-175C was designated for the SAS-A project. The vehicle propulsion system was shipped from NAD, Earle, New Jersey via ocean vessel on 12 September 1970 and arrived in Formosa Bay on 9 October. The vehicle assemblies were shipped by air carrier from Dallas, Texas on 18 September 1970, arriving in Nairobi on 21 September. Vehicle processing progressed normally with the vehicle system test being completed on 23 November. The SAS-A spacecraft was installed on the booster on 2 December. A complete dress rehearsal was performed on 8 December and all systems were declared "go". On 12 December 1970, Scout vehicle S-175C was launched at 10:53 Zulu from the San Marco Range placing the SAS-A spacecraft into direct equatorial orbit. The launching of this spacecraft by the CRA marked the first time that a United States satellite had been launched by another nation. The satellite remains in orbit at this writing meeting all objectives of the planned mission.

Representatives of NASA and Vought Missiles and Space Company observed the operation and were available for consultation and technical assistance.

The launch was covered by representatives of the press from Europe and the United States. Some selected press clippings are shown in Figure 34.

5.4 SAN MARCO C PROJECT

Having mutual interest to continue cooperative programs in space, the Italian Space Commission and the United States National Aeronautics and Space Administration entered into a second cooperative satellite project. The project, identified as San Marco C, required the development and integration of United States experiments on board an Italian satellite. Under the terms of the Memorandum of Understanding signed 18 November 1967, the Italian Space Commission would be responsible for the following:

a. Design, fabrication, and testing of the satellite.

b. Integration of U.S. supplied experiments.

c. Establishing, equipping, maintaining, and operating range facilities, including platforms, range equipment, and Scout checkout and launch equipment.

d. Assembly, checkout and launching of Scout vehicle including range safety.

e. Tracking and data acquisition facilities and operations, except as provided by NASA.

f. Analysis of data from the Italian experiment.

g. Support of Italian personnel in any retraining or requalification required.

h. Support logistics, spare parts, transportation cost, and all other costs peculiar to this project.

NASA would be responsible for the following:

a. Provide experiment.

b. Provide Scout launch vehicle.

c. Train or requalify Italian personnel as may be required.

d. Provide technical support.

e. Tracking and data acquisition services of suitably located STADAN stations.

f. Analysis of data from U.S. experiments.

Like the earlier Italian spacecraft, the San Marco C was designed and fabricated by CRA personnel at Rome. The spacecraft was basically a continuation of the Italian air density experiment and in addition, integrated two NASA experiments, a magnetic sector mass spectrometer and an omegatron mass spectrometer.

The primary scientific objective of the spacecraft mission was to obtain, by measurement, a description of the equatorial neutral particle atmosphere in terms of its density, composition and temperature behavior at altitudes of 200 Kilometers and above, and to obtain a description of variations in its behavior resulting from solar and geomagnetic activities.

The secondary scientific objective was to investigate the interdependence of three neutral-density-measurement techniques from one spacecraft: direct particle detection, direct drag, and integrated drag. It was anticipated that new data, such as those provided by direct drag force measurements combined with direct particle detection data, would provide information

necessary to resolve the discrepancies between the measured densities of direct particle and the integrated drag experiments.

The San Marco C Satellite was a 28-inch diameter sphere with four 19-inch monopole antennas for telemetry and command. The spacecraft weighed approximately 342 pounds. The spacecraft was equipped with a solar array and rechargeable battery system, and an attitude and spin rate control system. (Figure 5)

The spacecraft structure formed an integral part of the drag balance air density experiment consisting of a light external shell connected through the balance to the heavier internal structure of the spacecraft. The air density experiment performed a continuous measurement of the forces (aerodynamic pressure) acting on the external surface of the spacecraft. From the drag measurements, data on the local atmospheric density and molecular temperature is obtained.

The NASA omegatron experiment was to determine molecular nitrogen (N_2) concentration and temperature in a range of altitudes from 150 to 400 Km altitude. The purpose of the mass spectrometer experiment was to simultaneously measure the density of argon (A), helium (He), nitrogen (N), molecular nitrogen (N_2), oxygen (O), and molecular oxygen (O_2) in a range of altitudes between 150 and 800 Km.

The vehicle propulsion system was shipped from NAD Earle, New Jersey via ocean vessel on 10 February 1971 and arrived in Formosa Bay on 7 March 1971. Off-loading operations began at 0735 hours on 8 March and was completed by 1645 that day. For this off-loading operation, the ship tied up only a foot or two from the San Marco platform and the mobile crane on the platform transferred the vans directly from the ship. In one photograph in Figure 35, the platform is dwarfed by the 496 foot ship. The other photograph in the figure shows one of the vans being transferred from ship to platform.

The vehicle assemblies were shipped by air freight via New York and Frankfurt to Nairobi arriving 0304 hours on 1 March 1971. The assemblies were transported to Base Camp by truck and to the platform by CRA boats.

Receiving Inspections on the propulsion system and vehicle assemblies were started and vehicle processing had progressed through vehicle assembly on the transporter by the end of March. The All Systems Tests were completed on 5 April. Payload installation began on 14 April. A dress rehearsal was conducted on 21 April and all systems were found to be ready for launch.

The Mobile Italian Telemetry Station, located at Base Camp, was the primary station for commanding the San Marco C spacecraft. Quito, a NASA STADAN station located in South America, was responsible for commanding the spacecraft for tracking and data acquisition. Quito was also responsible for backup commanding of the experiments, the attitude and spin rate control systems (if required), and additional backup commands as required.

Scout vehicle S-173 was launched at 7:32 hours Zulu (10:32 local) on 24 April 1971 successfully placing the San Marco C spacecraft into equatorial oribt. On last report, the spacecraft was still operating as scheduled with a life time expectancy of 180 days.

6.0 FUTURE PLANS AND PROJECTS

6.1 SSS AND SAS PROJECTS

As mentioned in preceding paragraphs, the NASA contracted the University of Rome for launch services at the San Marco Range. A total of four launches were proposed. With the first launch, the SAS-A, complete, plans were proceeding for the remaining three launches. The SSS-A launch was scheduled for July 1971, the SAS-B for October-November 1971 and the SAS-C for late in 1972.

The mission objective of the SSS-A launch is to place a 105 pound satellite into an elliptical orbit with perigee of 150 nautical miles, a geocentric apogee of 17,900 miles and an inclination of 2.8 degrees. The experimentation is designed to investigate magnetospheric phenomenon including the ring current and development of the main phase magnetic storm, acceleration of charged particles within the inner magnetosphere, and the time variations of the charged particle population.

Scout vehicle S-163 was designated as the booster for the SSS-A project. The propulsion system was shipped from NAD Earle, New Jersey on 2 April 1961 via ocean vessel and arrived in Formosa Bay on 28 April. Off-loading operations were accomplished in less time than with previous shipments. The platform crane was used to make direct transfer from ship to platform. On this shipment, the running gear for each trailer van was not shipped with the vans but was left in storage in New York. The absence of these running gears was considered a significant factor in the reduction of off-loading time.

Technical difficulties were encountered with the spacecraft requiring the launch to be rescheduled for November 1971.

The SAS-B launch is scheduled for April 1972. The SAS-C launch is scheduled for April 1973.

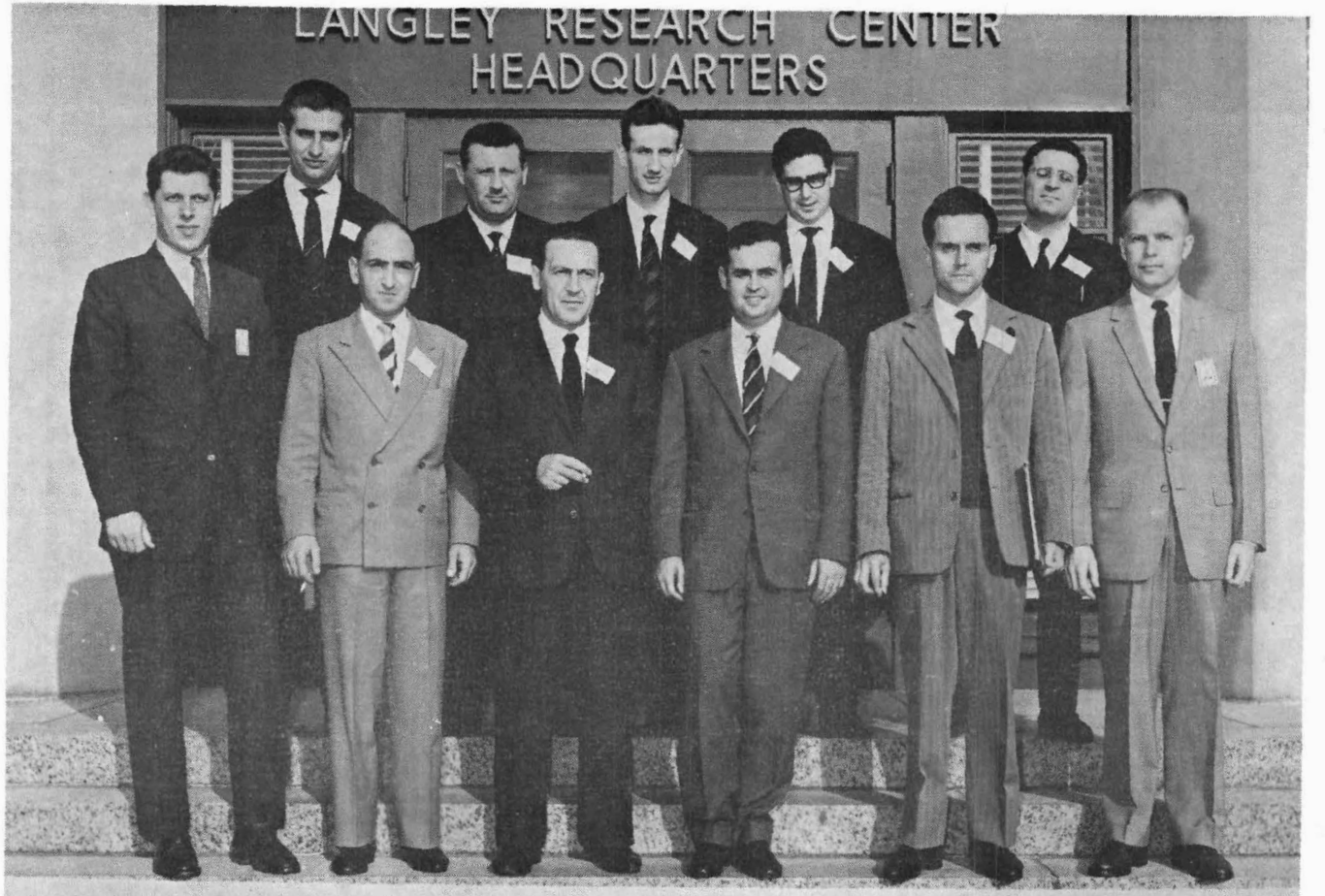
6.2 SAN MARCO D PROJECT

Included in the future planning for the range is the San Marco D Project.

The requirements for the San Marco D Project are described in a document SMD-1/A prepared by the Centro Ricerche Aerospaziali (Reference 12). The primary objective of the project is to provide an efficient and economic means to orbital test new types of instrumentation or advanced technological equipment prior to their being flown on larger and more expensive geostationary satellites.

The satellite consists of a basic spacecraft and an experiment package. The spacecraft carries all the basic subsystems required for power generation and distribution, data transmission, command reception and actuation and attitude control. The spacecraft design concept is a modular form vehicle which can be easily adapted to a variety of experiments and missions with minimum integration time and costs.

ILLUSTRATIONS



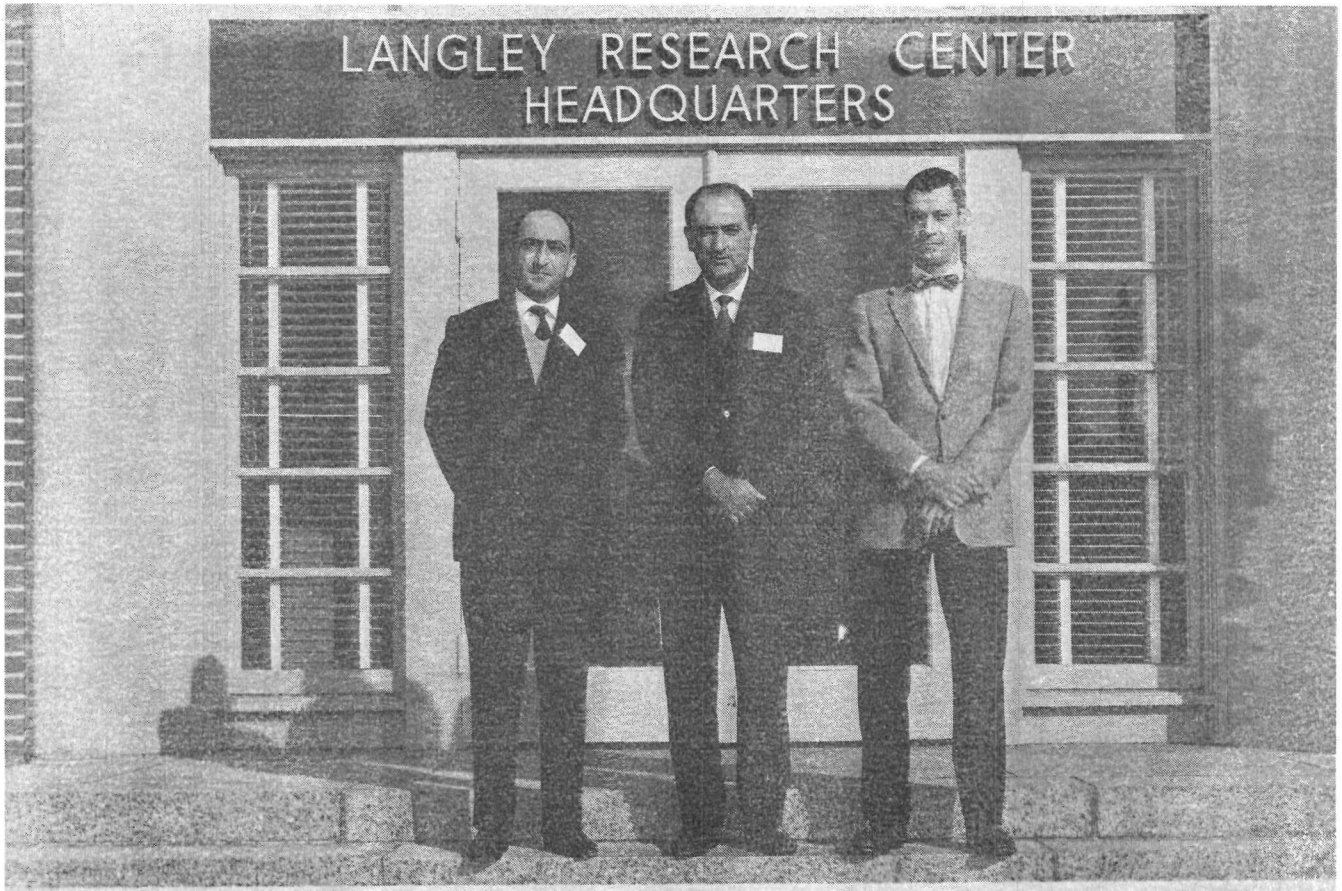
Left to right:

Front row: Lauren L. Suter - NASA Headquarters; Capt. Michele Sirinian, Italian Air Force, Lt. Mario Arcieri, Italian Air Force, Brono Ratti - Research Engineer, Capt. Robert Solimena, Italian Air Force, Italian Space Committee, Rome, Italy; and LCDR Reginald Machell, USN - Langley Research Center

Back row: Capt. Mario Marconi, Italian Air Force, Capt. Guiseppe Catellani, Italian Air Force, Lt. Giorgio Ravelli, Italian Air Force, Carlo Arduini - Civil Servant, and Capt. Guiseppe Spampinato, Italian Air Force - Italian Space Committee, Rome, Italy.

October 31, 1961

FIGURE 1 ITALIAN PERSONNEL AT LANGLEY RESEARCH CENTER (SHEET 1 OF 2)



Left to right: Messrs. Michele Sirinian - Project Director, Gennaro Orsi - Branch Operations Engineer, Italian Space Committee, Via Eudossiana 18, Roma, Italy; and Roland D. English - Langley Research Center.

September 24, 1962

FIGURE 1 ITALIAN PERSONNEL AT LANGLEY RESEARCH CENTER (SHEET 2 OF 2)

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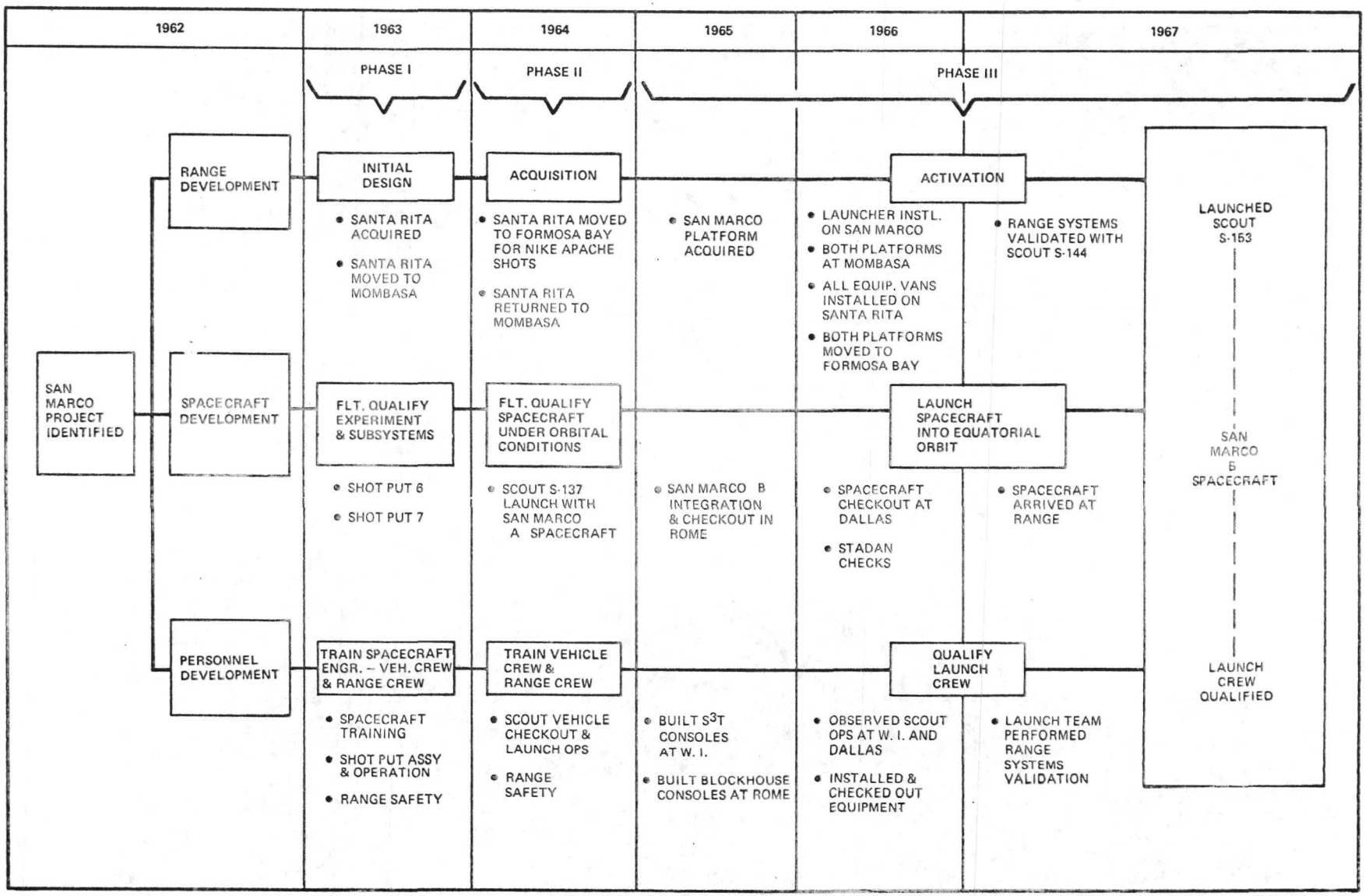


FIGURE 2 SAN MARCO PROJECT DEVELOPMENT SUMMARY

FIGURE 3 SHOTPUT LAUNCH VEHICLE

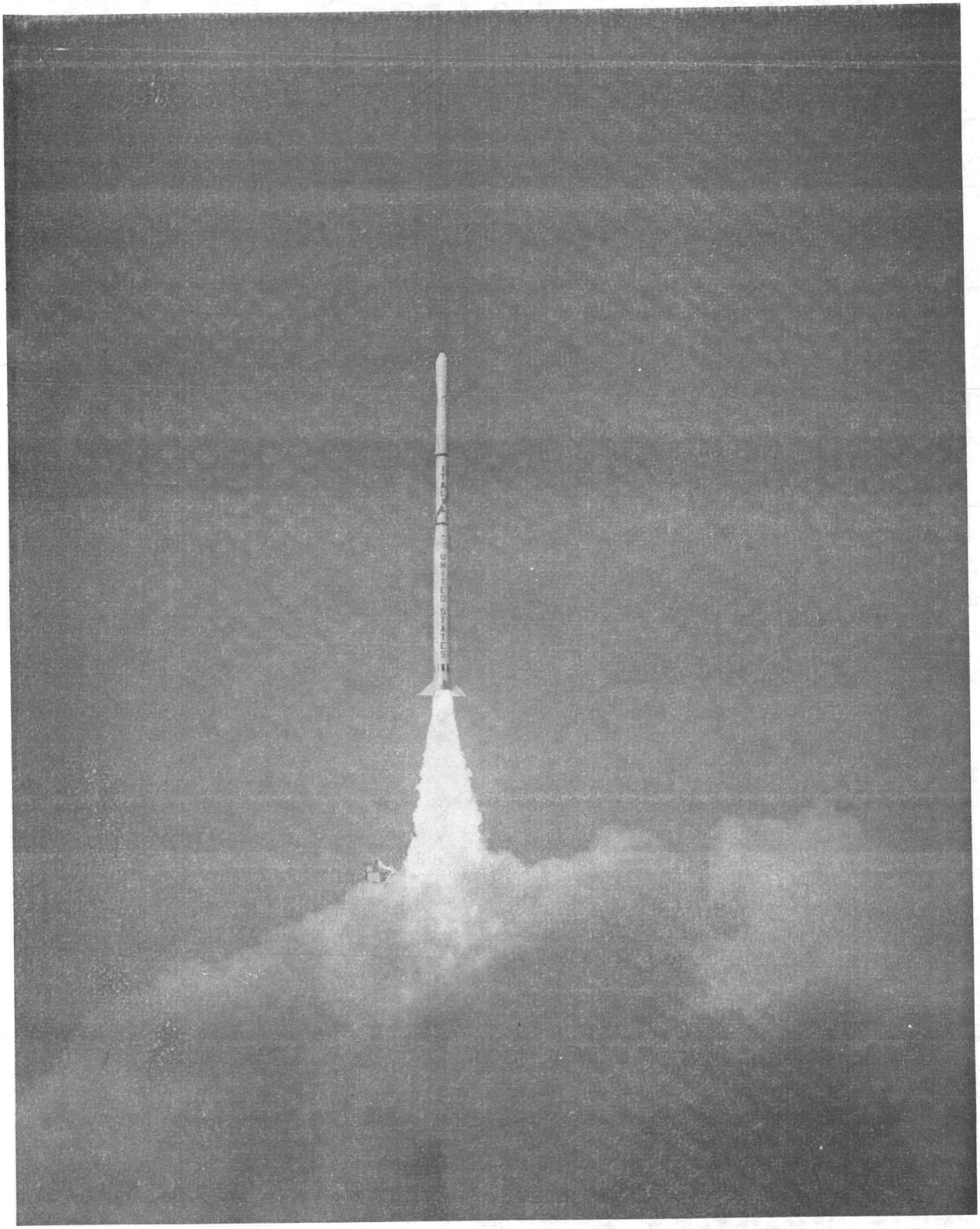
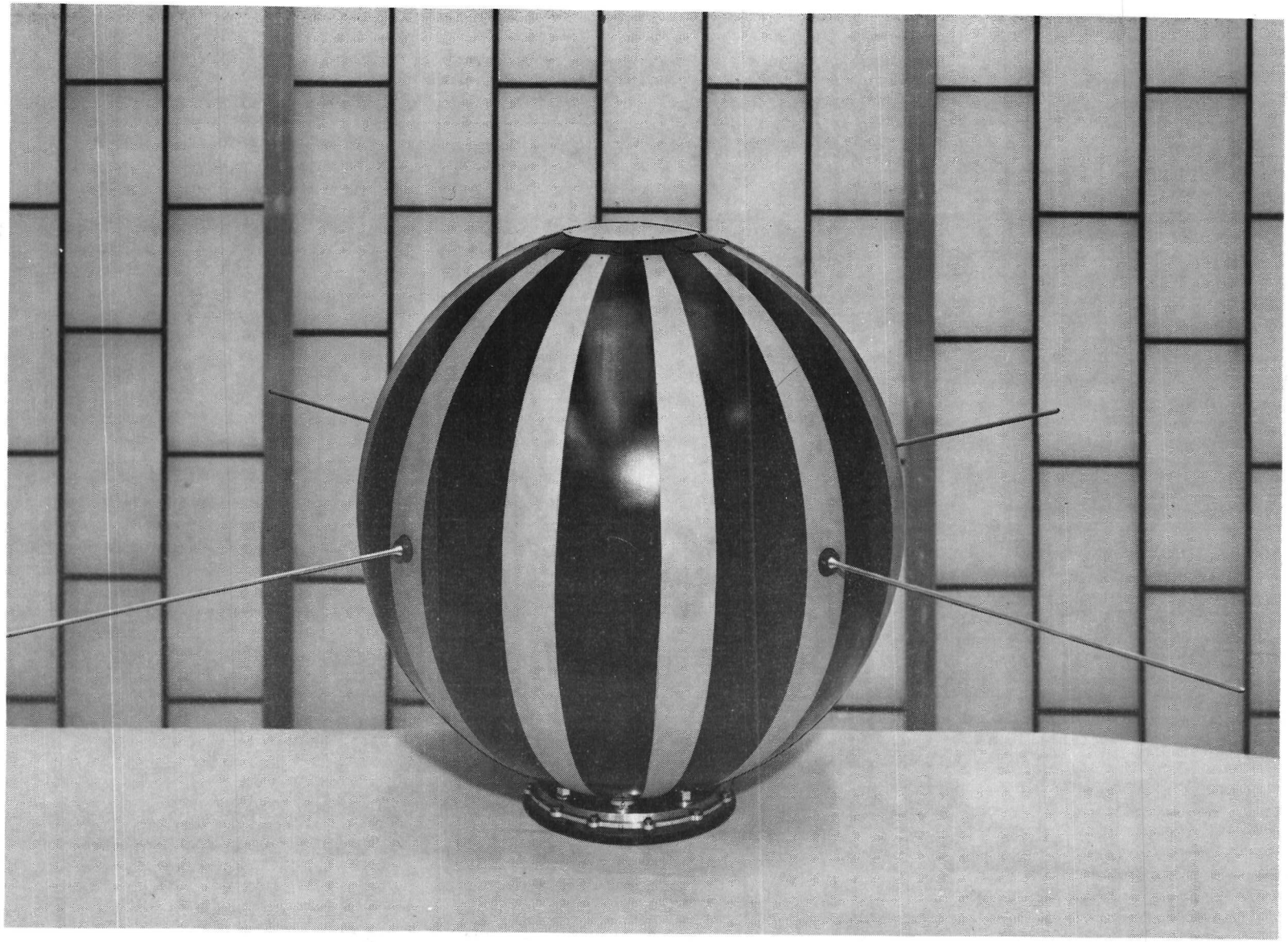
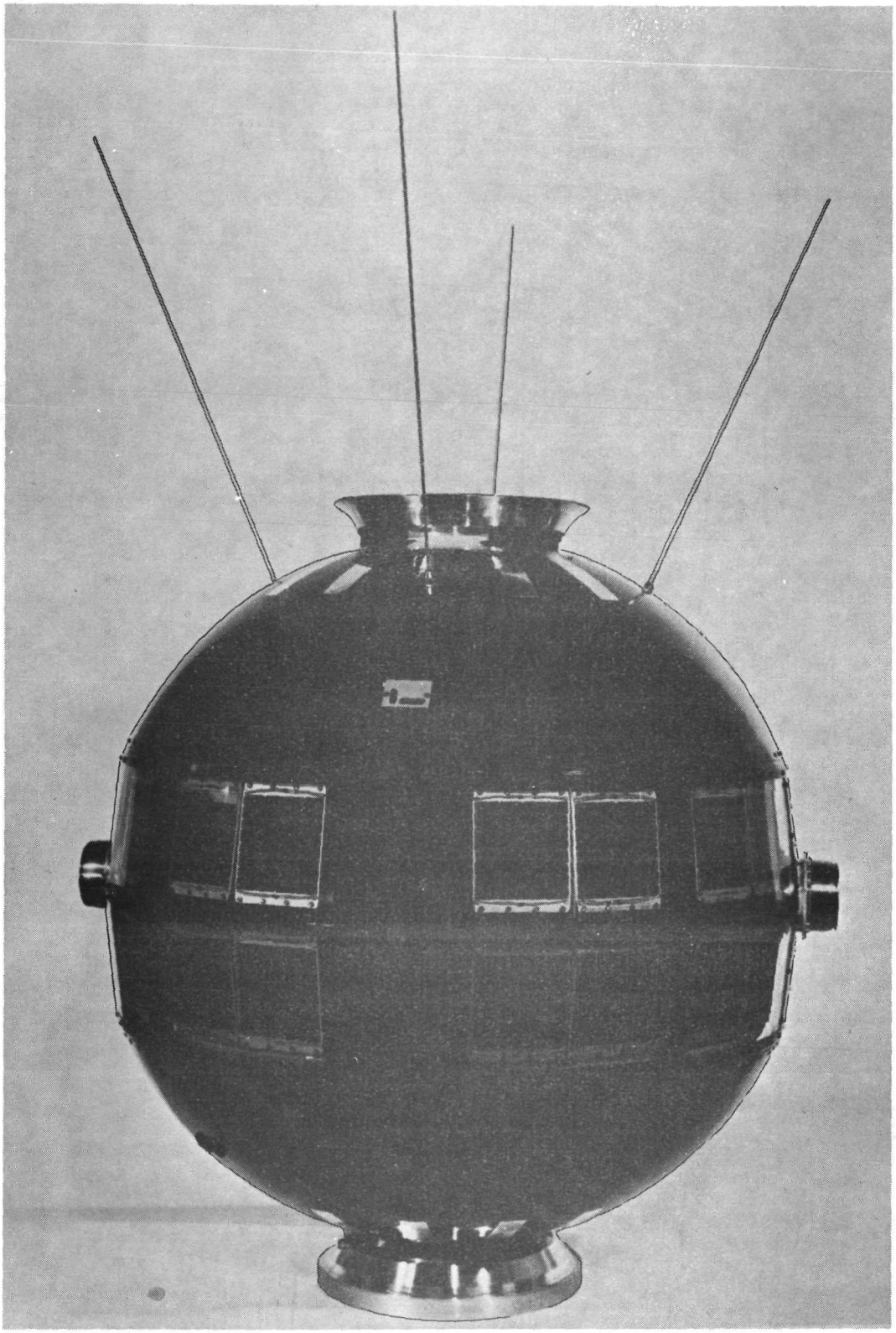


FIGURE 4 SAN MARCO "A" LAUNCH FROM WALLOPS ISLAND



SAN MARCO "B" SPACECRAFT

FIGURE 5 SAN MARCO SPACECRAFTS (SHEET 1 OF 2)



SAN MARCO "C" SPACECRAFT

FIGURE 5 SAN MARCO SPACECRAFTS (SHEET 2 OF 2)

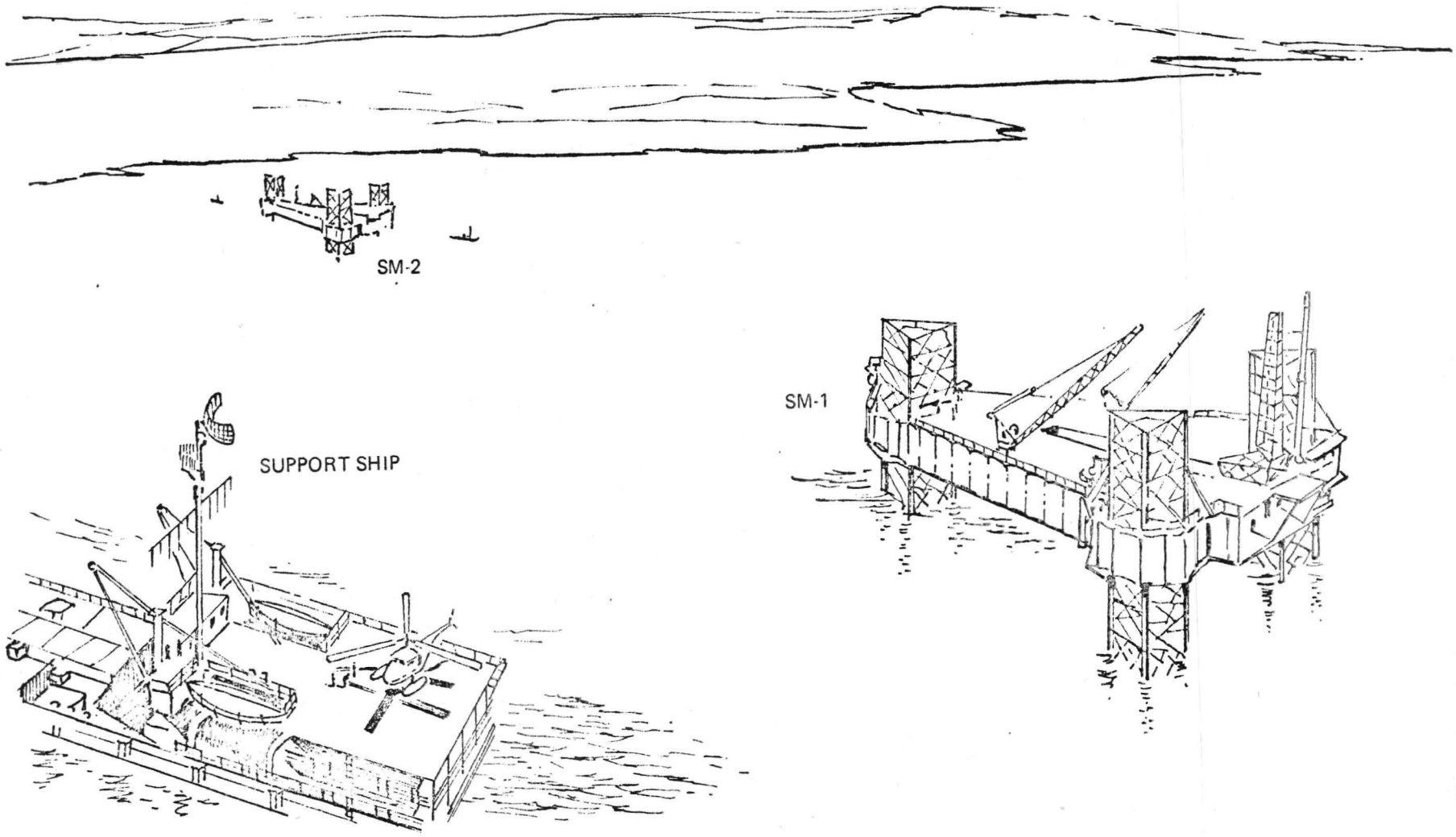
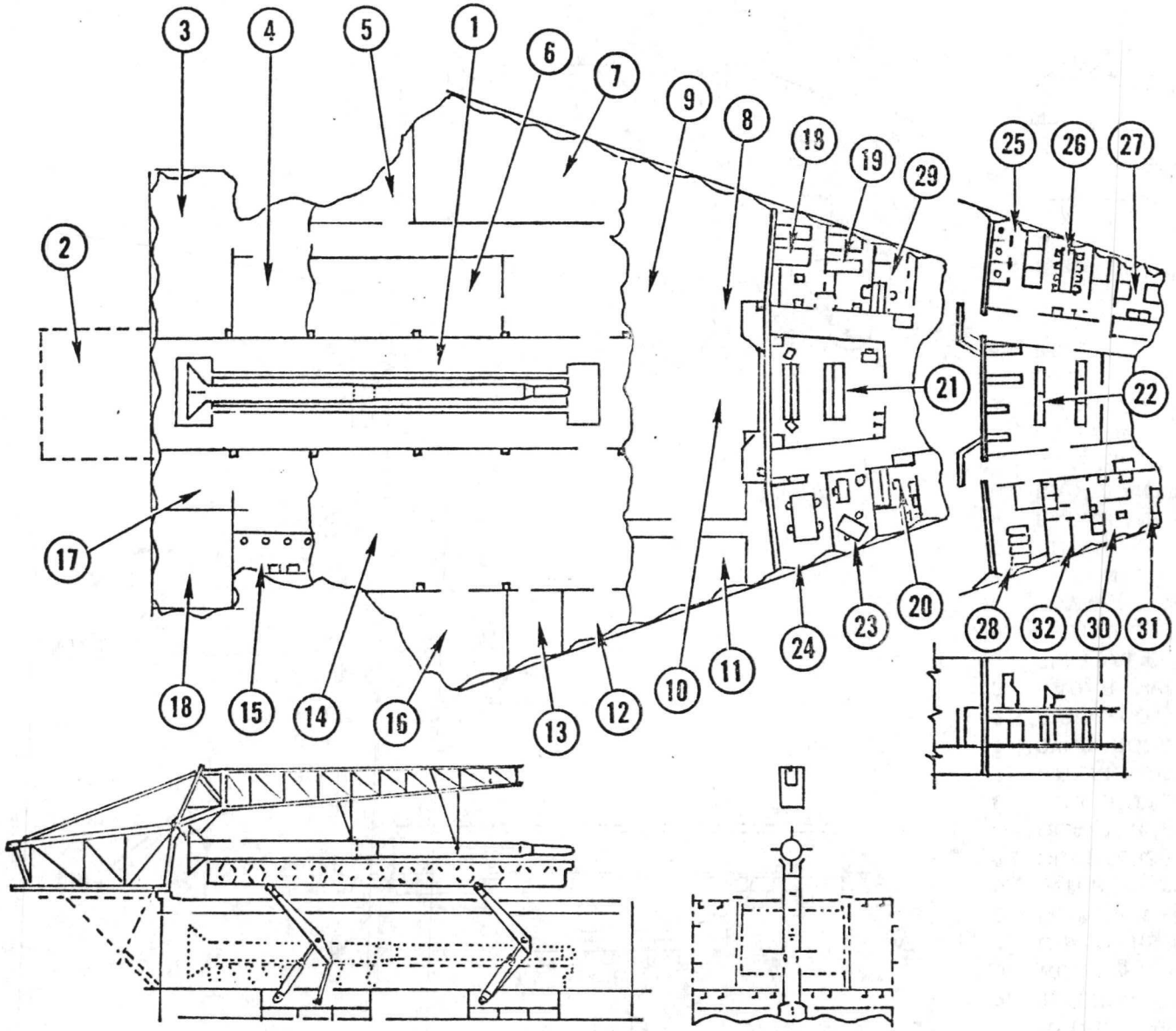
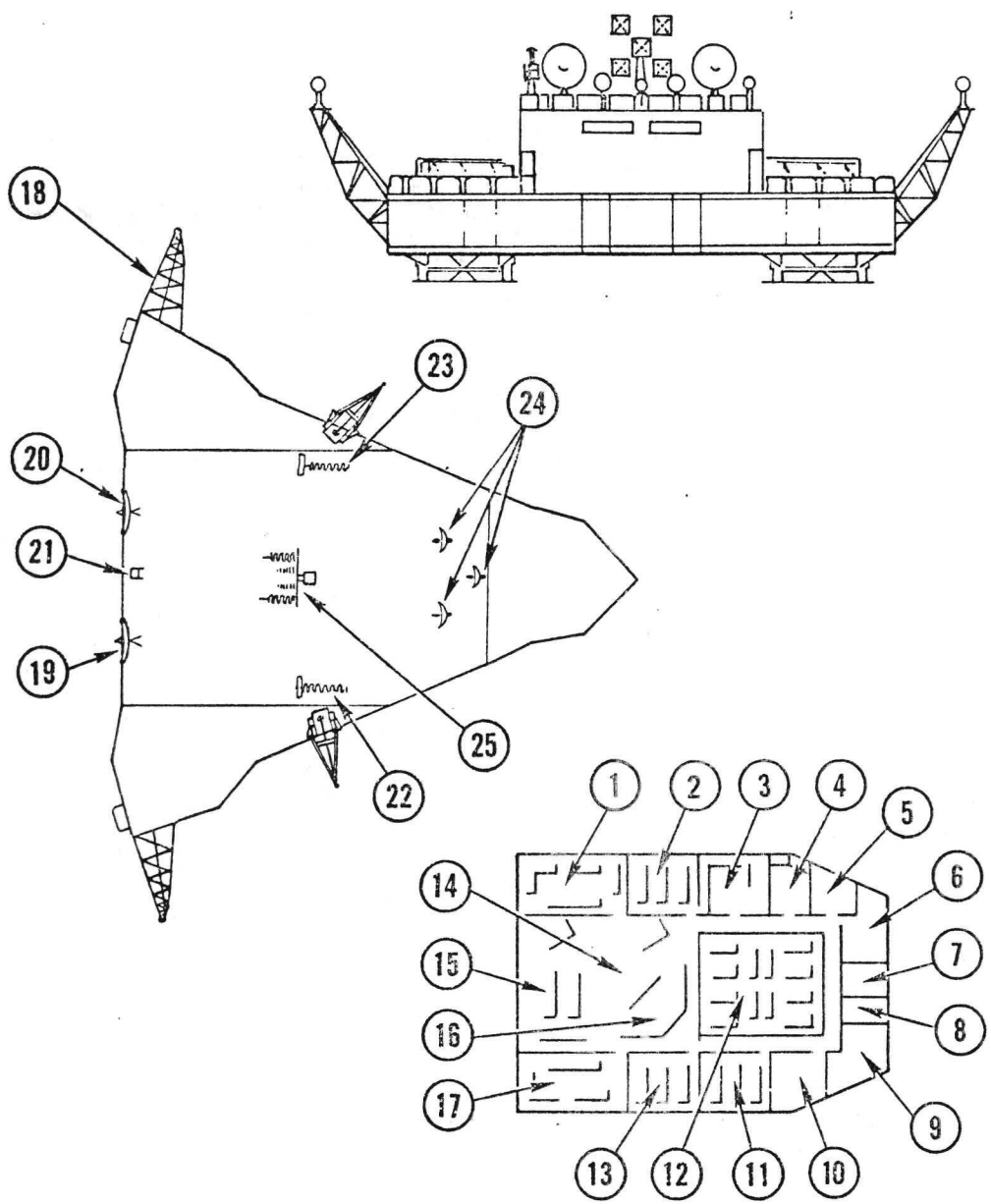


FIGURE 6 CONCEPT FOR THE SAN MARCO RANGE



1. MOTOR STORAGE & ASSY AREA
2. LAUNCH PAD
3. H_2O_2 STORAGE AREA
4. LABORATORY
5. HARDWARE & SPARE PARTS
6. LOGISTICAL STORAGE
7. REFRIG. & AIR COND. ROOM
8. POWER PLANT
9. SUPPORT SHOP
10. GENERAL ELECTRICAL CONTROL PANEL
11. DC BATTERY
12. OFFICE
13. ELECTRONIC ROOM
14. VEHICLE CHECKOUT SHOP
15. WC
16. STORAGE
17. STORAGE
18. QUARTERS
19. QUARTERS
20. COMMUNICATION
21. COUNTDOWN ROOM BLOCK HOUSE
22. COMMUNICATION
23. OFFICE
24. OFFICE
25. WC
26. DINING ROOM
27. KITCHEN
28. DC BATTERY
29. INFIRMARY
30. LAUNDRY
31. LAUNDRY OFFICE
32. STORE

FIGURE 7 CONCEPT FOR LAUNCH PLATFORM SM-1



1. RADAR # AND CONTROL CONSOLES
2. TM EQUIPMENT
3. WORK SHOP
4. QUARTERS
5. WC & SHOWERS
6. INTERNAL COMMUNICATION CENTER
7. QUARTERS
8. QUARTERS
9. WC & SHOWERS
10. INTERNAL COMMUNICATION CENTER
11. SYNCHRONIZATION & PROGRAMMING
12. FIRING COMMAND DESTRUCT TRANSMITTERS
13. RADAR # AND CONTROL CONSOLES
14. CENTRAL CONTROL ROOM
15. PLOTTING BOARDS – DISPLAY -- MONITORS
16. COMMAND DESTRUCT OPER. STATUS BOARD
17. INTERNAL & EXTERNAL COMM. BOARD
18. ANTENNAS
19. RADAR ANTENNAS
20. RADAR ANTENNAS
21. SKYSCREEN
22. DESTRUCT COMM. ANTENNA
23. TM ANTENNA
24. COTAR ANTENNAS
25. BALLISTIC CAMERA

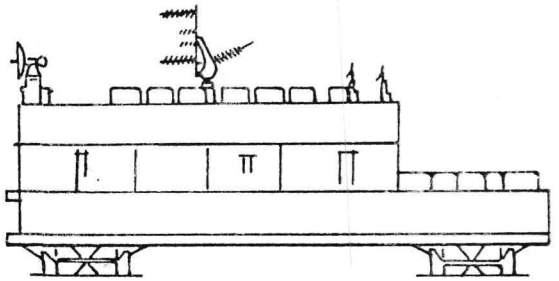
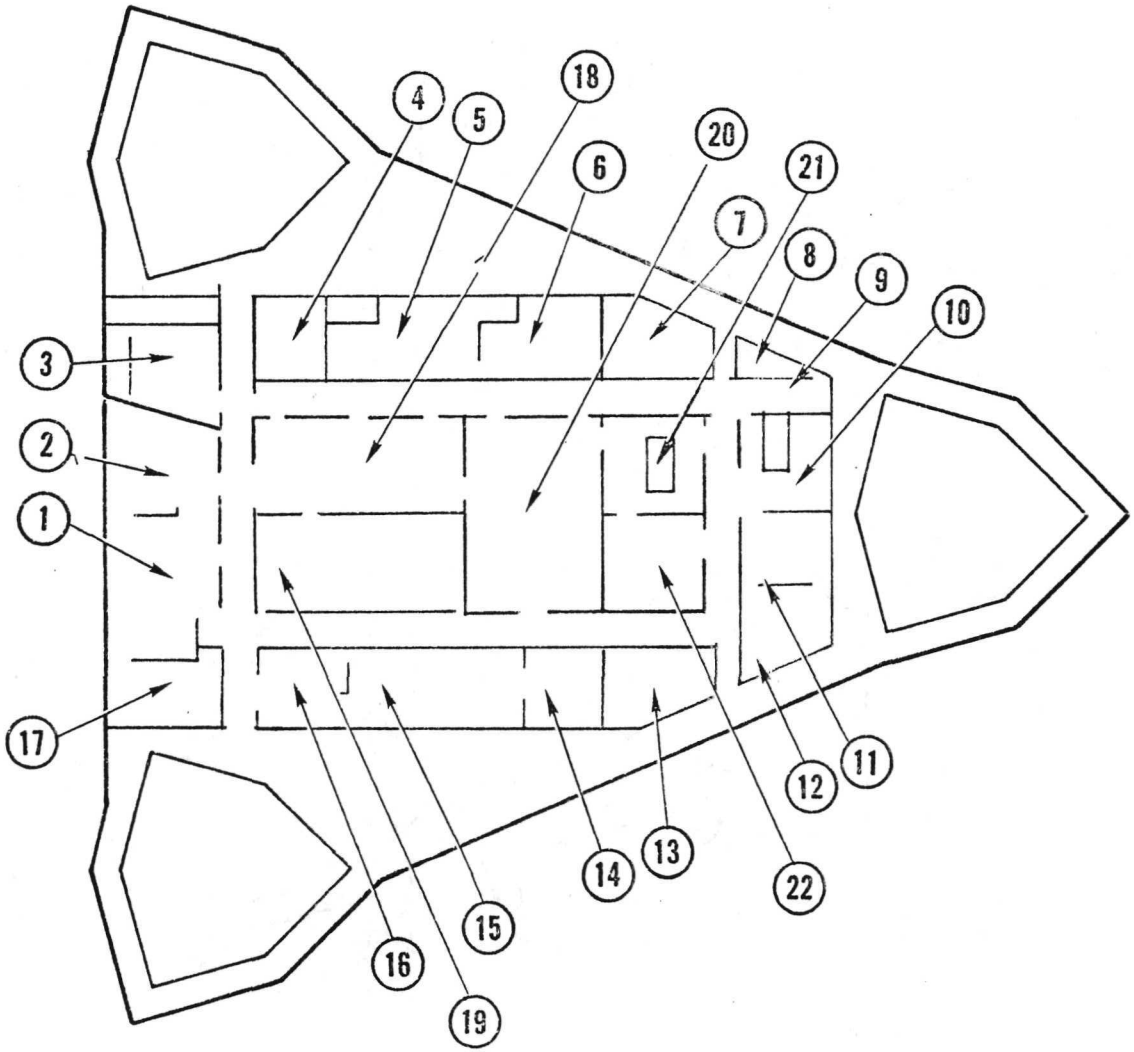
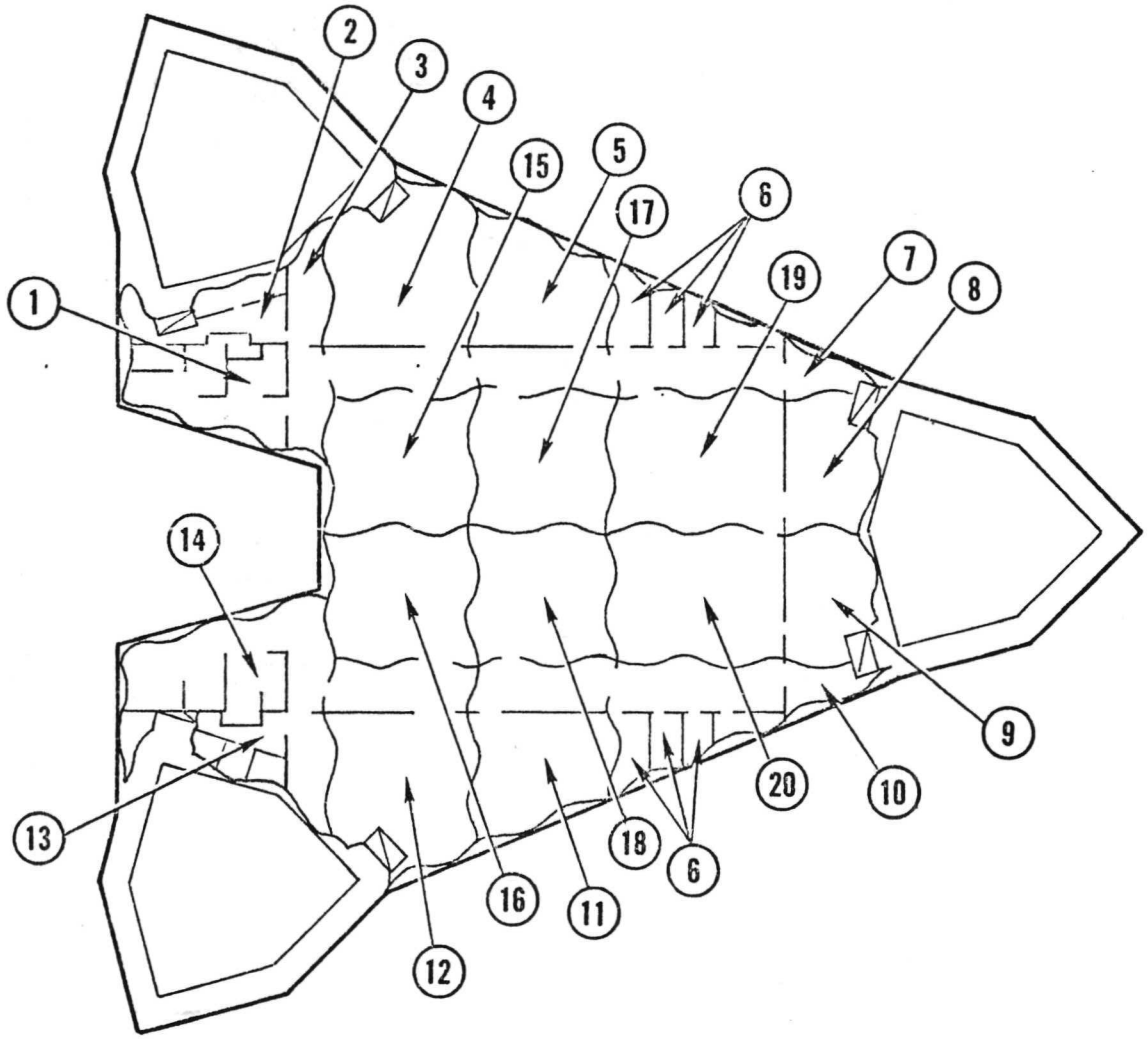


FIGURE 8 CONCEPT FOR CONTROL PLATFORM SM-2 SECOND DECK (SHEET 1 OF 3)



1. SAN MARCO PROG. MGR. LODGING
2. LOUNGE
3. TRACKING & TM SUP. DORM.
4. WC
5. OPERATOR DORM
6. CHECKOUT OPERATOR DORM.
7. WC
8. STORE
9. BARBER SHOP
10. LOGISTICAL SUPERVISOR DORM
11. HOSPITAL
12. STORE
13. WC
14. MECHAN. OPER. DORM
15. PLATFORM OPER. DORM.
16. PLATFORM SUPERVISOR DORM
17. SATELLITE SUPERVISOR DORM
18. LIVING ROOM
19. MEETING ROOM
20. DINING ROOM
21. OFFICES
22. DINING ROOM

FIGURE 8 CONCEPT FOR CONTROL PLATFORM SM-2 FIRST DECK (SHEET 2 OF 3)



1. LOGISTICAL OPER. DORM
2. WC
3. LUMBER ROOM
4. STORE
5. HOLD
6. WC
7. BREAD OVEN
8. LAUNDRY
9. DISTILLATOR
10. LUMBER ROOM
11. STORE (WAREHOUSE)
12. STORE
13. WC
14. MACHINE OPER. DORM
15. KC CHAMBERS
16. POWER STATION
17. REFRIG. & AIR COND. ROOM
18. POWER STATION
19. KITCHEN
20. SUPPORT SHOP

FIGURE 8 CONCEPT FOR CONTROL PLATFORM SM-2 BELOW DECK (SHEET 3 OF 3)

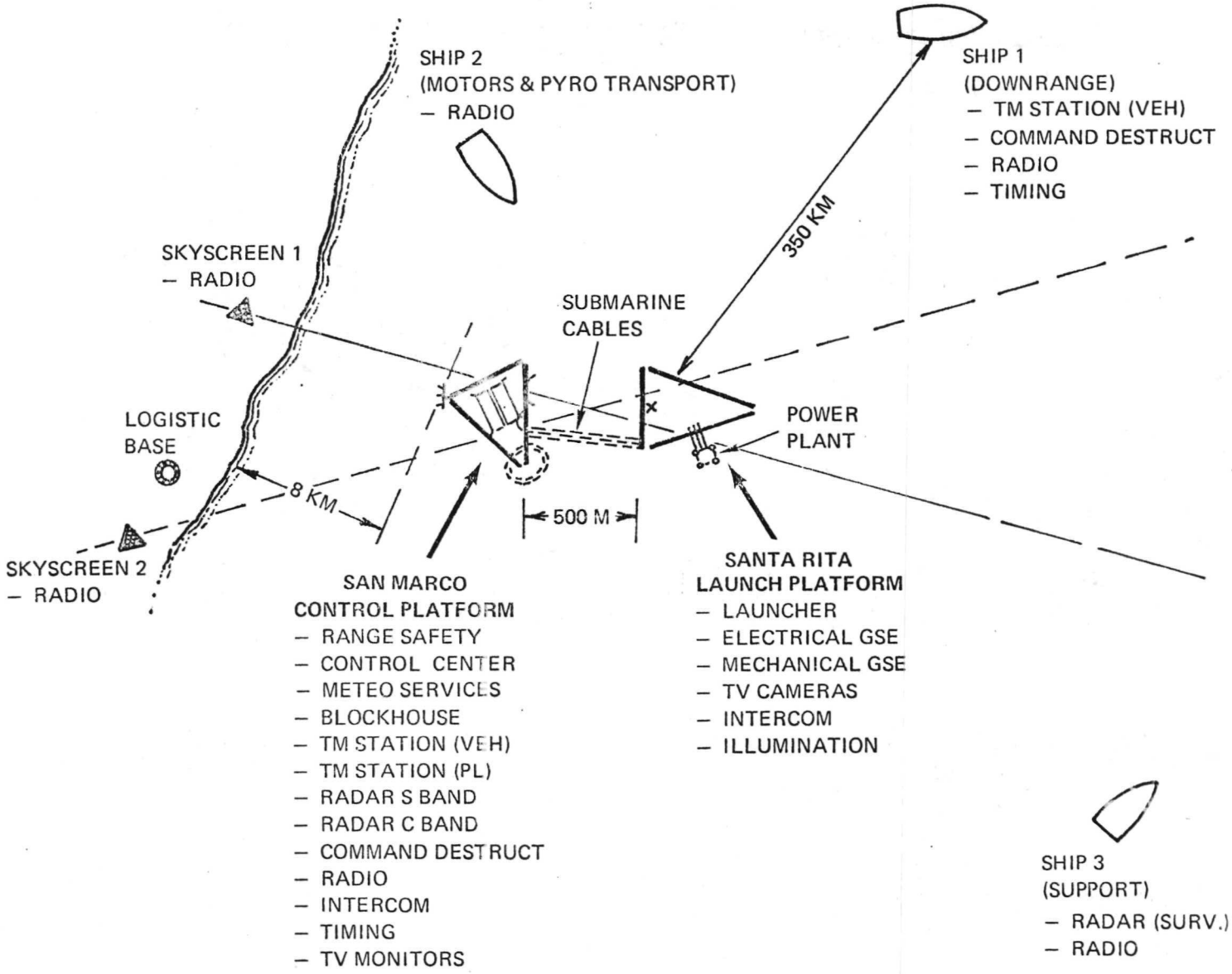


FIGURE 9 PROPOSED RANGE CONFIGURATION

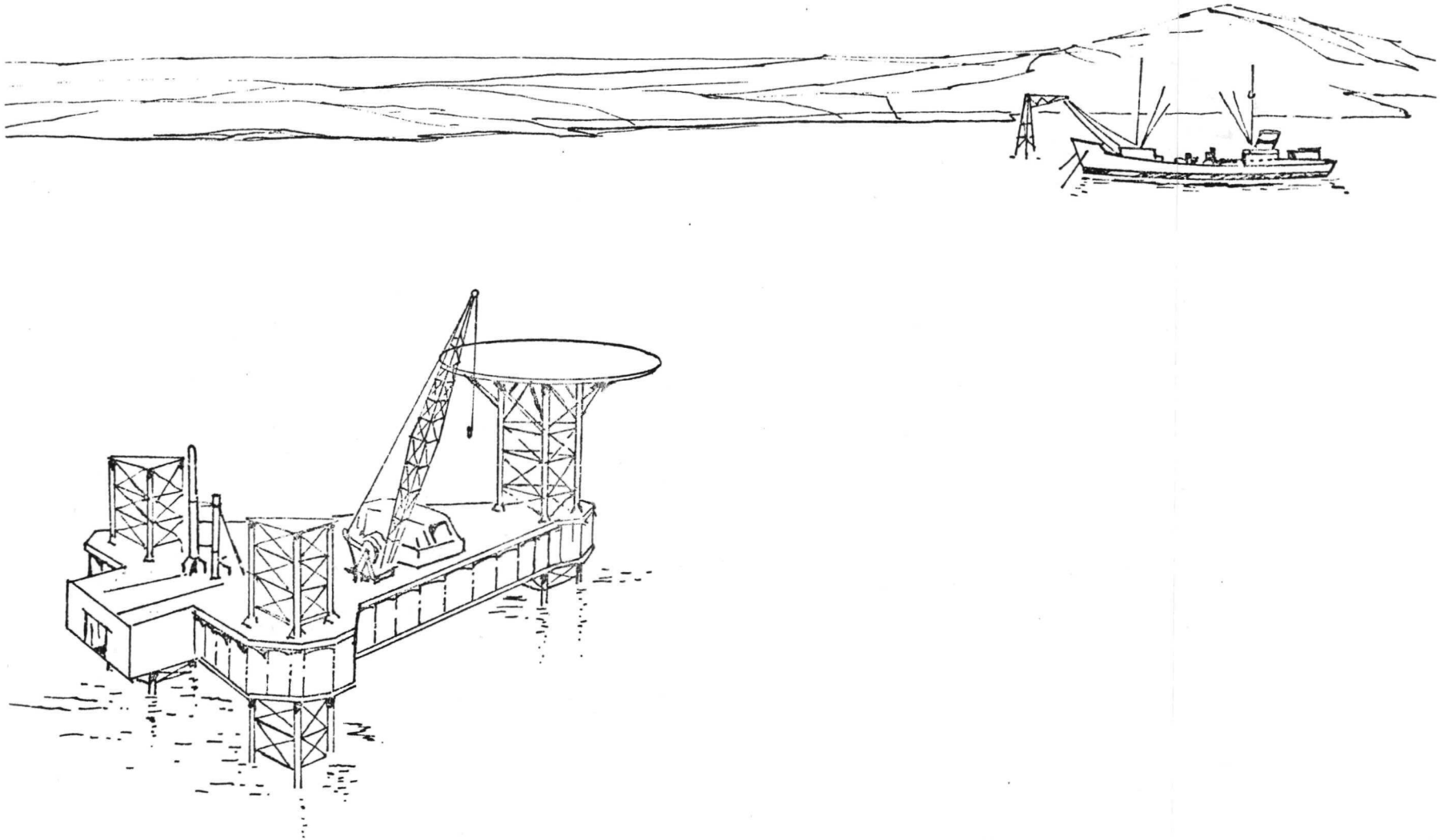


FIGURE 10 CONFIGURATION FOR NIKE/APACHE LAUNCHES (SHEET 1 OF 2)

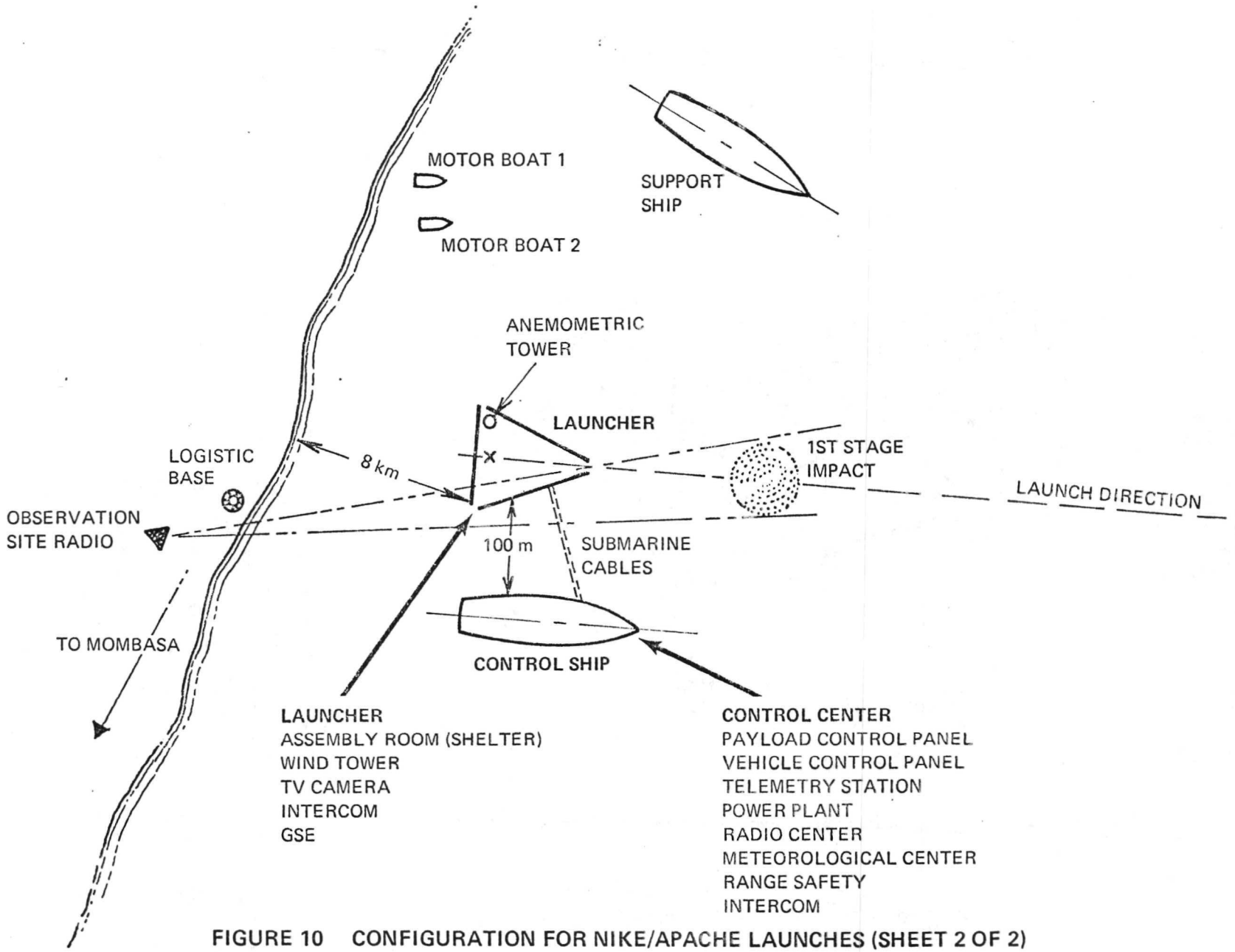


FIGURE 10 CONFIGURATION FOR NIKE/APACHE LAUNCHES (SHEET 2 OF 2)

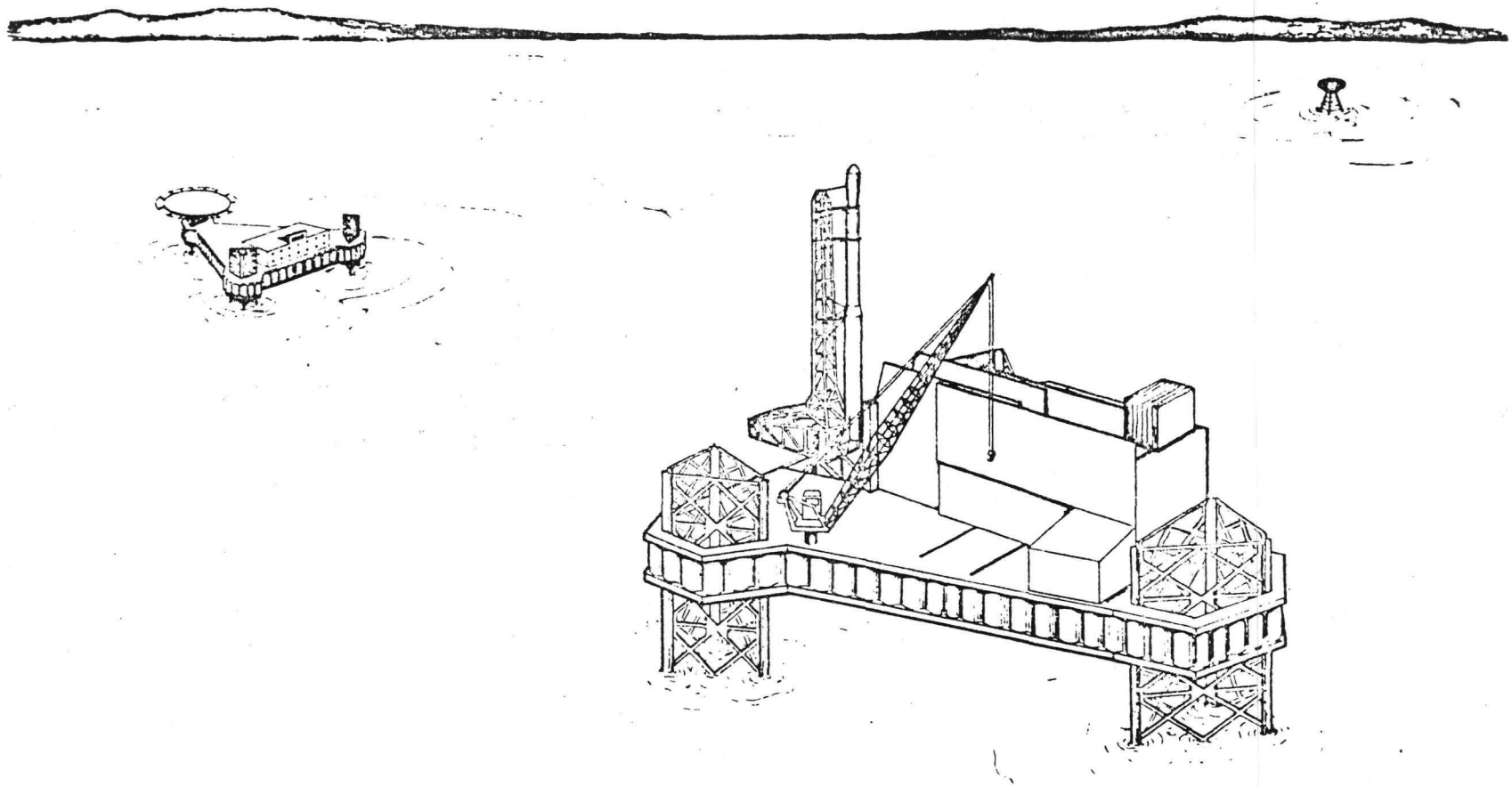


FIGURE 11 PROPOSED SANTA RITA PLATFORM WITH SCOUT LAUNCH COMPLEX (SHEET 1 OF 2)

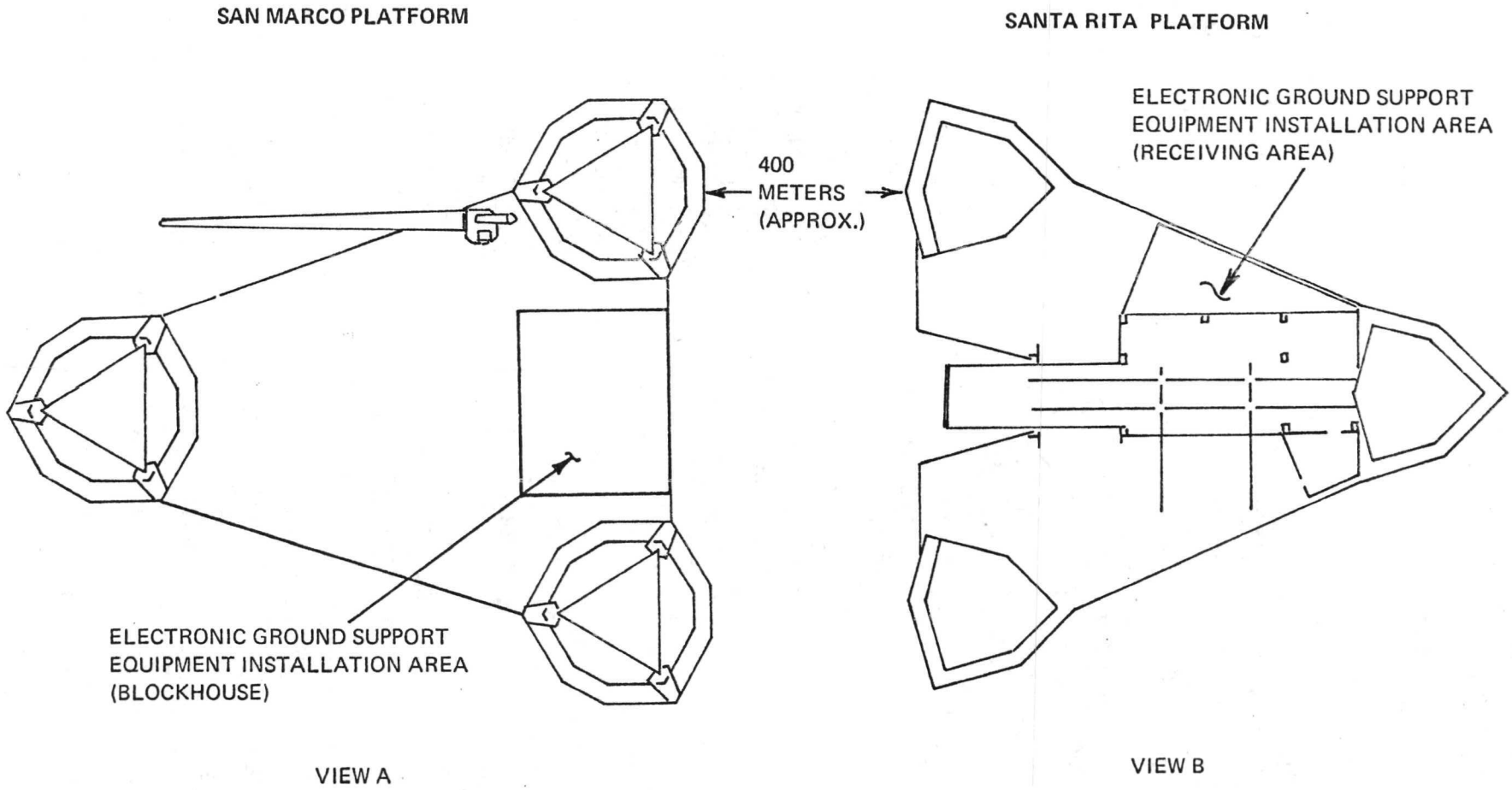
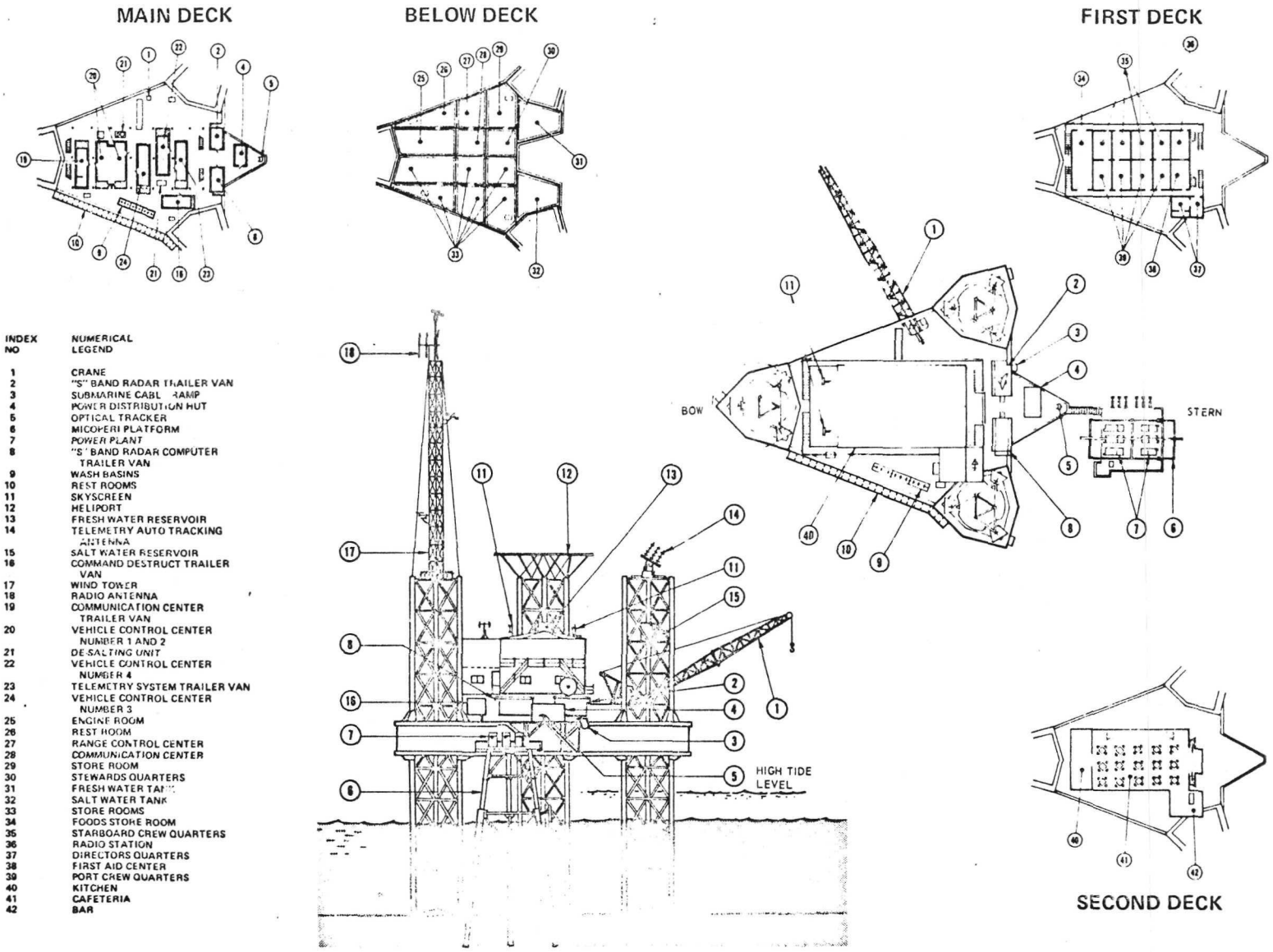
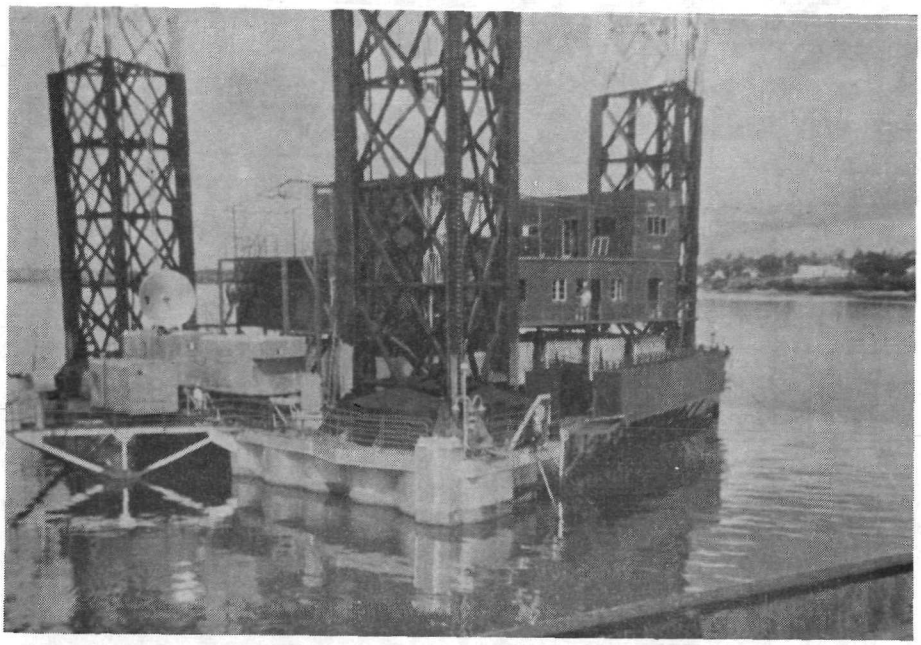


FIGURE 11 PROPOSED SANTA RITA PLATFORM WITH SCOUT LAUNCH COMPLEX (SHEET 2 OF 2)



INDEX NO	NUMERICAL LEGEND
1	CRANE
2	"S" BAND RADAR TRAILER VAN
3	SUBMARINE CABL RAMP
4	POWER DISTRIBUTION HUT
5	OPTICAL TRACKER
6	MICOPERI PLATFORM
7	POWER PLANT
8	"S" BAND RADAR COMPUTER TRAILER VAN
9	WASH BASINS
10	REST ROOMS
11	SKYSCREEN
12	HELIPORT
13	FRESH WATER RESERVOIR
14	TELEMETRY AUTO TRACKING ANTENNA
15	SALT WATER RESERVOIR
16	COMMAND DESTRUCT TRAILER VAN
17	WIND TOWER
18	RADIO ANTENNA
19	COMMUNICATION CENTER TRAILER VAN
20	VEHICLE CONTROL CENTER NUMBER 1 AND 2
21	DESALTING UNIT
22	VEHICLE CONTROL CENTER NUMBER 4
23	TELEMETRY SYSTEM TRAILER VAN
24	VEHICLE CONTROL CENTER NUMBER 3
25	ENGINE ROOM
26	REST ROOM
27	RANGE CONTROL CENTER
28	COMMUNICATION CENTER
29	STORE ROOM
30	STEWARDS QUARTERS
31	FRESH WATER TANK
32	SALT WATER TANK
33	STORE ROOMS
34	FOODS STORE ROOM
35	STARBOARD CREW QUARTERS
36	RADIO STATION
37	DIRECTORS QUARTERS
38	FIRST AID CENTER
39	PORT CREW QUARTERS
40	KITCHEN
41	CAFETERIA
42	BAR

FIGURE 12 LAYOUT AND GENERAL ARRANGEMENT OF SANTA RITA PLATFORM AS CONTROL PLATFORM



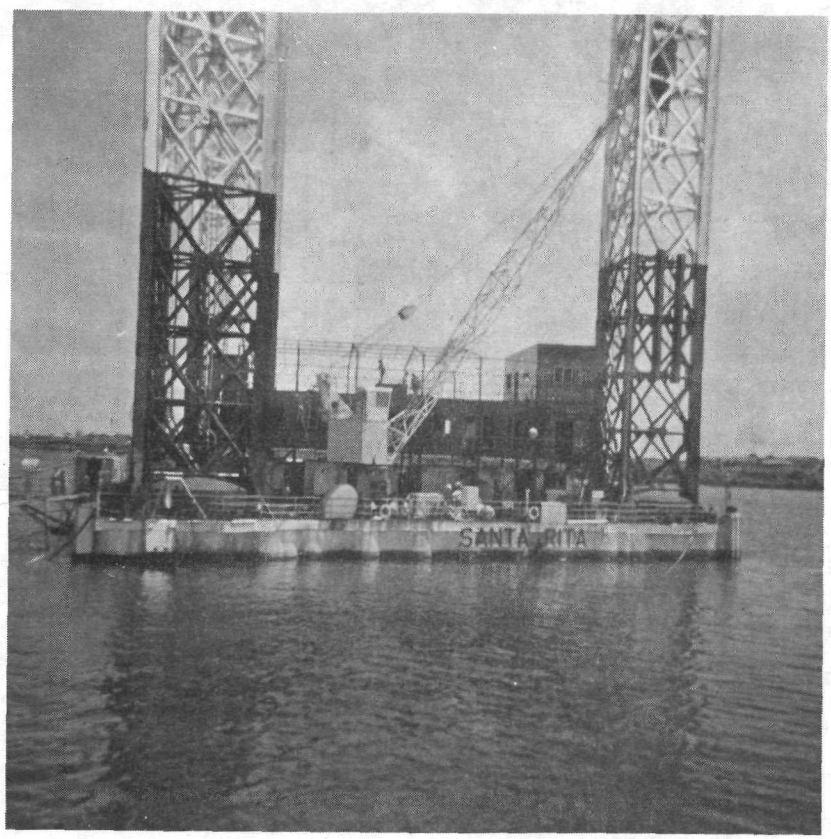
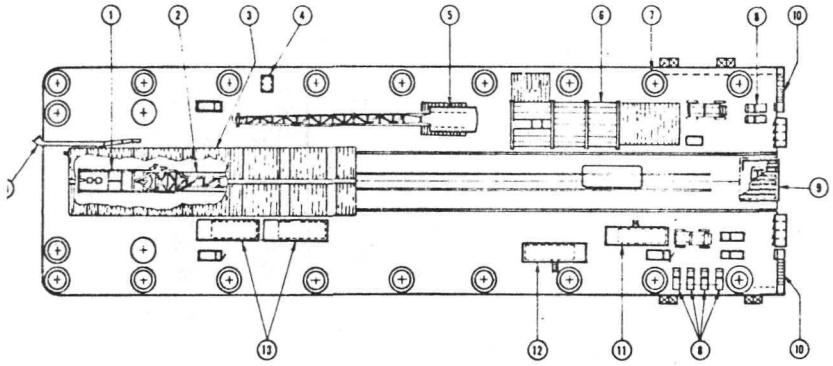
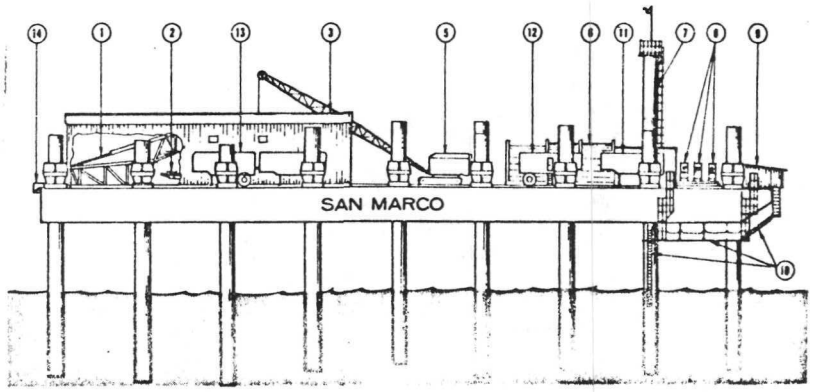
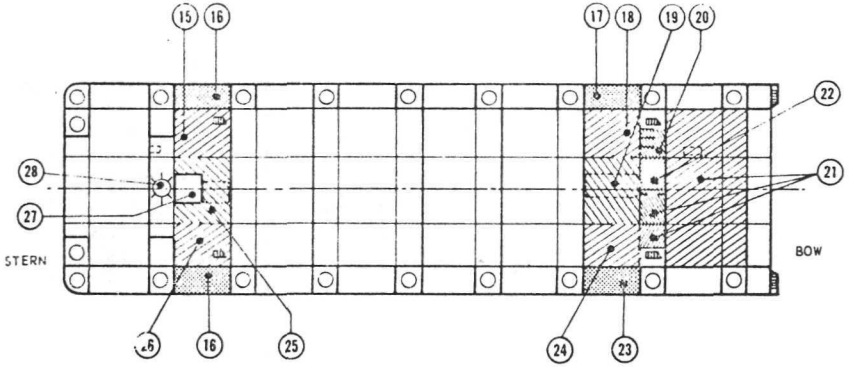


FIGURE 13 SANTA RITA PLATFORM AT MOMBASA



MAIN DECK

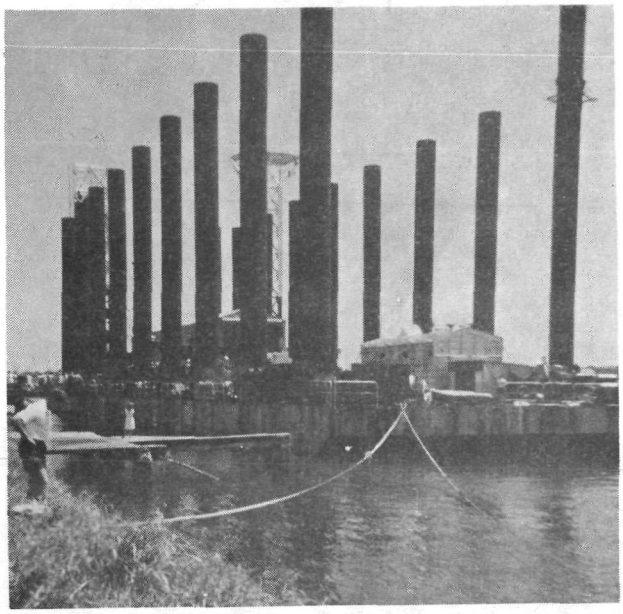




BELOW DECK

INDEX NO.	NUMERICAL LEGEND
1	LAUNCHER
2	VEHICLE TRANSPORTER
3	SHELTER S-1
4	PYROTECHNIC TEST ROOM
5	CRANE
6	SHELTER S-2
7	WATER RESERVOIR
8	POWER PLANT
9	CAPSTAN HUT
10	PLATFORM ACCESS LADDERS
11	WORKSHOP TRAILER VAN
12	OPERATIONS TRAILER VAN
13	VEHICLE TEST SET TRAILER VAN
14	SUBMARINE CABLE RAMP
15	ELECTRICAL TERMINAL ROOM
16	SALT WATER TANK
17	FRESH WATER TANK
18	ELECT PWR ROOM AND DE-SALTING UNIT
19	CREW QUARTERS
20	REST ROOM
21	STORE ROOM
22	TECHNICAL FILE ROOM
23	DIESEL OIL TANK
24	COMPRESSED AIR PLANT
25	STORE ROOM
26	H_2O_2 SERVICING UNIT
27	MISSILE GASES EXHAUST
28	LAUNCHER PIT

FIGURE 14 SAN MARCO PLATFORM LAYOUT AND GENERAL ARRANGEMENT



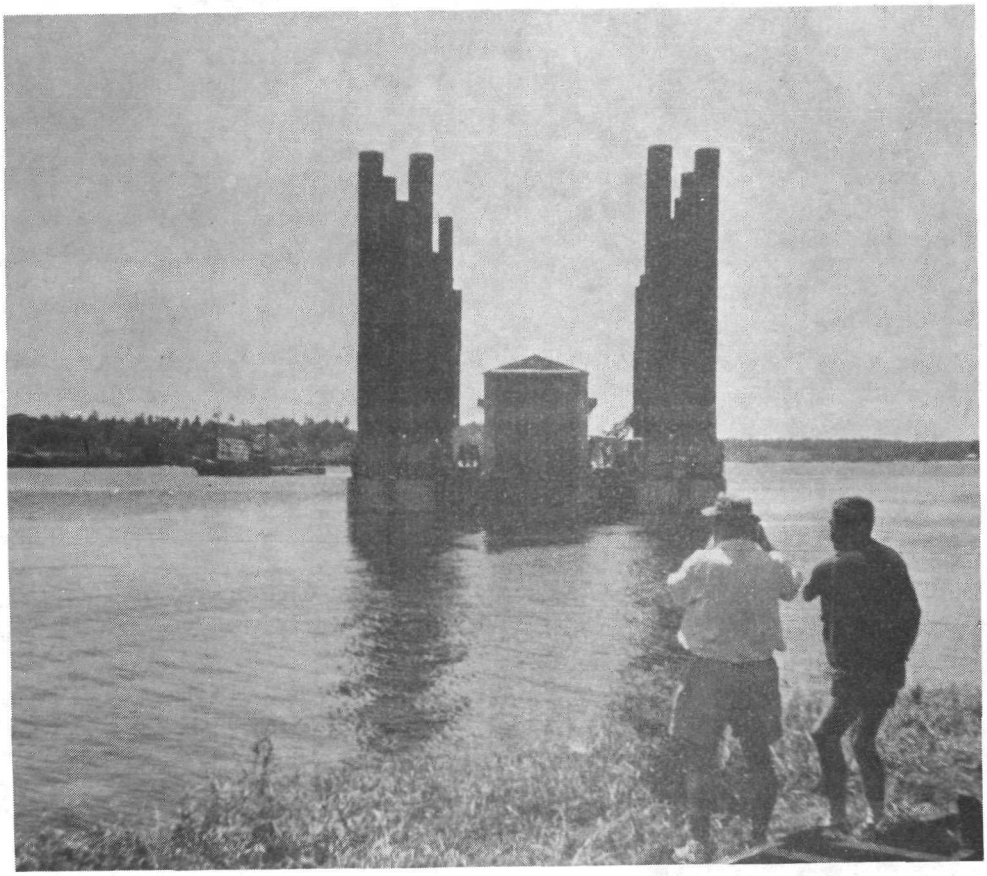


FIGURE 15 SAN MARCO PLATFORM AT MOMBASA

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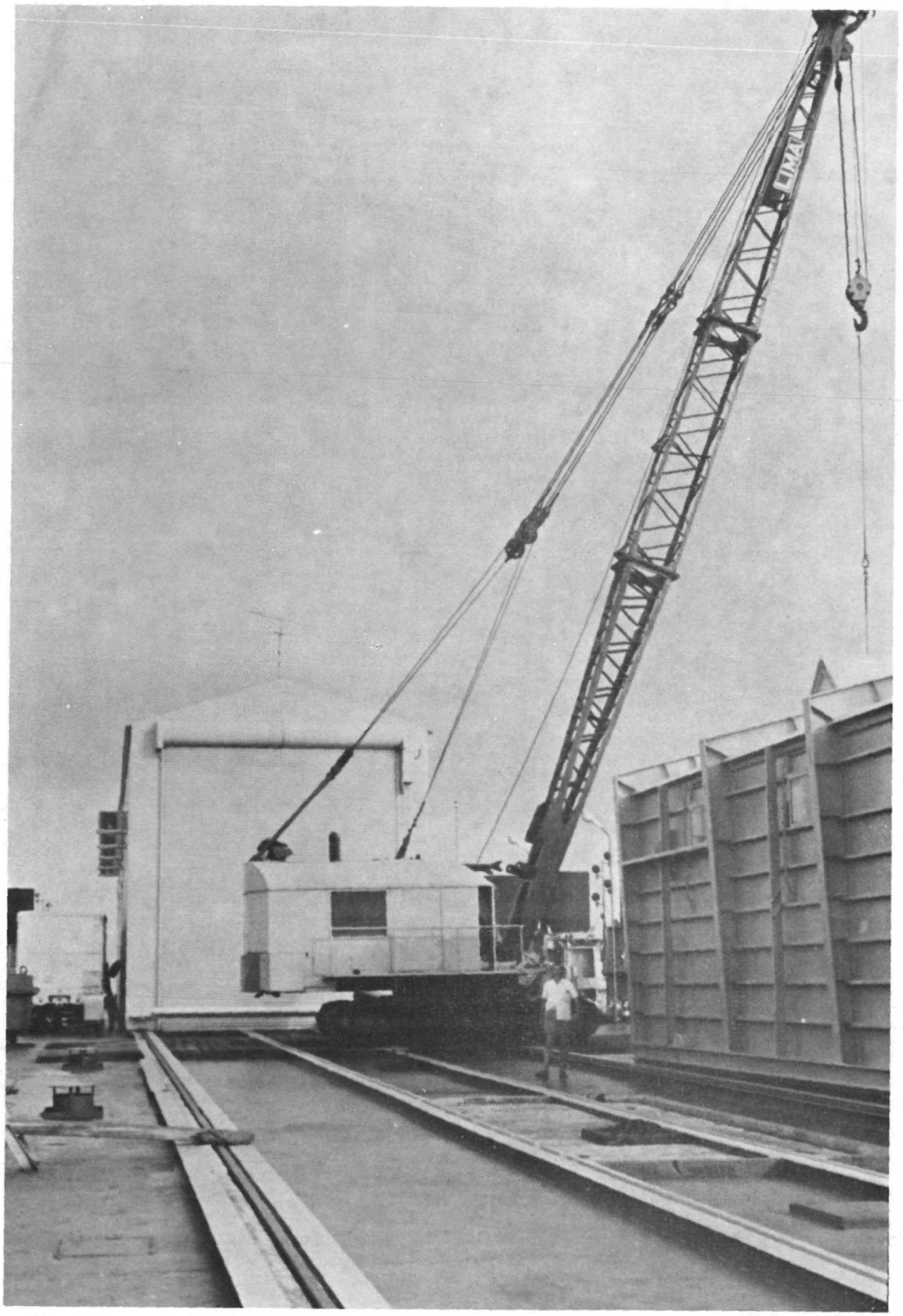
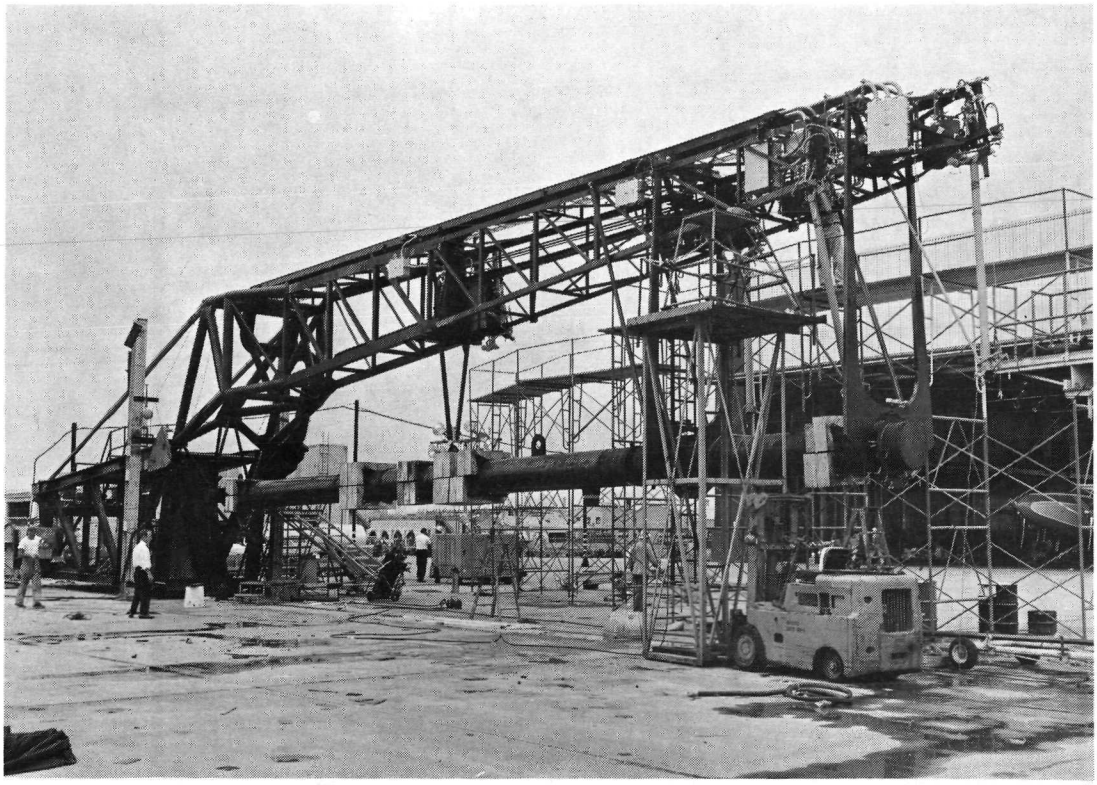


FIGURE 16 MOBILE CRANE



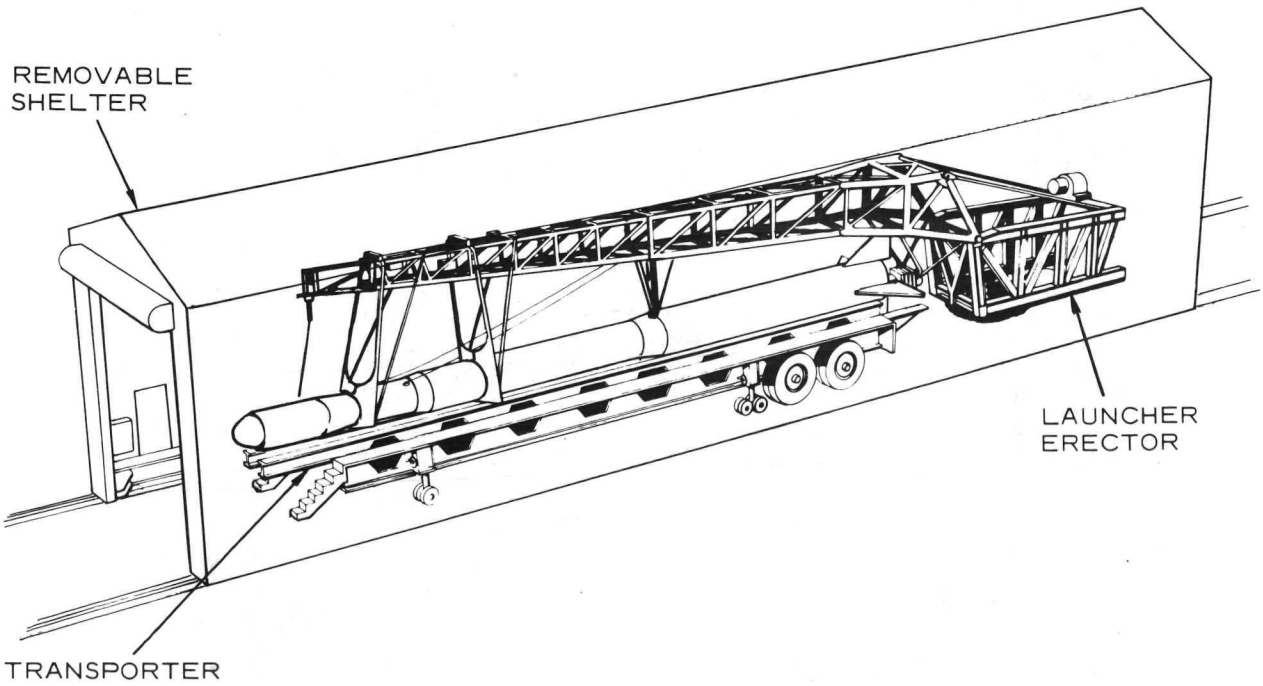
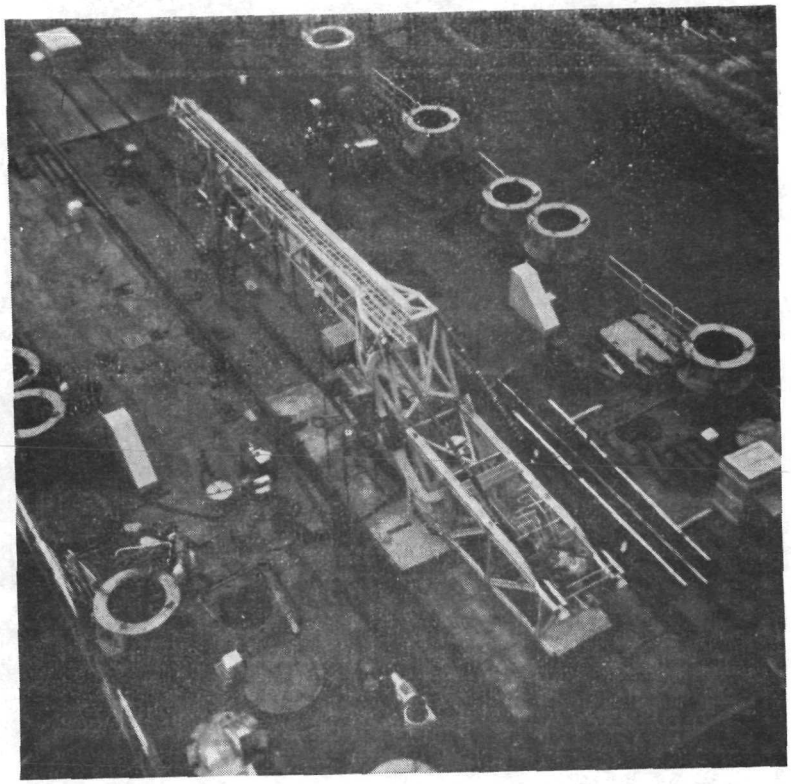


FIGURE 17 MARK II LAUNCHER (SHEET 1 OF 2)



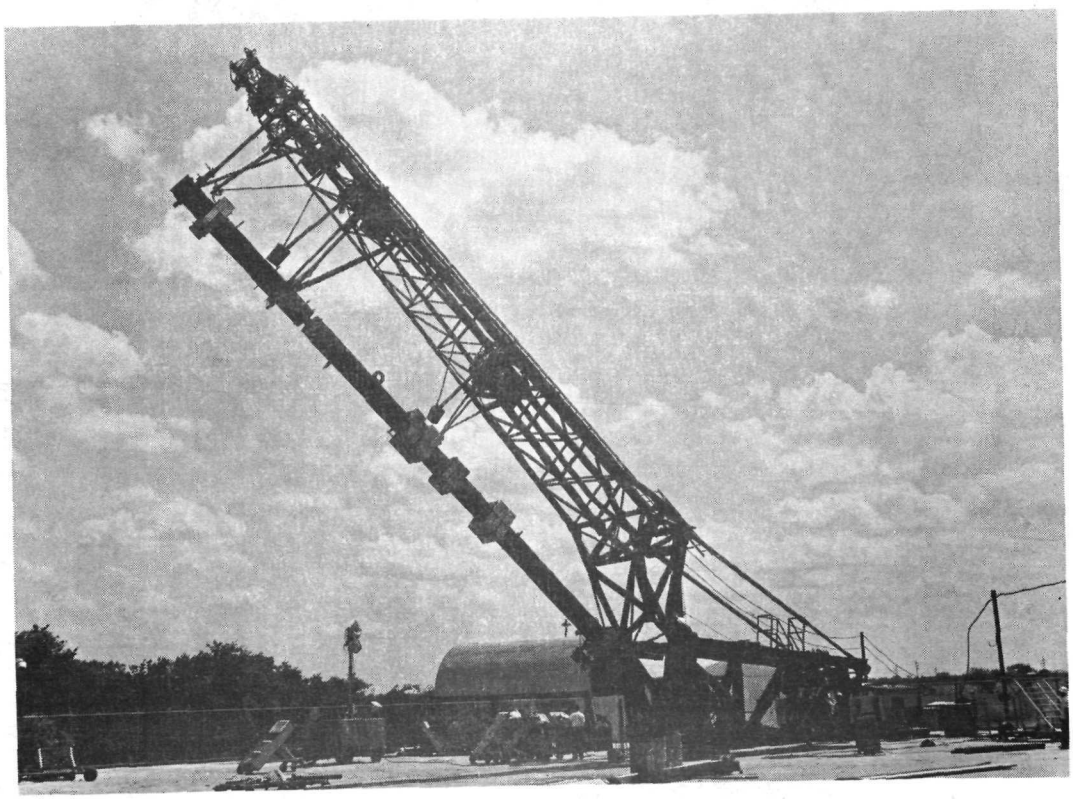


FIGURE 17 MARK II LAUNCHER (SHEET 2 OF 2)

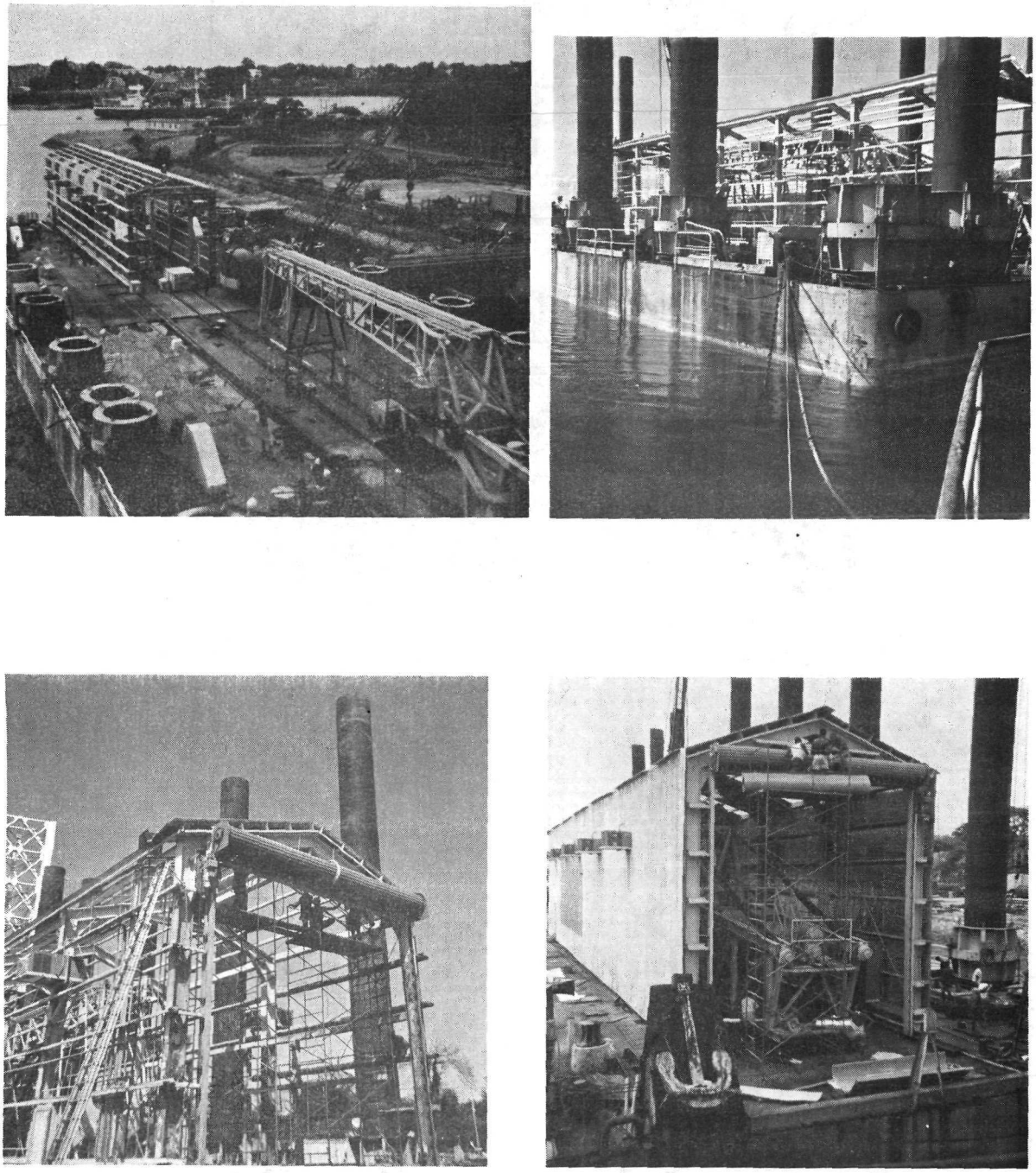
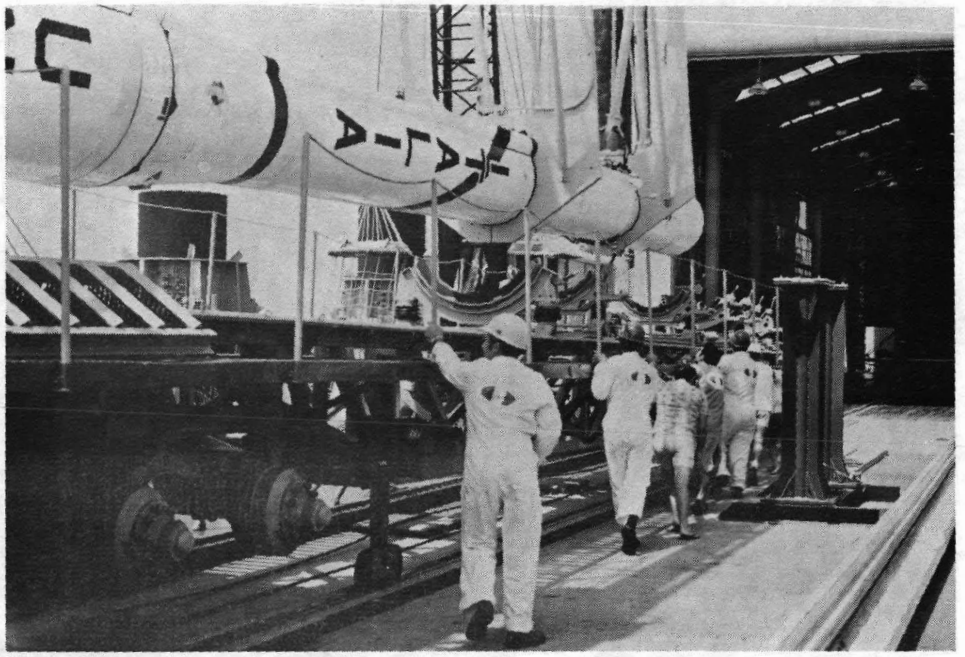


FIGURE 18 SCOUT VEHICLE SHELTER



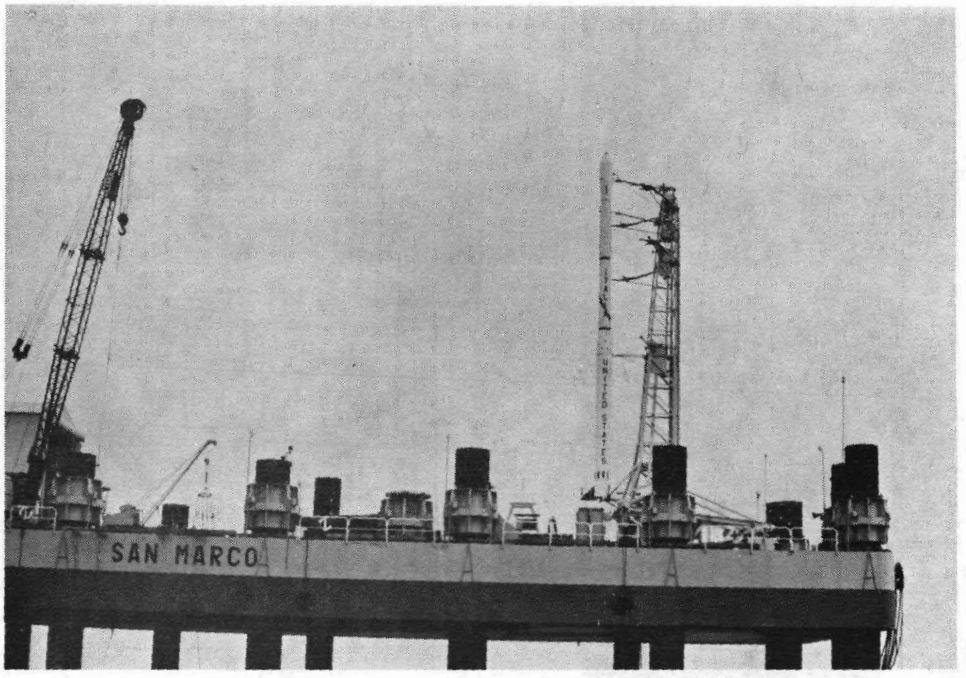
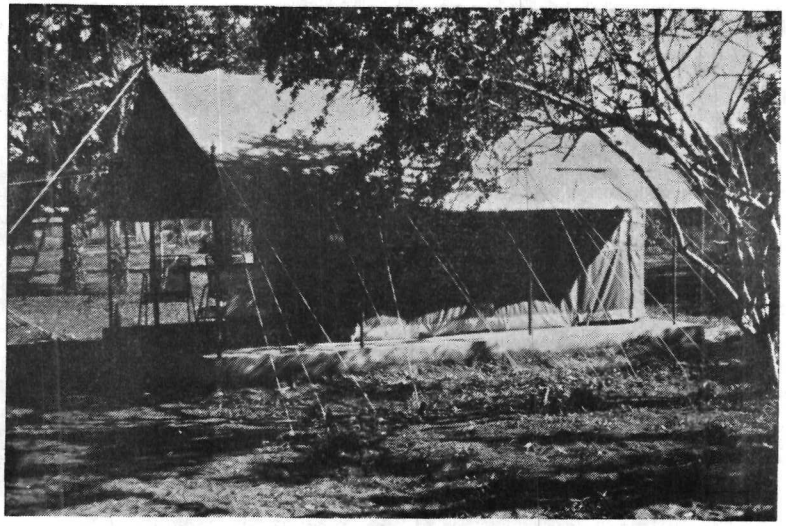
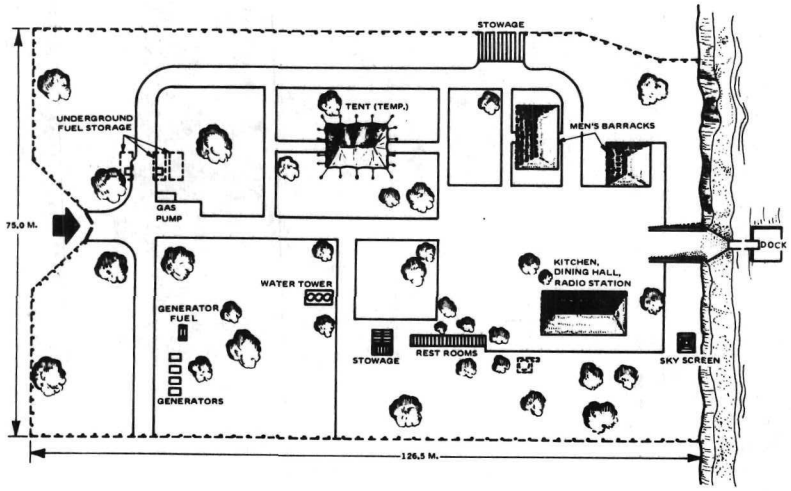


FIGURE 19 LAUNCH COMPLEX OPERATIONS





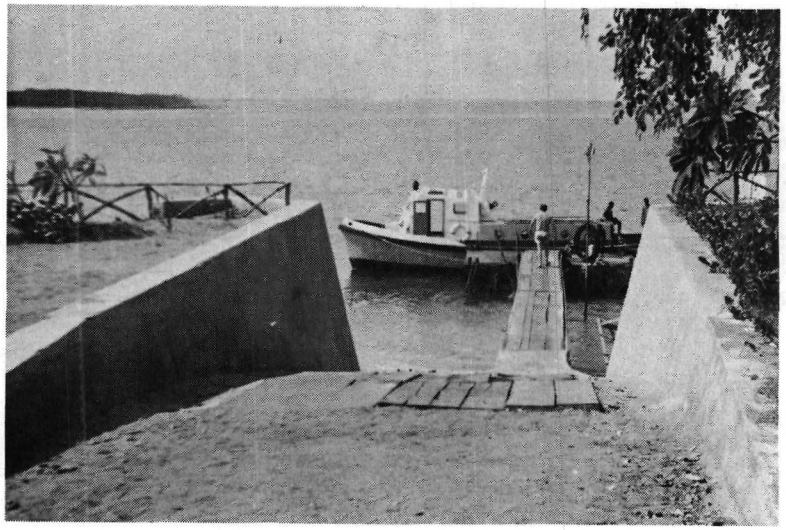


FIGURE 20 BASE CAMP 1967

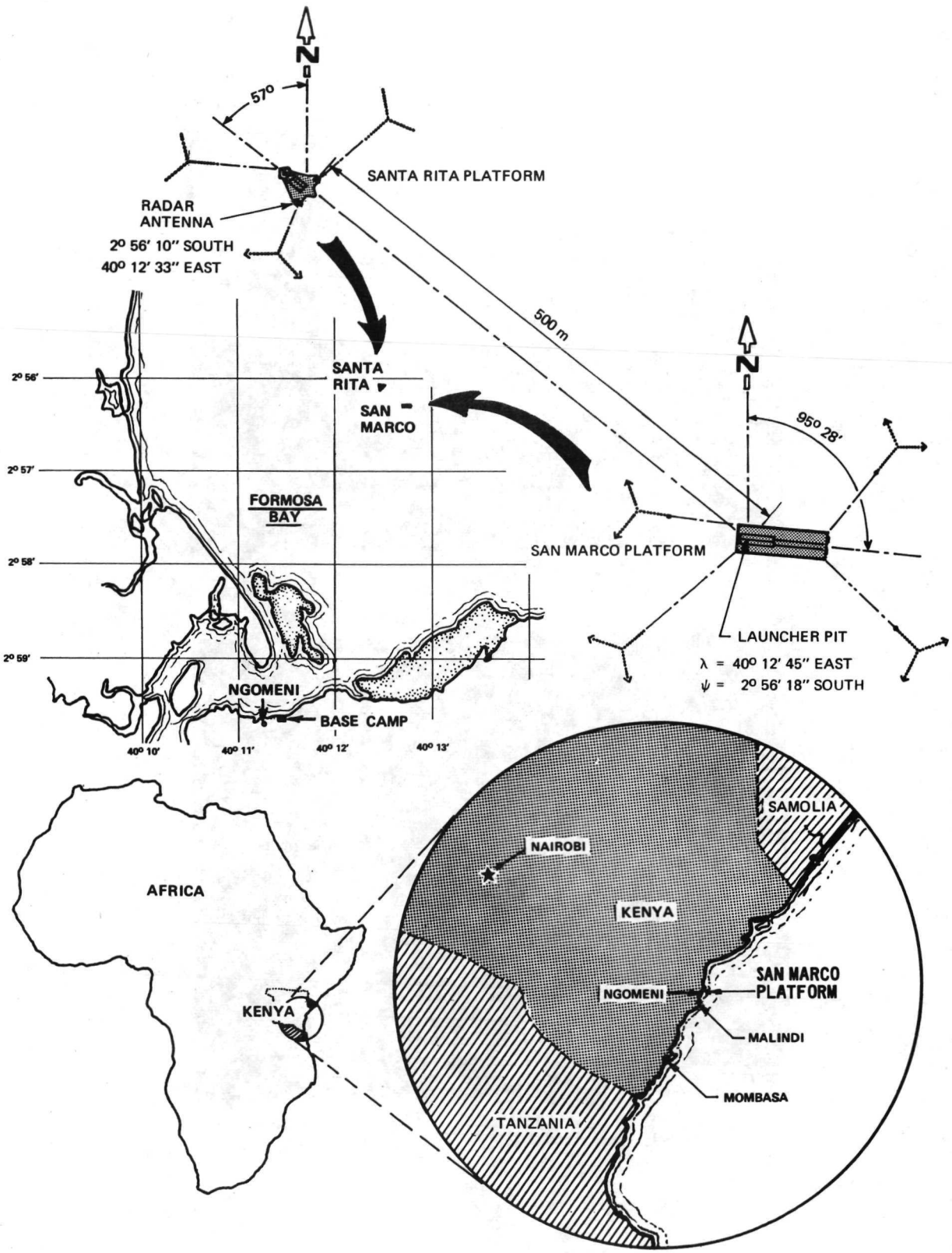
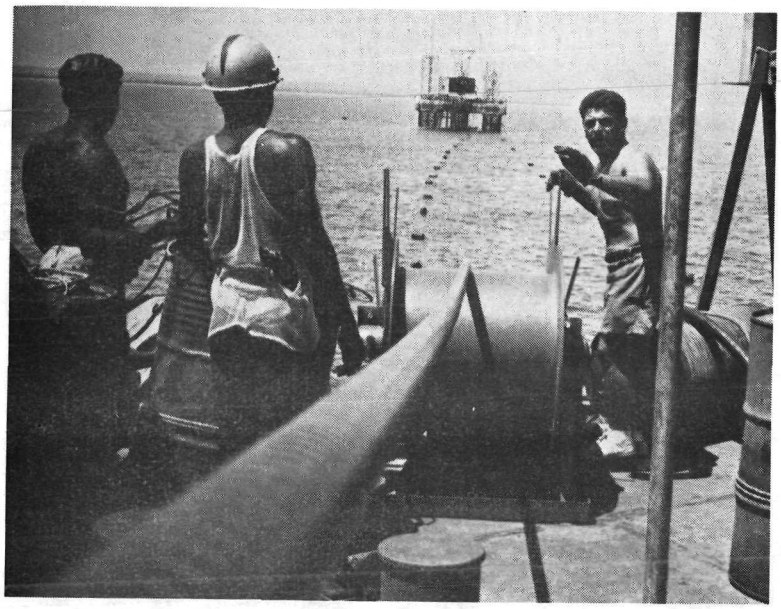


FIGURE 21 LAUNCH SITE LAYOUT IN FORMOSA BAY



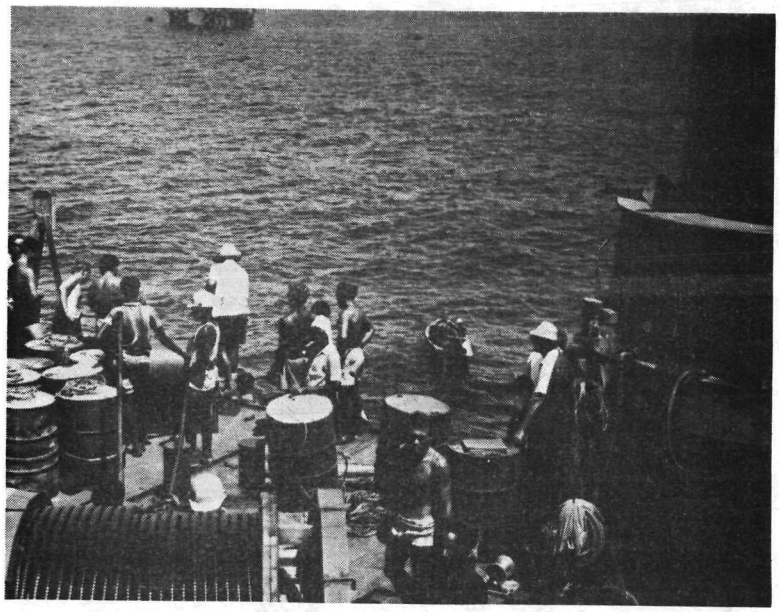


FIGURE 22 CABLE LAYING OPERATIONS

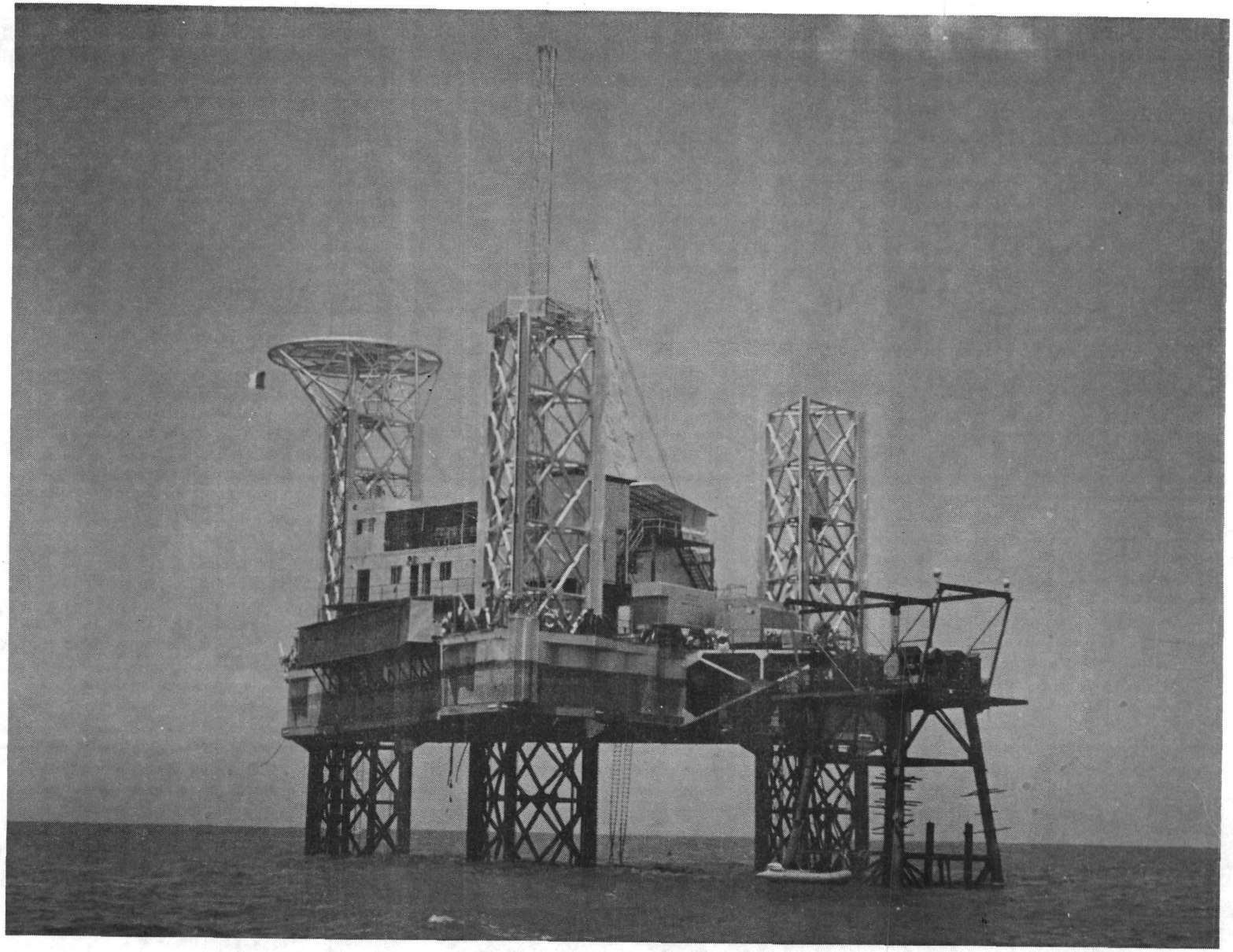


FIGURE 23 SANTA RITA PLATFORM – 1967

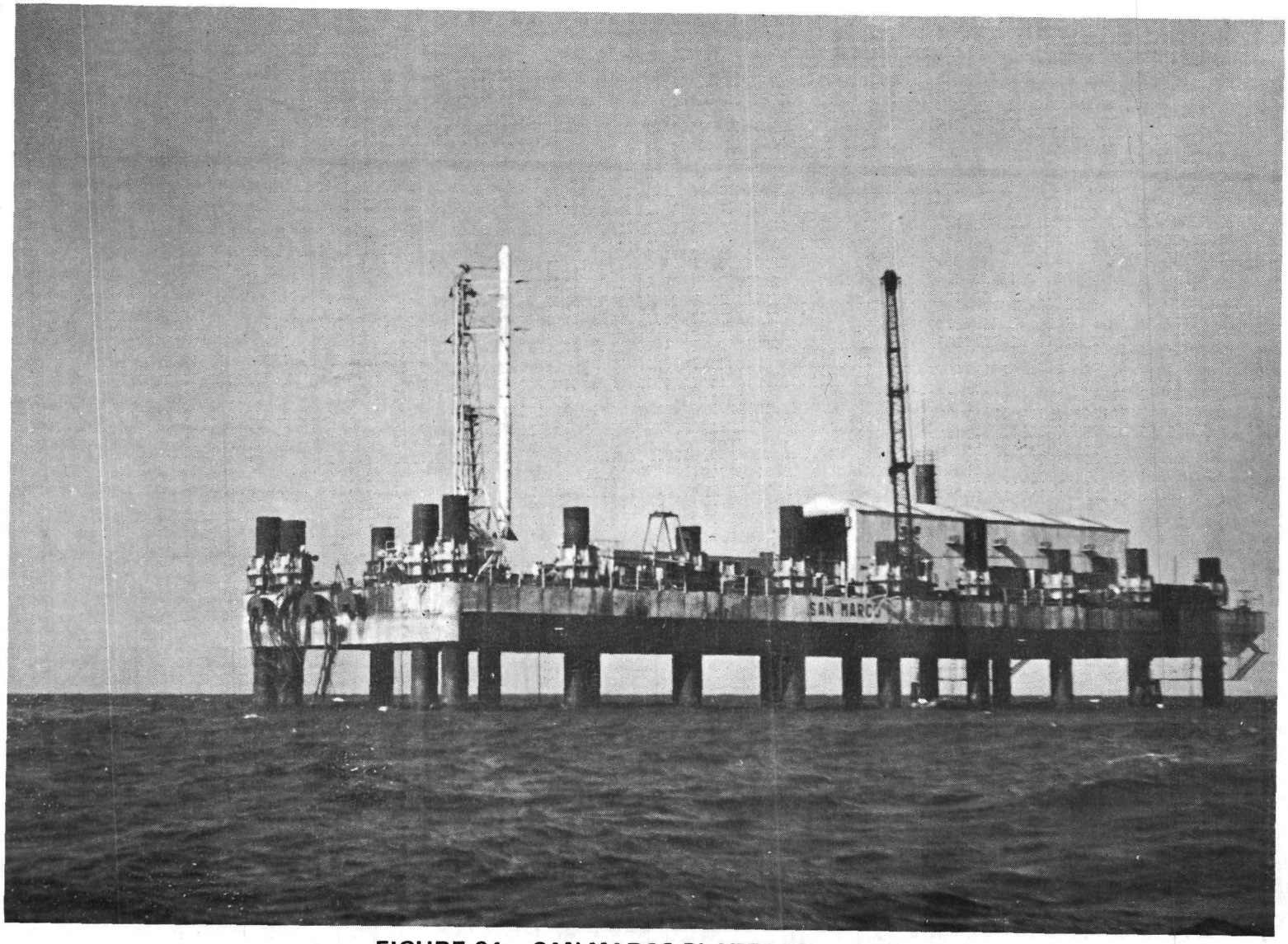


FIGURE 24 SAN MARCO PLATFORM – 1967

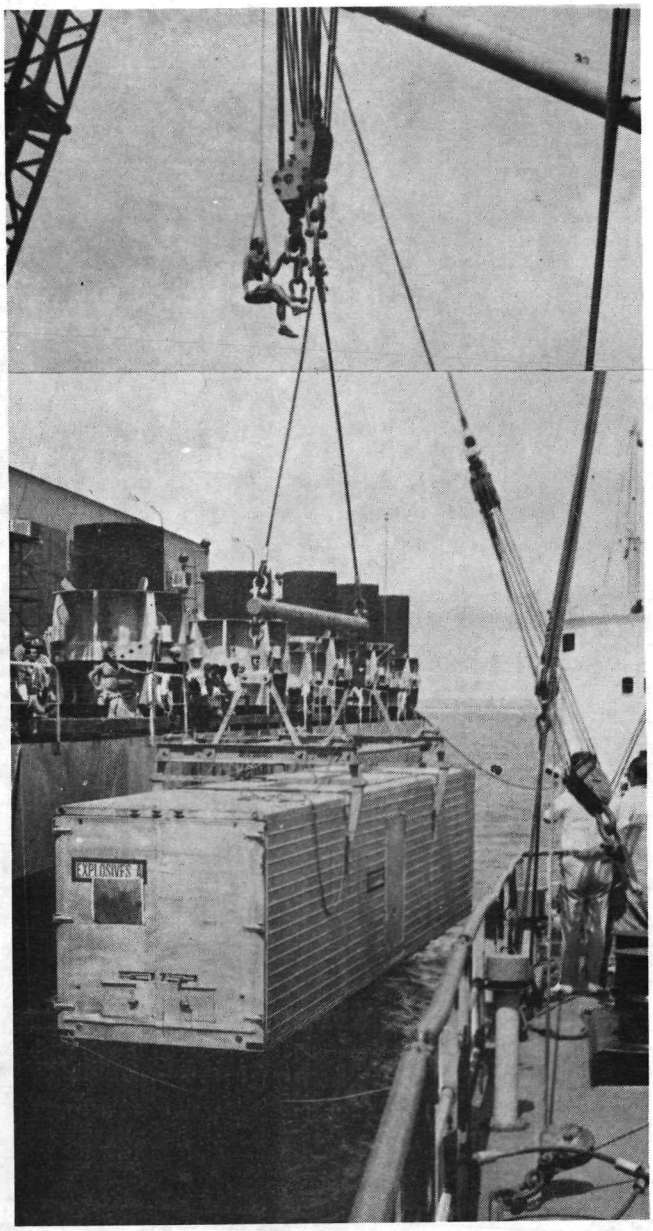


FIGURE 25 MOTOR OFF-LOADING MID AIR TRANSFER

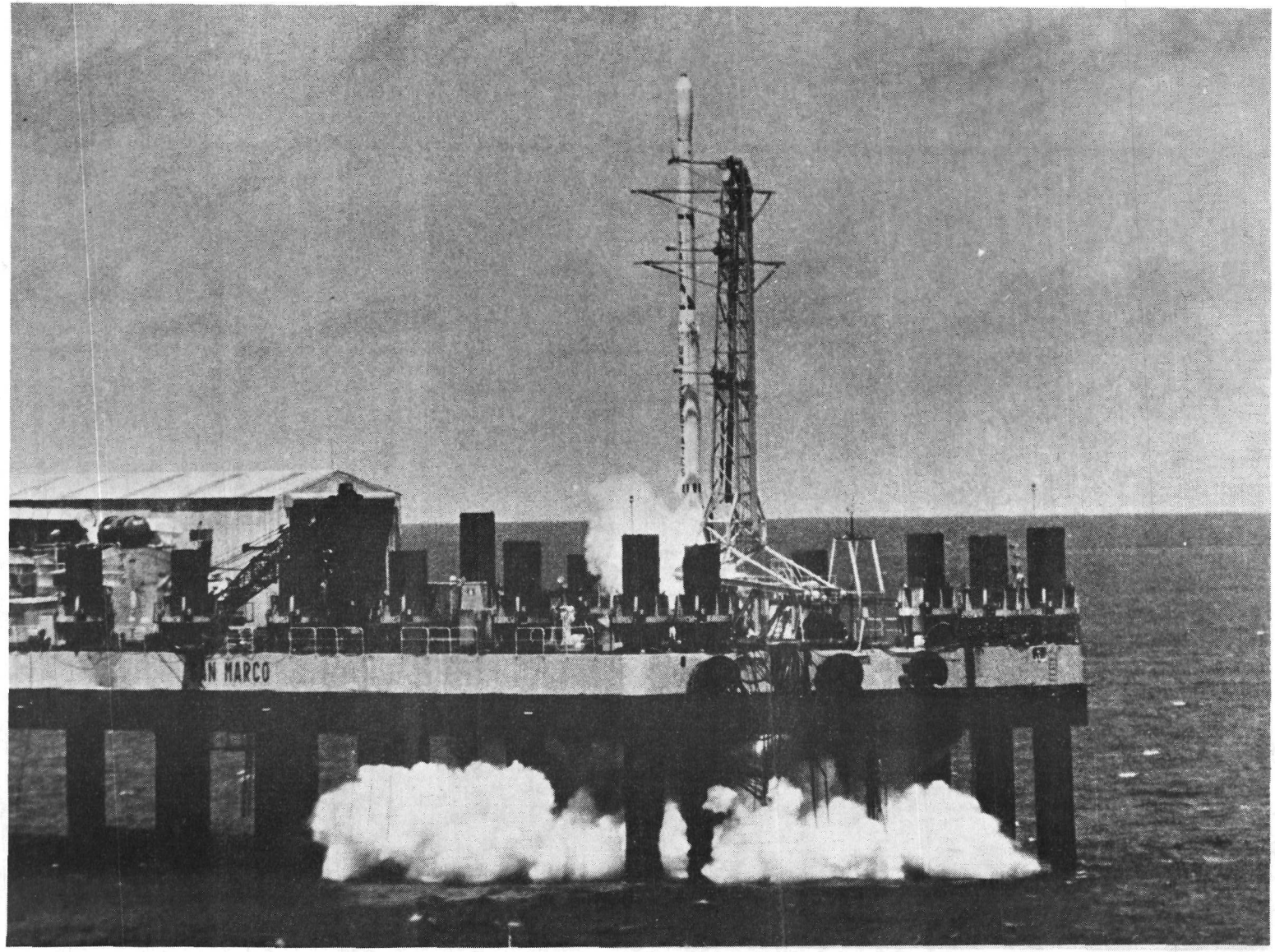


FIGURE 26 SAN MARCO "B" LAUNCH

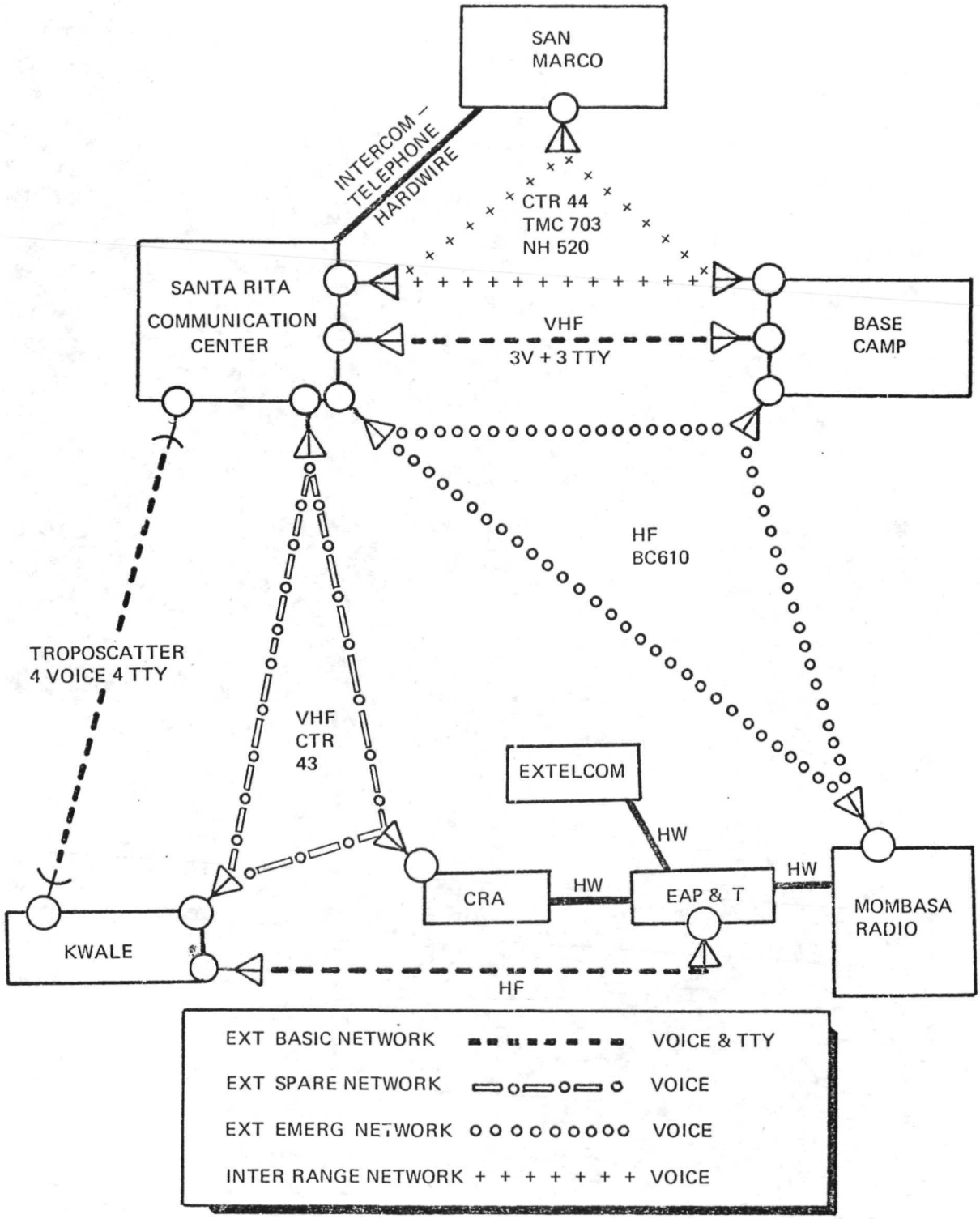


FIGURE 27 COMMUNICATION NETWORK BLOCK DIAGRAM

FIGURE 28 RADAR AUXILIARY PLATFORM

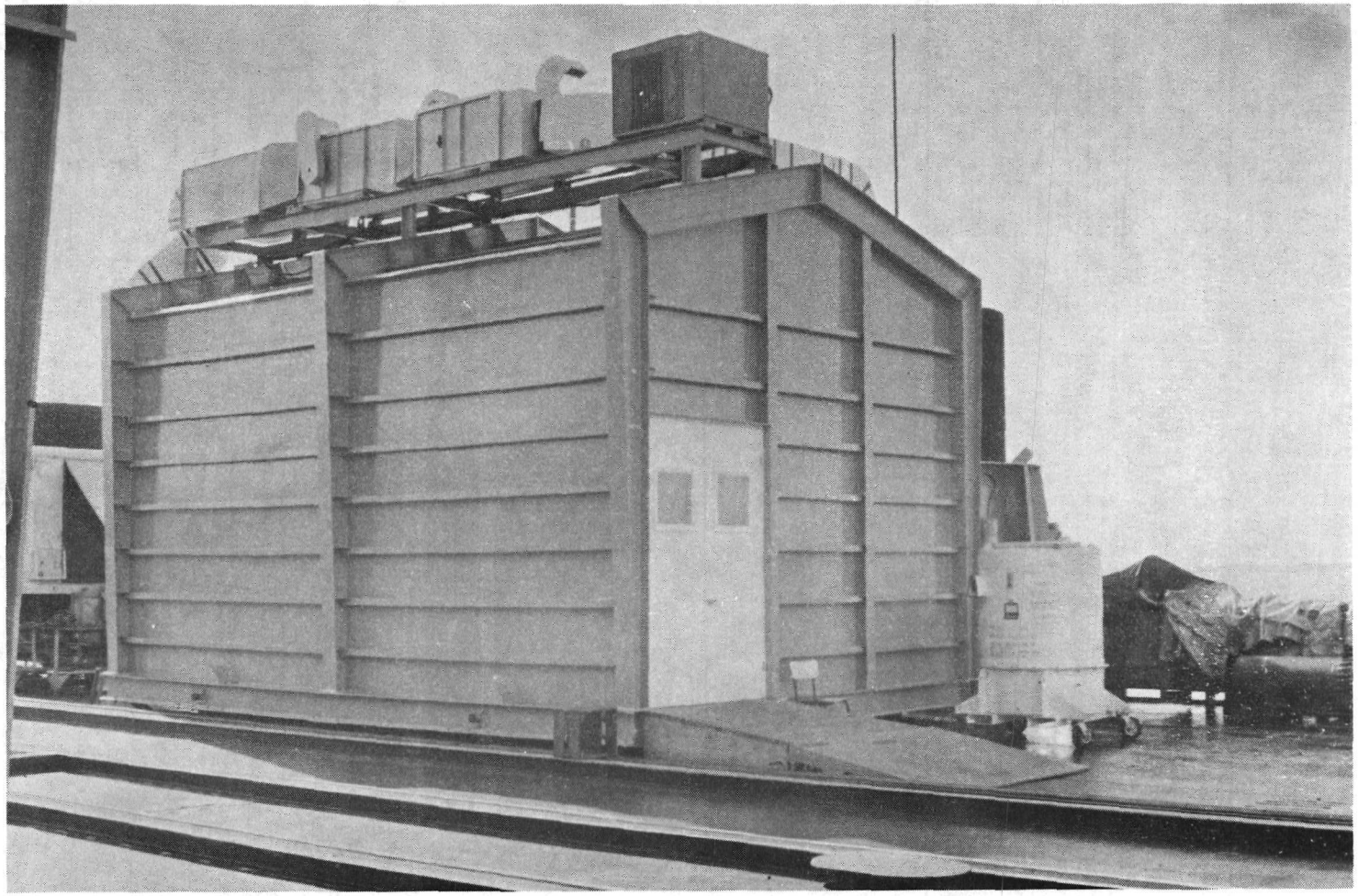


FIGURE 29 CLEAN ROOM

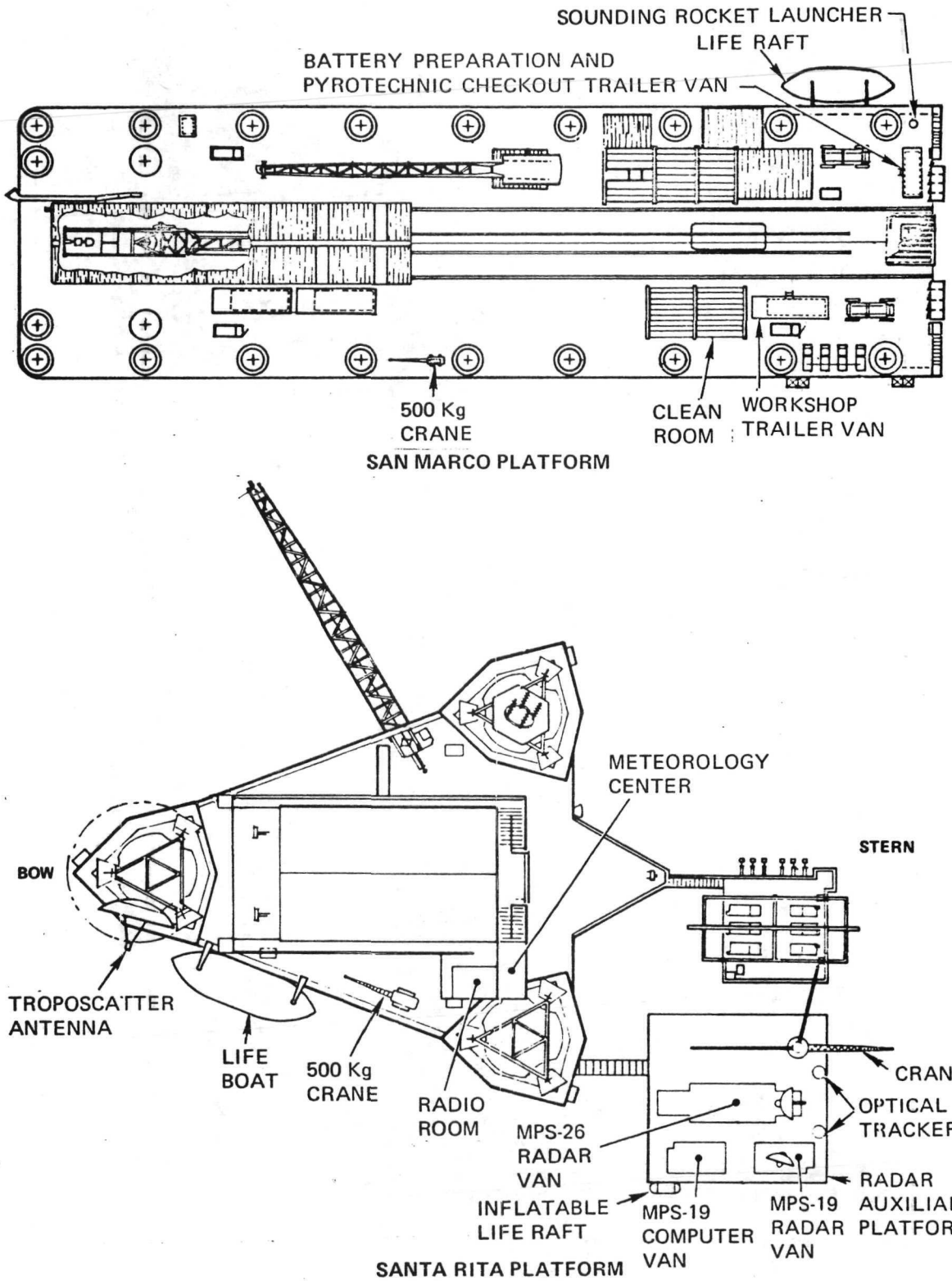
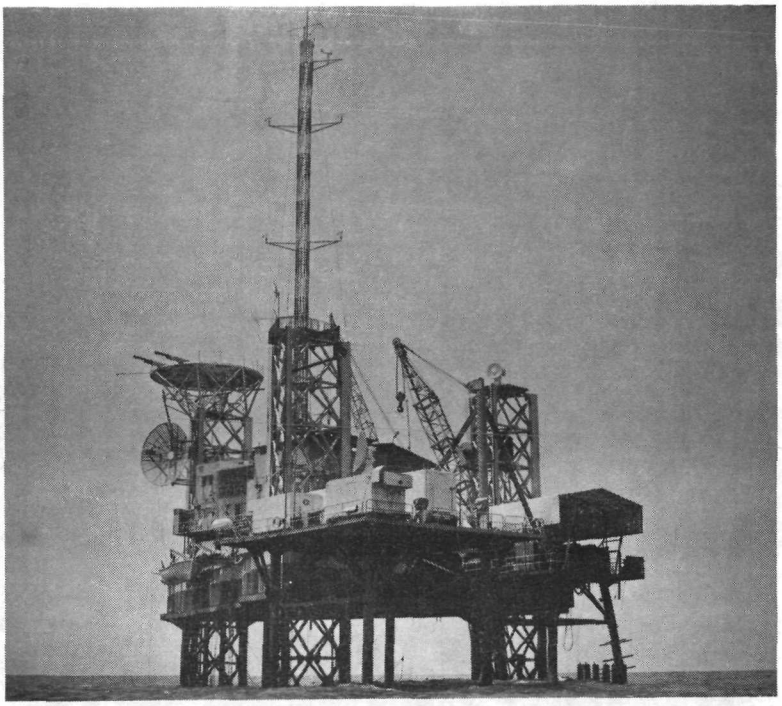


FIGURE 30 PLATFORM IMPROVEMENTS



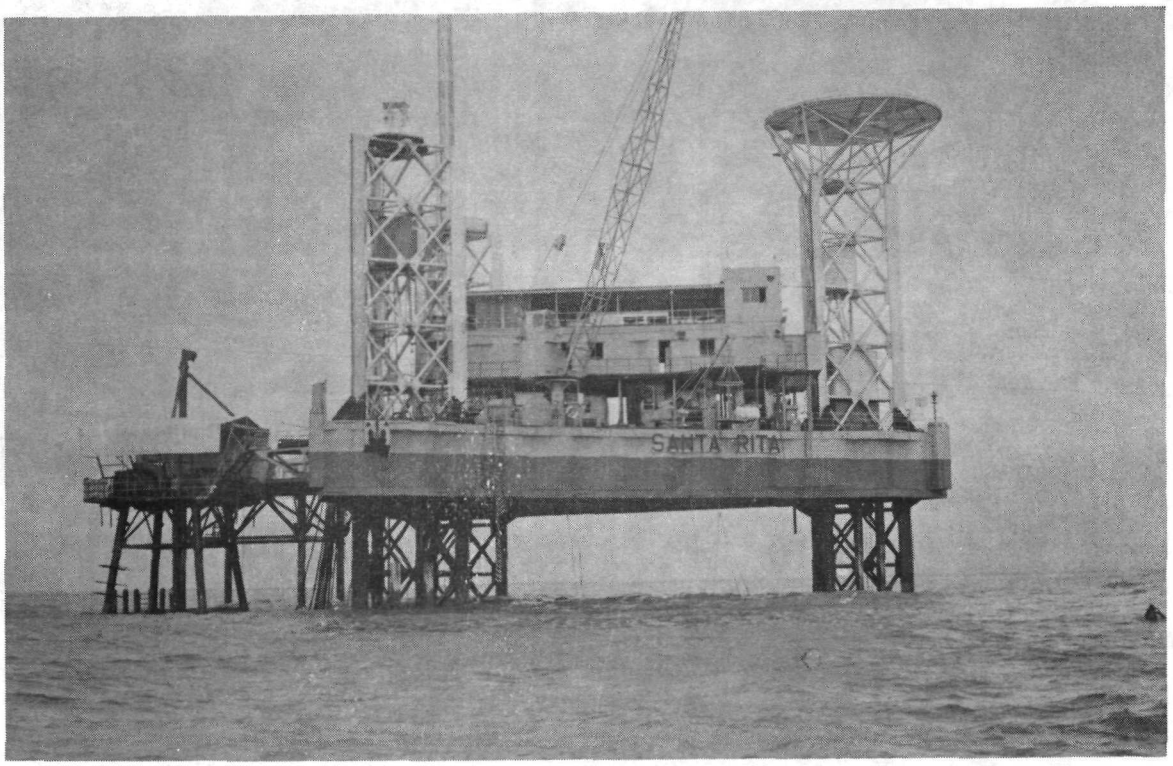


FIGURE 31 SANTA RITA PLATFORM 1970

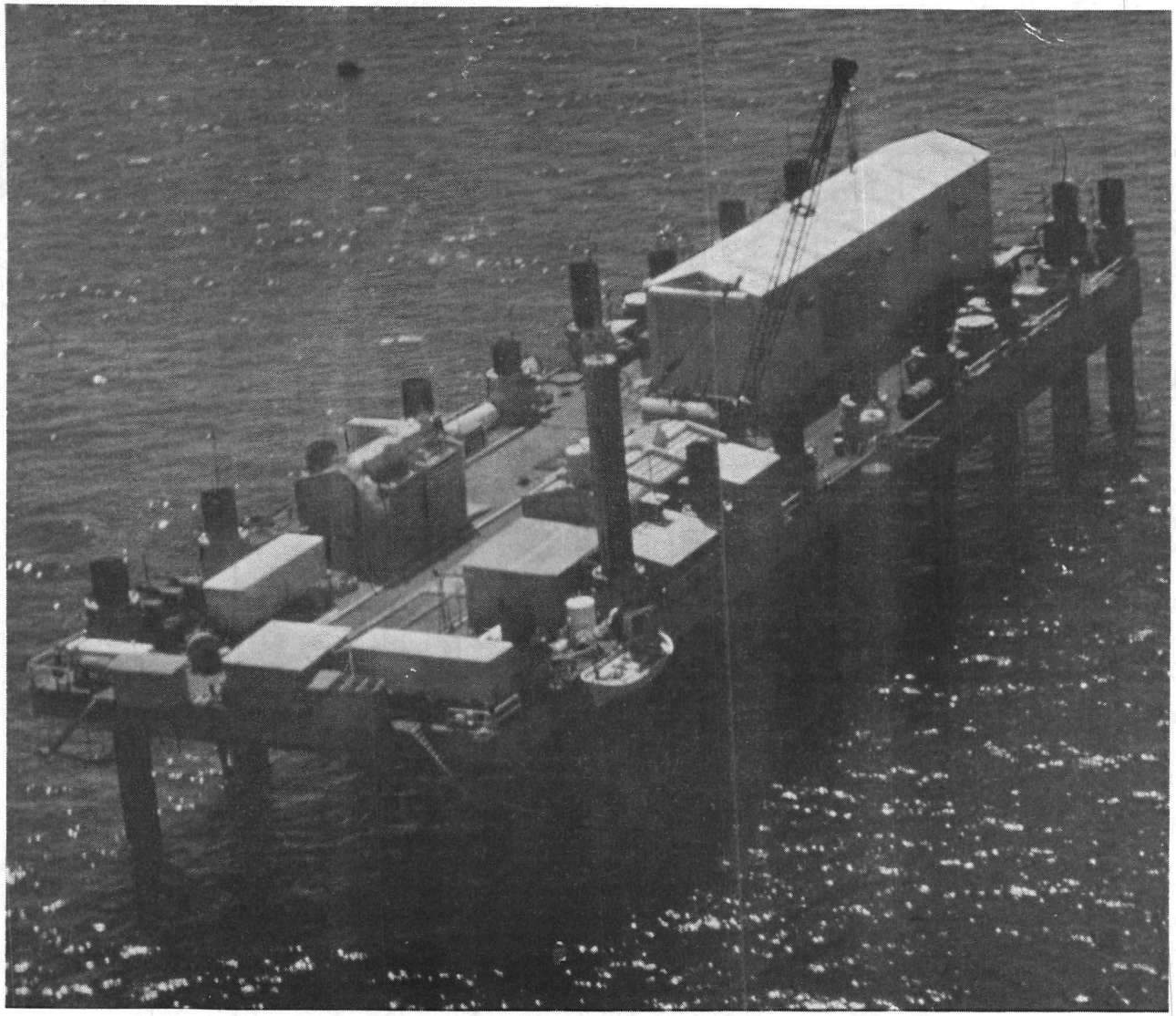
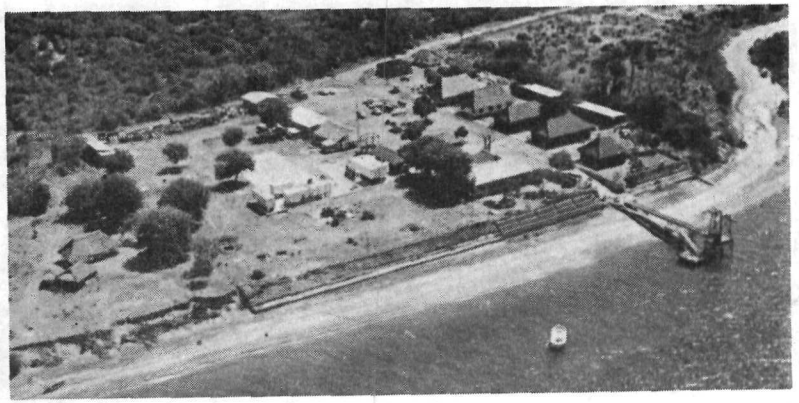
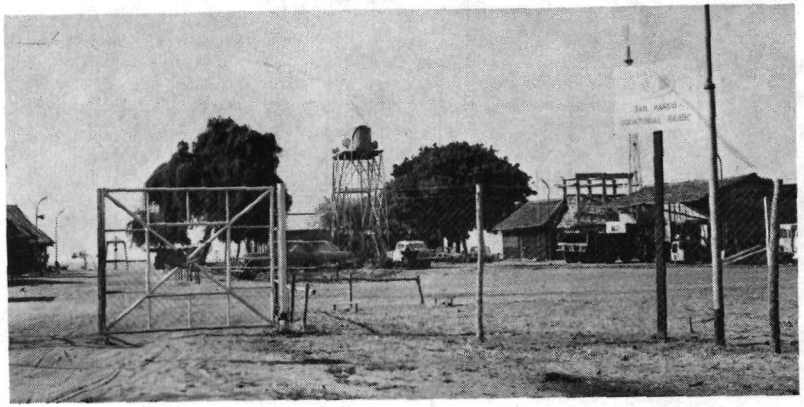


FIGURE 32 SAN MARCO PLATFORM 1970





INDEX NO.	NUMERICAL LEGEND
1	DOCK
2	STAND
3	SKY SCREEN
4	MESS HALL
5	INTERFEROMETER
6	CONCRETE SLAB
7	CONCRETE SLAB
8	VOLLEY BALL COURT
9	WELL
10	POWER PLANT
11	SHOP
12	SHED
13	AUTOMOTIVE MAINTENANCE PIT
14	SHOP
15	ANTENNA TOWER
16	WATER TOWER
17	COMMUNICATION CENTER
18	GAS PUMP
19	OFFICES
20-21-28	BARRACKS
22	DISPENSARY
23	QUARTERS
24	LAUNDRY
25-27	TOILETS AND SHOWERS
26	STORE ROOM

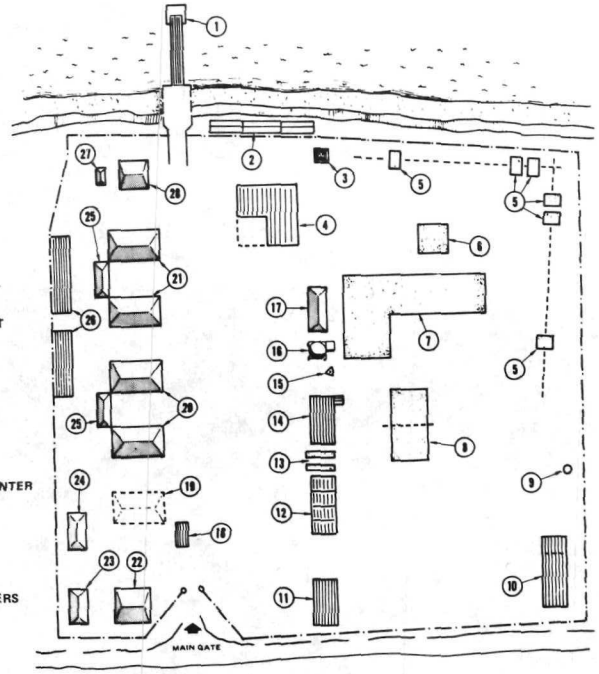


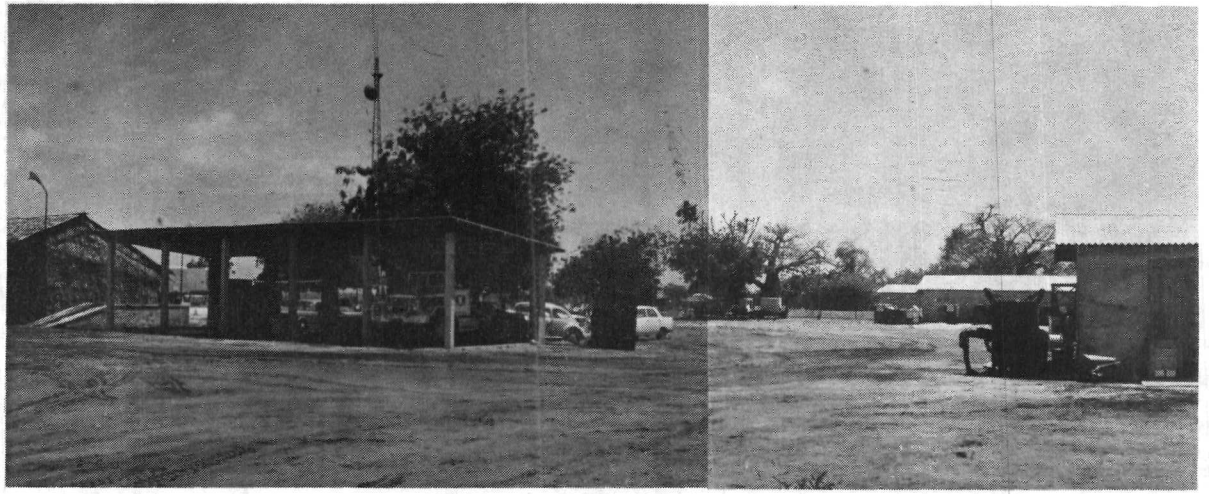
FIGURE 33 BASE CAMP 1970 (SHEET 1 OF 4)

BARRACKS

MESS HALL

WATER TOWER (UNDER CONSTRUCTION)

SHOP



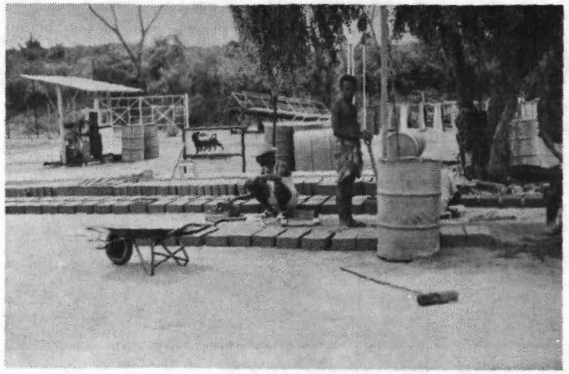
AUTOMOTIVE MAINTENANCE PIT

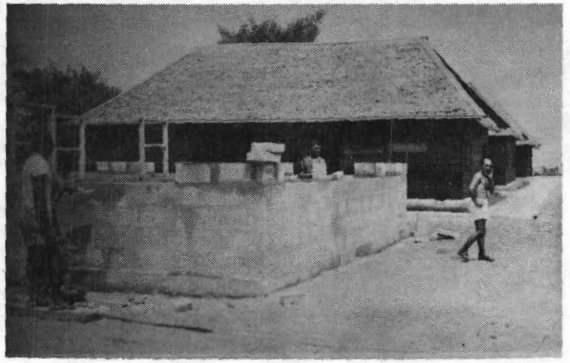
SHED

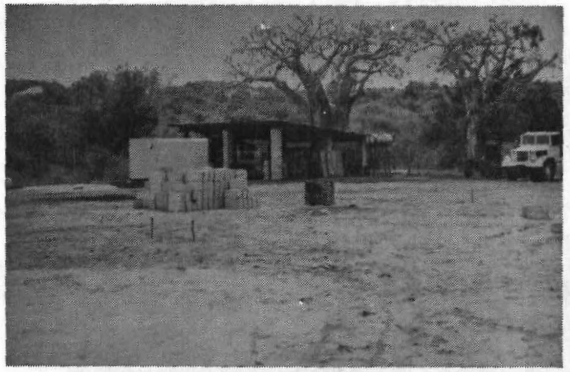
POWER PLANT

SHOP

FIGURE 33 BASE CAMP 1970 (SHEET 2 OF 4)







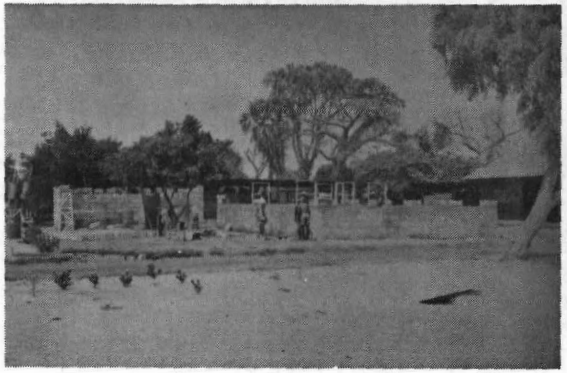
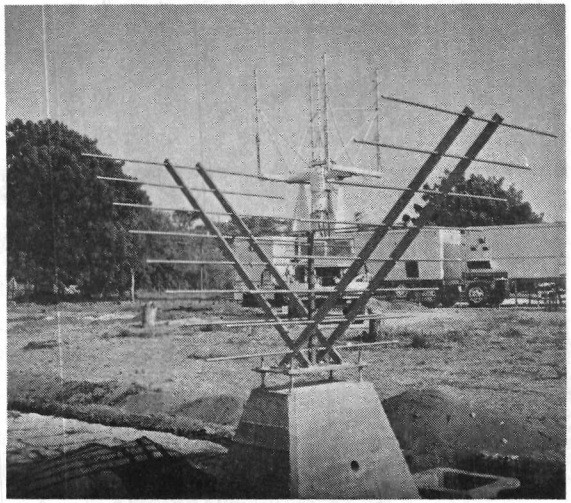
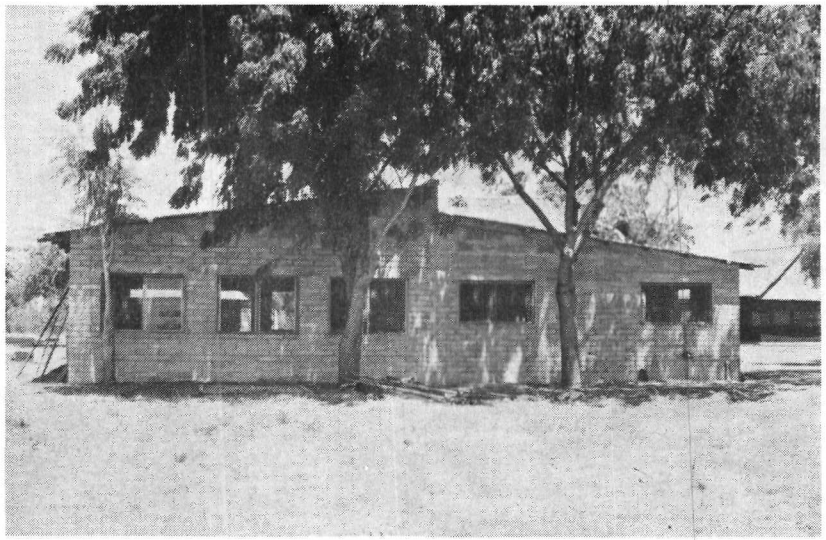


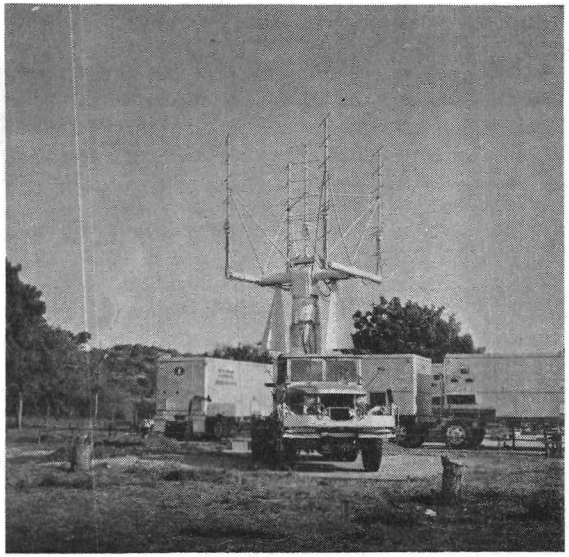
FIGURE 33 BASE CAMP 1970 (SHEET 3 OF 4)



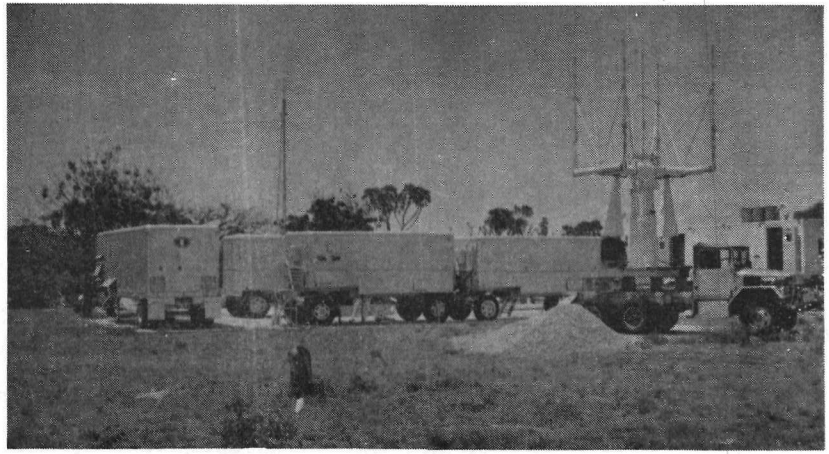
INTERFEROMETER ANTENNA



MESS HALL



MITS ANTENNA



MOBILE ITALIAN TELEMETRY STATION (MITS)

FIGURE 33 BASE CAMP 1970 (SHEET 4 OF 4)

All ready to start the countdown for Kenya's Jamhuri Day satellite

EAST AFRICAN STANDARD
DECEMBER 11, 1970

Standard Staff Reporter

Preparations for the launching of the American astronomy satellite at the Coast are well under way, according to a statement issued in Nairobi yesterday.

PIENO SUCCESSO DELL'ESPERIMENTO ITALO-AMERICANO

Il satellite «SAS» è in orbita

Il «laboratorio spaziale» è stato lanciato per conto della NASA da un gruppo di scienziati italiani La partenza è avvenuta dal poligono mobile equatoriale «San Marco» nell'Oceano Indiano - Il satellite, che fa parte della serie «Explorer», è destinato al rilevamento dei raggi X nello spazio

Nostro servizio

MOMBASA, 13 dicembre

Un satellite scientifico americano di circa 143 chili di peso è stato lanciato ieri, per mezzo

Il lancio di ieri si è fatto per conto della NASA. Il satellite messo in orbita, infatti, è americano, il 42 della serie «Explorers», è destinato al rilevamento dei raggi x nello spazio. Per questo rilevamento è essenziale

La ricerca c
«raggi X» è
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dei fenomeni d
governano i p
fisic. dell'Univ

Perchè si usi
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THE SUNDAY STAR
Washington, D. C., December 13, 1970
A-3

U.S. Satellite Launched By Italians Is in Orbit

NAIROBI, Kenya (UPI) — The first American satellite launched by another government outside U.S. territory reached equatorial orbit yesterday.

The astronomy satellite, a joint U.S.-Italian space venture, lifted off at 5.54 A.M. EST. One hour later a tracking station in Quito, Ecuador, confirmed it had entered orbit.

The launch, controlled by an Italian government space crew working alongside a Rome University scientific team, was from a sea platform north of Mombassa, Kenya's principal port.

The silver 72-foot package's orbiting module will collect data on X-ray sources in the celestial sphere as it circles the earth every 96 minutes.

Engineers said a 3½-hour delay in launching was not important and would not affect the satellite's functioning.

American scientists helped the send, who oversaw the launching, said the use of the Kenyan site resulted in a saving of $1.6 million because a similar launching from Cape Kennedy

A 26 *Sunday, Dec. 13, 1970* THE WASHINGTON POST

U.S. Satellite Launched By Italians in Kenya

Reuter

NAIROBI, Kenya, Dec. 12— The first U.S. satellite to be launched by another country was fired into earth orbit today by Italian engineers from a platform off the Kenya

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day. The
y the Na-
nd Space
ts partner
University
Research

stablized and rotating at the correct rate it will begin its X-ray experiments and radio the information collected once every orbit to a ground receiving station at Quito, Ecuador.

France also launched a scientific research satellite today, to take measurements of the earth.

The French space authority in Paris said the satellite was sent aloft from its South American launching site at Kourou, French Guyana.

First reports said the satellite was in a near circular orbit around the equator. Scientists intended it to orbit at a distance of 435 to 530 miles from earth.

14 *DAILY NATION, Monday, December 14, 1970*

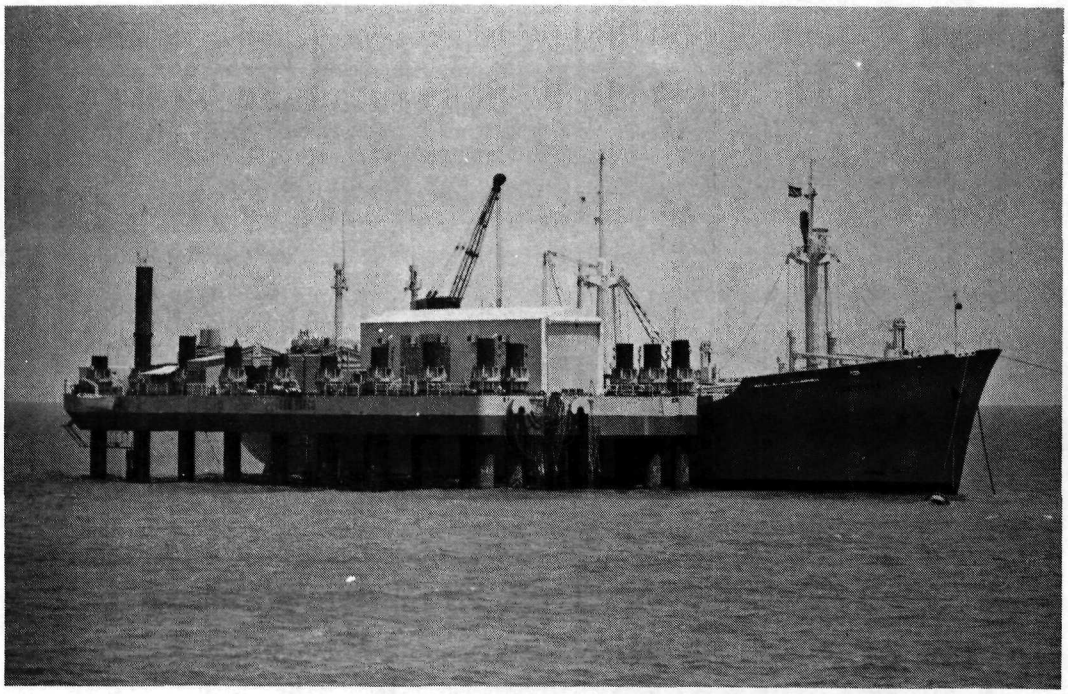
'UHURU' LAUNCHED WITHOUT A HITCH

By MONTE VIANNA

IMPORTANT data on X-ray sources in the celestial sphere was being sent back to the earth station at Quito, Equador, yesterday by "Uhuru" the American National Aeronautics and Space Administration's first small astronomical satellite, successfully launched on an Equtorial orbit from the Italian off-shore base at Formosa Bay.

"Uhuru", dedicated jointly by NASA and the University of Rome's Aerospace Research Centre to Kenya's seventh independence day, was fired into

FIGURE 34 PRESS CLIPPINGS OF SAS A LAUNCH



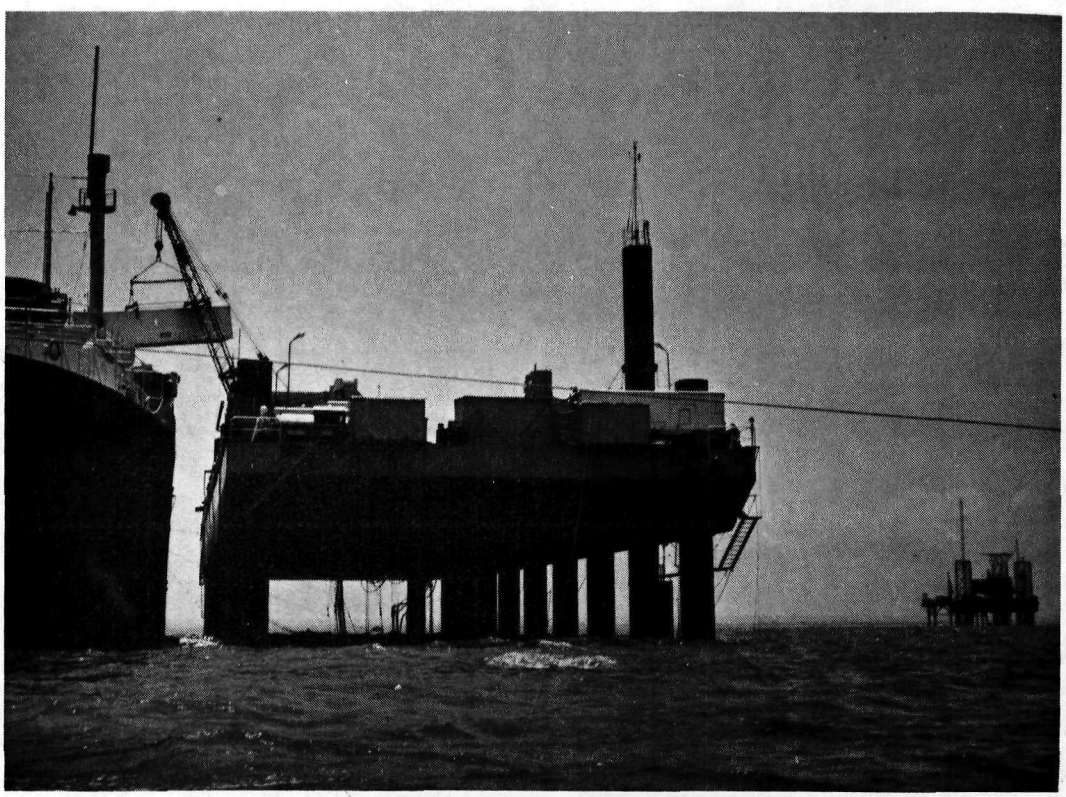


FIGURE 35 MOTOR OFF-LOADING FROM SS TORTUGAS

APPENDIX A

MEMORANDUM OF UNDERSTANDING BETWEEN THE ITALIAN SPACE COMMISSION OF THE NATIONAL COUNCIL OF RESEARCH AND THE UNITED STATES NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

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APPENDIX A

MEMORANDUM OF UNDERSTANDING BETWEEN THE ITALIAN SPACE COMMISSION OF THE NATIONAL COUNCIL OF RESEARCH AND THE UNITED STATES NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

1. The Italian Space Commission of the National Council of Research (The Commission) and the United States National Aeronautics and Space Administration (NASA) affirm a mutual desire to conduct a series of experiments which it is hoped will culminate in the launching of a scientific satellite into an equatorial orbit. The objective is to perform measurements of atmospheric and ionospheric characteristics in a region of the earth's atmosphere not previously explored and to make the resulting scientific data freely available. This experiment program is planned to consist of three phases:

(a) First phase - An appropriate sounding rocket will be utilized to provide a flight test of the principal elements of the scientific payload. This launching will take place from the Wallops Island Station and/or from an Italian platform of the San Marco type located near the equator.

(b) Second phase - A prototype of the ultimate satellite payload will be placed in orbit by means of a Scout booster launched from the Wallops Island Station.

(c) Third phase - A scientific satellite, bearing experiments as described above, will be placed in an equatorial orbit by means of a Scout booster launched from a platform of the San Marco type, located in equatorial waters.

2. The cooperating agencies shall proceed from each phase to the next upon mutual agreement that technical feasibility has been demonstrated and, in particular, that environmental requirements for the third phase of the program have been satisfied.

3. The Commission shall, in general, assume responsibility for the following:

(a) Support of Italian personnel for any training required in launching, tracking, data reduction and analysis, and other elements of the program as mutually agreed.

(b) Design, fabrication, and testing of all payloads, including satellite engineering.

(c) Such studies and action as are required to assure a mutually acceptable environment for transport, handling, and launching of the Scout in the third phase of the program.

(d) The availability, equipping, maintenance, and operation of the "San Marco" towable platforms.

(e) The establishment of a suitable launch complex for the third phase of the program, including range safety provisions, as mutually agreed.

(f) Launching of the satellite in the third phase of the program.

(g) Data analysis in all phases of the program.

(h) Tracking and data acquisition facilities required in Phase III that are particular to Project San Marco and which are not available from NASA.

(i) Support, logistics, and all other costs peculiar to Project San Marco.

4. The NASA shall be responsible, in general, for the following:

(a) Provision of an appropriate sounding rocket and backup, as mutually agreed, for the first phase of the program.

(b) The provision of Scout boosters with backups for the second and third phases of the program.

(c) Such training of Italian personnel as may be feasible, and as may be accommodated without significant incremental expense.

(d) Technical consultation, as appropriate.

(e) Such additional ground testing of the payloads as may be required.

(f) The provision of data to facilitate effective design, fabrication, and testing of the payloads.

(g) Tracking and data acquisition in the first and second phases of the program as can be accomplished by existing NASA sounding rocket and unmanned satellite tracking and data acquisition facilities.

(h) Provision of tracking and data acquisition services of the Quito, Ecuador, Minitrack Station in Phase three of the program, and such additional communications support at other locations as may be feasible on a noninterference basis, subject to the concurrence, as appropriate, of any foreign governments involved. Special equipment or personnel needed in this connection will be the responsibility of The Commission.

5. No exchange of funds is contemplated between the two cooperating agencies.

6. Each agency agrees to designate a single project manager who shall be responsible for coordinating the agreed functions and responsibilities of each agency with the other. Together they will establish a joint working group with appropriate membership. Details for implementation shall be resolved on a mutual basis within this working group.

7. The scheduling of each of the three phases of the program shall be as mutually agreed.

8. All launches which are a part of this program will be in such areas as may be agreed between the two agencies which shall consult their governments as appropriate.

9. This Memorandum of Understanding shall be subject to the concurrence of the Italian Foreign Office and the U.S. Department of State, expressed through an exchange of notes.

FOR THE COMMISSION:

/s/ Professor LUIGI BROGLIO

FOR NASA:

/s/ Dr. H. L. DRYDEN

GENEVA--May 31, 1962

APPENDIX B

Agreement effected by exchange of notes
Signed at Rome September 5, 1962;
Entered into force September 5, 1962.

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APPENDIX B

ITALY

Outer Space Cooperation: Space Science Research Program

Agreement effected by exchange of notes
Signed at Rome September 5, 1962;
Entered into force September 5, 1962.

The Vice President of the United States of America to the Italian Minister for Foreign Affairs

EMBASSY OF THE
UNITED STATES OF AMERICA
Rome, September 5, 1962

No. 236

EXCELLENCY:

I have the honor to refer to previous conversations between representatives of the United States National Aeronautics and Space Administration and the Italian Space Commission of the National Council of Research regarding cooperation in a scientific experiment which proposes the placement in orbit around the earth of an Italian satellite from an Italian launching facility by means of a rocket provided by the National Aeronautics and Space Administration. The objective of the experiment is to perform measurements of atmospheric and ionospheric characteristics of the earth's atmosphere and to make the resulting scientific data freely available to the world scientific community.

The United States Government confirms the Memorandum of Understanding signed May 31, 1962 by the United States National Aeronautics and Space Administration and the Italian Space Commission, a copy of which Memorandum is enclosed. It is understood that implementation and direction of United States participation in the proposed scientific experiment shall be the responsibility of the Italian Space Commission. The fulfillment and pace of progress of the scientific experiment shall be mutually determined by the two cooperating technical agencies and subject to the conditions which the two agencies have incorporated in the Memorandum of Understanding.

I have the honor to propose that this Note, together with Your Excellency's reply concurring therein and confirming the enclosed Memorandum of Understanding, shall constitute an Agreement between our two Governments, which shall enter into force on the date of Your Excellency's reply.

Accept, Excellency, the assurances of my highest consideration.

LYNDON B. JOHNSON
Vice-President
of the United States of America

Enclosure:

Memorandum of Understanding
May 31, 1962

His Excellency
ATTILIO PICCIONI,
Minister for Foreign Affairs,
Rome.

APPENDIX C

MAJOR MILESTONE EVENTS

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APPENDIX C

MAJOR MILESTONE EVENTS

1961	
October	Group from Italian Space Commission visited Langley Research Center.
1962	
May 31	Signing of the memorandum of understanding.
September 17-21	First working group meeting, Washington DC.
September 24	First CRA personnel arrive LRC to work on Shotput.
November 30	Began Environmental Study for Range concept.
1963	
April 20	First Shotput (No. 6) launched from Wallops Island.
August 2	Second Shotput (No. 7) launched from Wallops Island.
August 19 - October 11	Training at Vought Missiles and Space Company - Texas for CRA personnel.
December 21	Started towing operations of Santa Rita platform from Italy enroute to Africa.
1964	
January 29	Santa Rita platform arrived in Africa.
March 1	Santa Rita platform positioned in Formosa Bay.
March 25 - April 2	Nike-Apache launches from Santa Rita platform.
	Santa Rita platform returned to Mombasa.
December 15	San Marco A launched from Wallops Island by CRA launch team.
March 3	Negotiations completed to build a Mark II launcher.
1965	
May 30	San Marco platform departed Charleston, South Carolina, USA towed by Italian tug to La Spezia, Italy.

1965

September 13	Satellite SM-1 decayed from orbit.

1966

February 18	Launcher shipped from Houston, Texas to La Spezia, Italy.
March 25	San Marco platform departed La Spezia for Mombasa.
May 15	S^3T equipment shipped from Wallops Island.
July 18	Blockhouse equipment shipped from Rome, Italy.
August 28	All equipment vans installed on Santa Rita.
November 10	Moved San Marco platform to Formosa Bay.
November 26	Moved Santa Rita to Formosa Bay.
December 10	Base Camp operational.
December 16	Power generators installed on platform.
December 20	First underwater cable installed between platforms.

1967

January 17	Underwater cable installation and termination complete (21 cables).
January 22	Propulsion system for vehicle S-153 departed USA for San Marco platform.
February 16	Blockhouse validation completed.
February 27	Mock countdown completed with vehicle S-144.
March 2	S-153 propulsion system arrived at Formosa Bay.
March 4	Completed mock countdown with vehicle S-144 using live pyrotechnics.
March 10	Started processing vehicle S-153.
April 26	Launched San Marco B on Scout vehicle S-153 from San Marco Range.
November 18	Signing of the second memorandum of understanding for San Marco C.
November 20-22	Working Group Meeting in Washington on San Marco C.

1968

March 25	Performed checkout of the Launch Complex equipment.
May 21	San Marco C Working Group Meeting in Washington.
August 19	Negotiated first phase of an Italian manufacturing program.
November 4-25	Range inspected for general condition. SAS-A personnel given an introductory tour of range.
December 8	Published the Range User's Manual.
December 21	Published a Shipping Procedure document for potential range user's.

1969

January 13-17	SAS and SSS Working Group Meeting in Washington to review range requirements.
January 21 - February 10	CCA Representative reviewed the Command Destruct Transmitters.
March 19	San Marco Working Group Meeting in Washington.
April 7-19	Le Tourneau personnel conducted structural survey of the Santa Rita platform.
April 9	Working Group Meeting in Rome.
April 23- June 11	CRA personnel refresher training program at Wallops Island.
July 1-18	Range inspected and Working Group Meeting in Rome.
September 23-24	Working Group Meeting in Washington. Spacecraft/ Range Meeting at GSFC.
November 17	Began range safety refresher training at Wallops Island for CRA personnel.

1970

January 12	Completed safety refresher training at Wallops Island for CRA personnel.
February 6-15	Inspected range.

1970

March 11	Completed validation of range systems.
May 6-8	Negotiated Launch Service Contract for NASA launches.
May 22	Started rework of range H_2O_2 system.
June 5-20	San Marco Working Group Meeting and Range Readiness Review for spacecraft.
September 3	MPS-26 Radar System departed New York on Hellenic Lines "SS African Dawn".
September 12	Vehicle S-175C propulsion system departed NAD, Earle, New Jersey on Hellenic Lines "SS Hellenic Laurel".
September 18	Vehicle S-175C assemblies shipped from Dallas, Texas via commercial air; arriving in Nairobi 21 September.
October 9-10	"Hellenic Laurel" anchored in Formosa Bay at 2100 hours on October 9. Motors transferred to San Marco platform on October 10.
October 7	"African Dawn" arrived at Mombasa and transferred MPS-26 radar van to a lighter.
October 9	The lighter with radar van arrived at Base Camp.
October 13	MPS-26 Radar van transferred to auxiliary platform.
November 10	SAS-A spacecraft arrived at Base Camp.
November 21	Radar and telemetry systems checked out using a light aircraft.
November 23	System Tests completed on Vehicle S-175C.
December 2	SAS-A spacecraft installed on booster vehicle.
December 8	Completed Dress Rehearsal.
December 12	SAS-A spacecraft placed in equatorial orbit with Scout vehicle S-175C.

1971

February 10	Vehicle S-173C propulsion system departed NAD Earle, New Jersey aboard the Barber Lines "SS Tortugas".
February 27	Vehicle S-173C assemblies shipped by commercial air from Dallas, Texas, via New York and Frankfurt, arrived in Nairobi on 1 March.
March 7-8	"SS Tortugas" anchored in Formosa Bay on the 7th and the propulsion system was off-loaded on 8 March.
April 2	Vehicle S-163C propulsion system departed NAD Earle, New Jersey, aboard the Barber Lines "SS Tennessee".
April 5	All Systems Test with vehicle S-173C completed.
April 14	San Marco C payload installed on vehicle.
April 21	Mock Countdown conducted with Scout vehicle S-173C and San Marco C payload.
April 24	Scout S-173C launched at 7:32 hours Zulu successfully placing San Marco C spacecraft in equatorial orbit.
April 28	"SS Tennessee" arrived in Formosa Bay and off-loaded propulsion system.

APPENDIX D

SUPPORT TO SAN MARCO PROJECT

by

LTV AEROSPACE CORPORATION
VOUGHT MISSILES AND SPACE COMPANY - TEXAS

under contract to

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
SCOUT PROJECT OFFICE
LANGLEY FIELD

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APPENDIX D

SUPPORT TO SAN MARCO PROJECT

by

VOUGHT MISSILES AND SPACE COMPANY - TEXAS

As the San Marco Project was being developed, LTV Aerospace Corporation, Vought Missiles and Space Company - Texas, the prime contractor to NASA for the Scout vehicle, was called upon to provide material and services to support the project.

Technical support services were provided between December 1962 and May 1963 under NASA contract NAS1-1928-4. The major activity encompassed the Environmental Study Report. The interim report was submitted March 1963 with the final report being submitted May 1963. The platform motion study portion of the Environmental Report was prepared as a supplement and submitted in September 1963. Other activities during this period of time included investigating modes of transportation available to Formosa Bay, reviewing Scout vehicle and GSE to identify components which might require additional environmental protection, and investigating air conditioning requirements.

Technical support services were provided between June 1963 and December 1964 under NASA contract NAS1-1928-9. The support provided during this period of performance is summarized in Table D-1.

Task order No. 11 of NASA contract NAS1-3899 was negotiated in October 1964 with provisions for Vought Missiles and Space Company to provide technical support services to the San Marco Project for the ensuing twelve months. In September 1965, Modification No. 1 extended the period of performance to 8 October 1966. The support provided by Vought Missiles and Space Company during this contract is summarized in Table D-2.

Under the terms of the memorandum of understanding, the provisioning of the range with facility and ground support type equipment was the responsibility of the Centro Ricerche Aerospaziali. In November of 1964 the CRA requested the NASA to act as procurement agent for a Mark II Scout launcher. Negotiations were completed in March 1965 and the launcher was produced by Vought Missiles and Space Company under contract NAS1-4899 to NASA. In March 1966 the CRA placed Vought Missiles and Space Company on contract to furnish the shelter and its associated equipment, the transporter, the vehicle handling equipment, the vehicle joining inspection and checking tools, the vehicle fluid systems servicing and checkout equipment, the compressed air system for the launcher and specified spare components for the fluid and pneumatic systems. Table D-3 lists the material furnished by Vought Missiles and Space Company under CRA contract number 011/19232.

The CRA has since placed continuing purchase order contracts with Vought Missiles and Space Company for facility and equipment spares and emergency repair parts.

During 1969 and 1970 approximately $150,000 worth of material and services was supplied.

A San Marco Field Support Program was implemented by Vought Missiles and Space Company in June 1966 under NASA contract NAS1-5880. The period of performance was for 18 months. In December 1967, Modification 2 of the contract extended the period of performance to 30 months. In December 1968, Modification 3 of the contract extended the period of performance to approximately 34 months. Modification 5 in April 1969 extended the period of performance to 46 months. In March 1970, Modification 6 to the contract increased the period of performance by 6-1/2 months with a completion date of 31 October 1970. The material and services furnished by Vought Missiles and Space Company under this contract are summarized in Tables D-4 through D-8.

In November 1970, the NASA negotiated contract NAS1-10000 for Vought Missiles and Space Company to furnish services and materials necessary to provide system management for the Scout Program for the ensuing 3 years. Task J under this contract encompassed the Vought Missiles and Space Company support to the San Marco Project. The support provided thus far is summarized in Table D-9.

TABLE D-1
Sheet 1 of 3

SUPPORT TO SAN MARCO PROJECT
VOUGHT MISSILES AND SPACE COMPANY

NAS1-1928-9 Contract
June 1963 through December 1964

DATE	SUPPORT
1963	
July	Reviewed report, "Logistics Support".
August	Provided complete set of drawings (636) of Mark II launch complex electrical electronic and mechanical ground support equipment.
September	Prepared recommended layout of test equipment for Bench Tests at Wallops Island.
	Reviewed CRA report, "SM Scout Vehicle".
	Prepared layout of San Marco payload on the Scout heat-shield.
December	Prepared a specification for a Mark II launcher modified for use on Santa Rita platform. (Reference 13)
	Prepared specification for complete set of Scout system intercommunication cables between platforms. (Reference 14)
	Prepared plan for instrumenting Santa Rita platform to measure environmental conditions. (Reference 15)
1964	
January	Supplied one complete set of specifications for Wallops Mark II launch complex.
February	Prepared plan for documentation of the San Marco/Scout Program. (Reference 16)
	Performed a feasibility study on various methods of shipping a Mark II launcher overseas. (Reference 17) (Reference 18)

TABLE D-1
Sheet 2 of 3

SUPPORT TO SAN MARCO PROJECT
VOUGHT MISSILES AND SPACE COMPANY

NAS1-1928-9 Contract
June 1963 through December 1964

DATE	SUPPORT
1964	
March	Supplied complete set of procurement, acceptance and operational test specifications for EGSE.
May	Performed a stiffness analysis of the launcher support structure on the Santa Rita. (Reference 19)
	Revised PMR launch maintenance manual for applicability to the San Marco Launcher.
	Performed study of safety equipment and access provisions on oil drilling platforms operating in the Gulf of Mexico. (Reference 20)
June	Provided one complete set of Scout vehicle drawings.
	Reviewed report, "Proposal for Fabrication of the Scout GSE for the San Marco Program".
	Prepared detailed definition of interface between the launcher and Santa Rita platform. (Reference 21)
	Studied methods of isolating rate table and Griswold dividing head from deck vibration on the Santa Rita platform. (Reference 22)
July	Recommended vehicle spares list. (Reference 23)
	Prepared a NASA/ISC San Marco Scout Master Plan. (Reference 24)
	Provided all change documents generated since effectivity date of Mark II FCI plus one copy of all Scout vehicle and GSE change documentation for the remainder of the performance period.

TABLE D-1
Sheet 3 of 3

SUPPORT TO SAN MARCO PROJECT
VOUGHT MISSILES AND SPACE COMPANY

NAS1-1928-9 Contract
June 1963 through December 1964

DATE	SUPPORT
1964	
August	Prepared report on Mission Accuracy Analysis for the Scout Launch Vehicle. (Reference 25)
September	Prepared detailed description of all instruments on blockhouse consoles. (Reference 26)
November	Conducted a study of San Marco Ground Support Equipment Calibration Laboratory requirements. (Reference 27)
December	Prepared detailed instructions for shipping a Mark II launcher in the assembled condition. (Reference 28) (Reference 29)
	Prepared instructions for shipping San Marco/Scout vehicle. (Reference 30)
	Prepared requirements for procurement of the ground air system for the San Marco Launcher and vehicle. (Reference 31)

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TABLE D-2
Sheet 1 of 4

SUPPORT TO SAN MARCO PROJECT
VOUGHT MISSILES AND SPACE COMPANY

NAS1-3899-11 Contract
January 1965 through October 1966

DATE	SUPPORT
1965	
	Continued to provide change documentation for Standard Vehicle and Ground Support Equipment. Prepared a report on status of drawing documentation. (Reference 32)
January	Prepared a set of recommended procedures and list of equipment required to demonstration test Scout EGSE and the compelte Mark II complex (5 copies). (Reference 33)
February	Provided 15 complete sets of Mark II launcher drawings and specifications.
April	Provided two copies of Vought Missiles and Space Company Design Data Manuals, AN and MS, NAS, AS, CUC, CPC, SCD Drafting procedures.
	Provided five copies of functional schematics for guidance system bench check, telemetry system bench check, and "E" Section assembled vehicle checks.
June	Provided one copy of ground support equipment drawings (100 drawings).
	Provided one copy of 12 Vought Missiles and Space Company Specifications.
July	Provided one reproducible and 10 nonreproducible copies of two Vought Missiles and Space Company drawings.
August	Provided one copy each of negatives suitable for producing identification plates (22 Vought Missiles and Space Company drawings).
	Conducted feasibility study of shipping an assembled Scout vehicle, mounted on a Scout transporter from Wallops Island to Mombasa, there to be loaded on the San Marco platform for operations. (Reference 34)

TABLE D-2
Sheet 2 of 4

SUPPORT TO SAN MARCO PROJECT
VOUGHT MISSILES AND SPACE COMPANY

NAS1-3899-11 Contract
January 1965 through October 1966

DATE	SUPPORT
1965	
August	A separate study was conducted on the feasibility of returning the San Marco from Italy to the United States for installation of the launcher complex equipment, check out the complex and return the platform to Mombasa with an assembled Scout vehicle on board. (Reference 35)
November	Prepared 10 copies of each of four preliminary trajectories for Scout/San Marco satellite. (Reference 36)
	Prepared 10 copies of a study of vehicle spare parts recommended to support San Marco launches. (Reference 37)
	Conducted study to determine methods of reducing residual motion in the San Marco spacecraft subsequent to separation from fourth stage motor. (Reference 38)
	Repaired GFE Scout 1.0g vehicle.
	Provided one complete set of Scout Standard Operating Procedures with subsequent changes.
	Investigated and proposed the amount and location of ballast to modify ascent trajectory to use Castor II and FW-4S motors with a payload weight of 254 pounds.
December	Provided Project Engineer to attend program meeting in Rome in January 1966.
1966	
February	Provided 10 copies of detailed hydrogen peroxide passivation instructions with listing of equipment required to permit proper installation of peroxide system on the San Marco platform. (Reference 39)

TABLE D-2
Sheet 3 of 4

SUPPORT TO SAN MARCO PROJECT
VOUGHT MISSILES AND SPACE COMPANY

NAS1-3899-11 Contract
January 1965 through October 1966

DATE	SUPPORT
1966	
February	Provided five copies of recommendations for refurbishment of the available San Marco separation system hardware. (Reference 40)
	Provided two complete sets of nonreproducible FCI, San Marco launcher drawings (30 drawings).
	Prepared 10 copies of recommended procedures for environmental recording for overseas shipment of Scout motors. (Reference 41)
	Prepared 15 copies of a document covering the Scout vehicle restrictions and aerodynamic data. (Reference 42)
	Prepared 10 copies of a document containing preliminary design information to integrate a Sandia/Whittaker G649 package in the San Marco/Scout vehicle. (Reference 43)
	Provided one copy of the latest version of specified Scout vehicle specifications (86 items).
March	Conducted a San Marco Range safety study based on predicted errors of the Sandia/Whittaker Gyro Package. Provided 15 copies of report. (Reference 44)
April	Reviewed the CRA report, "Flow of Operation for the San Marco/Scout Assembly and Launch from the Equator". Provided 10 copies of the review.
	Provided Project Engineer to attend Program Meeting in Rome on May 16-20, 1966.
May	Supplied services of one EGSE Engineer to support blockhouse equipment checkout in Rome.

TABLE D-2
Sheet 4 of 4

SUPPORT TO SAN MARCO PROJECT
VOUGHT MISSILES AND SPACE COMPANY

NAS1-3899-11 Contract
January 1965 through October 1966

DATE	SUPPORT
1966	
July	Furnished one set of nonreproducible Scout motor drawings (52 drawings).
August	Furnished one set of Scout Standard Operating Procedures to Italian Space Commission at Wallops Island.
	Provided one electrical engineer to Africa for technical support to San Marco Range.
	Provided services of Project Engineer to attend San Marco Program Meetings at Rome and Africa.
September	Provided services of one mechanical GSE engineer to San Marco Range for technical support.
October	Provided technical support to the Italian Space Commission on shipment of San Marco vehicle and motors from Dallas and Wallops Island to the Range.
	Prepared and submitted five copies of a simulated preflight report for vehicle S-144. (Reference 45)

TABLE D-3
Sheet 1 of 5

SUPPORT TO SAN MARCO PROJECT
VOUGHT MISSILES AND SPACE COMPANY

ISC Contract 011/19232
March 1966 to September 1966

	NOMENCLATURE	PART NUMBER
A.	HANDLING EQUIPMENT	
	Beam Assy - Base "A"	23-000716-1
	Stand Assy - Base "A"	23-001514-1
	Sling Assy - Base "A"	23-001513-2
	Stay Set - Base "A"	23-000718-1
	Sling Assy - B & C Sections	23-001515-1
	Diaphragm Instl. Tool	23-000704-1
	Bar Assy - "D" Section Hoist	23-000713-1 23-000712-1
	Transportation Rig - 4th Step	23-000714-1
	Sling Assy - Castor & Antares	23-001519-1
	Adapter Kit - Antares to Airlog 3500	23-001520-1
	Handling Fixtures - Altair Vertical Buildup	322-40120-1
	Transporter Le Tourneau P/N 590-2	Spec. 304-232B
	Adapter - 4th Step Transporter	321-60621-1
	Insert - Cushion Altair to Transporter	321-60624-1
	Support Sling - P/L Installation	321-60066-1
	Algol Motor Lifting Beam	Aerojet 368593-13
	Positioning Fixture - 4th Stage	331-63040-1
	4th Step Heat Shield Supt.	331-63020-1
	Clamp Assembly	321-60637-1
	Roll Stand - "B" Section	331-63030-1
	Roll Stand - "C" Section	331-63031-1
	X-258 Motor Cradle (Adapter)	331-63090-1
	Hoist Adapter	M331-40104-1
B.	JOINING, INSPECTION & CHECKING TOOLS	
	Guide Set - Vehicle Joining	331-63091-1
	Bolts 1/2-20 UNF 1.75	Long 1-1/2 Thd.
	Safety Fork Assembly	23-000547-1
	Force Indicator 1-10 lb.	Model L-10-M
	Castor Closure Bonding Tool	321-60613-1
	Diaphragm Lock Pin	23-001524-1
	Safe Arm Unit Ground Lock Pins	23-001530-1
	Gage Assy - Launcher Pin Location	321-60626-1
	Stand Assy Guidance Test	331-65175-1

TABLE D-3
Sheet 2 of 5

SUPPORT TO SAN MARCO PROJECT
VOUGHT MISSILES AND SPACE COMPANY

ISC Contract 011/19232
March 1966 to September 1966

	NOMENCLATURE	PART NUMBER
B.	JOINING, INSPECTION & CHECKING TOOLS (Continued)	
	Base "A" Fin Protractor	331-63094-1
	Bench Mark Rings	NASA-LD803659
	Fixture IRP Roll Alignment	321-60630-1
	Torque Tool Set	331-50002
	Strap Wrench	Rigid 5
	Separation Tool & Guide Pin	M331-40103-1
	Rate Gyro Mt. Plate Kit	401-30050-1
C.	FLUID SYSTEMS SERVICING AND CHECKOUT EQUIPMENT	
	N_2 Servicing Cart	Vinson A62254
	Plug Set - H_2O_3 Motor Nozzle	321-60618
	Plug - 500# Motor	M331-50041
	N_2 Pressure Test Gage Set	M331-40105-1
	Hose Set N_2 Fill	M331-50036-1
	Hose Set - Jumper Line	M331-50037-1
	Hose Set - Bleed & Vent	M331-50004-1
	H_2O_2 Service Unit	Vinson A62074 Per Spec. 304-523
	Pumping Unit	321-60616-1
	Hose Set - Service Unit Filling	321-60608-1 321-60608-2 321-60608-6
	Motor Pressure Test Set	M331-50039-1
	Hydraulic Power Cart - Pump Unit	HPE-1
	Hose Set - Hydraulic	M331-50003-1
	Filter Patch Kit	23-002901
	Booster Air Driven	Haskell Model AG-2D
D.	COMPRESSOR TO PROVIDE 160 PSI AIR TO THE LAUNCHER	
	Electric Motor - 60 HP	Ingersoll Rand
	Total enclosed - fan cooled	Supplied
	Air Compressor Motor	Ingersoll Rand 9x4x7 ESH-2 NL2

TABLE D-3
Sheet 3 of 5

SUPPORT TO SAN MARCO PROJECT
VOUGHT MISSILES AND SPACE COMPANY

ISC Contract 011/19232
March 1966 to September 1966

	NOMENCLATURE	PART NUMBER
D.	COMPRESSOR TO PROVIDE 160 PSI AIR TO THE LAUNCHER (Continued)	
	Air Inlet Filter	Staynew G-3
	Compressor Regulator	Ingersoll Rand UL-95
	Aftercooler	Ingersoll Rand HP7-PL-12
	Receiver	Ingersoll Rand 24 HP 275
	Drain Regulator	Armstrong 213
	Filter	Norgren Co. 12-002-043
	Hydrier	Pritchard Product Model 62P Type P
	Filter	Westward Engineer Model 20060
	Controller, Pressure	Fisher Governor Type 4150 with 667A Valve
	Filter, Regulator, Lubricator Comb.	Hanna Engr. Works. H631W-8
	Manual Valve	Walworth Co. Model 205
	Dial Thermometer	Weston Instru. Model 4310 150-750°F
	Dial Thermometer	Weston Instru. Model 4310 50-300°F
	Pressure Gage	Marsh Instru. 4-1/2" 1 DP 0-400 psi
	Pressure Relief Valve	Republic Mfg. Model 625-5 Type BH-1
	Flexible Coupling	2-1/2" dia. 26" long Compressor Ser. Co.
	Manual Valve	Republic Mfg. Model 133-1/4B

TABLE D-3
Sheet 4 of 5

SUPPORT TO SAN MARCO PROJECT
VOUGHT MISSILES AND SPACE COMPANY

ISC Contract 011/19232
March 1966 to September 1966

	NOMENCLATURE	PART NUMBER
D.	COMPRESSOR TO PROVIDE 160 PSI AIR TO THE LAUNCHER (Continued)	
	Radiator & Fan	Young Radiator Co. Young 0H325
	Pump, Water	Ingersoll Rand Co. 3/4 K-1/2
	Pressure Gage	Marsh Instru. 4-1/2" 1 DP 0-100 psi
	Volume Tank, Cooling Water	McMaster-Carr Co. No. HL
	Filling Cap, Cooling Water	Federal Brass Mfg. Brass Type 700
	Manual Throttling Valve	Walworth Co. 237P
	Manual Valve	Republic Mfg. Co. 133 - 1/4B
	Flexible Coupling	Aeroquip 1534 - 24/24" long with 412-24 fitting
E.	LAUNCH PAD AND SHELTER EQUIPMENT	
	Winch Installation	M331-62501
	Come Along Installation	321-60063-1
	Transporter Elevation Jack Motor	CP3090-RAN-300
F.	SHELTER AND SHELTER INSTALLATIONS	
	Shelter	M321-60503
	Shelter 2000# Hoist	M331-40102-2
	Boom and "J" Box Installation	M331-63100
	Shelter Water Installation	331-65101
	Shelter Air Installation	331-65151-1
	Shelter Electrical Installation	M331-60402-2
	Shelter Air Conditioning	M331-40101-2

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SUPPORT TO SAN MARCO PROJECT
VOUGHT MISSILES AND SPACE COMPANY

ISC Contract 011/19232
March 1966 to September 1966

	NOMENCLATURE	PART NUMBER
G.	LAUNCHER FLUID SYSTEM SPARES	
	Flexible Hose	AQ 656949F-1400
	Flexible Hose	AQ 656949F-1350
	Flexible Hose	AQ 656952F-1220
	Flexible Hose	AQ 656949F-1170
	Coupling Q.D.	SYM46135
	Coupling Q.D.	SYM46235
	Filter Element, H_2O_2	80778-11
	Coupling Nipple N_2	SYM56131-1
	Filter N_2	56411 Type PR403-21
	Coupling Nipple N_2	SYM56138-1
H.	LAUNCHER - N_2 CONTROL SYSTEM COMPONENTS	
	Shutoff Valve	Republic 8111-4AS2
	Regulator 300 psi	Benbow 8225-4-300
	Regulator 2000 psi	Benbow 8225-4-2000
	Gage 0-400 psi	Marsh 220-3S FMS
	Gage 0-2000 psi	Marsh 220-3S FMS
	Gage 0-6000 psi	Marsh 220-3S FMS

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TABLE D-4
Sheet 1 of 3

SUPPORT TO SAN MARCO PROJECT
VOUGHT MISSILES AND SPACE COMPANY

NAS1-5880 Contract
November 1966 through November 1967

DATE	SUPPORT
1966	
	Continued to provide change documentation for vehicle and GSE configuration and for Design Data Manuals, Drafting Procedures and material processing specifications.
November	Provided technical assistance at San Marco Range with one off-site program coordinator.
	Provided EGSE engineer to San Marco Range for technical assistance 12-12-66 to 3-15-67.
1967	
January	Prepared and submitted a San Marco Spares Procedure Document - (10 copies) Project Engineer presented procedure to ISC at San Marco. (Reference 46)
	Furnished one vehicle mechanical technician, one instrumentation engineer and one guidance engineer to San Marco Range to provide technical assistance 1 February 1967 through launch of S-153 vehicle.
	Prepared and submitted a document establishing a communication link between Santa Rita platform and Green Belt, Maryland to provide flight data on San Marco launch for transmittal to GSFC (15 copies). (Reference 47)
February	Performed design study and submitted a proposed design for a fixture to permit exchanging nozzles on the FW-4S motor at San Marco Range.
	Provided personnel and services of one QC engineer, one ignition engineer andone propulsion engineer for technical support at San Marco Range.

TABLE D-4
Sheet 2 of 3

SUPPORT TO SAN MARCO PROJECT
VOUGHT MISSILES AND SPACE COMPANY

NAS1-5880 Contract
November 1966 through November 1967

DATE	SUPPORT
1967	
February	Provided three sets of data sheets for Standard Procedures, Volumes III, IV, and V.
March	Prepared procedures for installation of FW-4S redesigned nozzle for San Marco vehicle.
	Provided data and Engineering technical support to perform a simulated operation of the communication link between San Marco Range and Goddard Space Flight Center.
	Updated the Scout S-153 Preflight Planning Report and Trajectory data to incorporate latest changes (15 copies produced).
	Provided electrical GSE Engineer to assist in the San Marco vehicle launch (10 April 1967 through launch).
	Provided one engineer for technical assistance at San Marco Range on replacement of FW-4S nozzle.
April	Provided Engineering assistance for precountdown and countdown checks on S-153 at San Marco Range. Project Engineer to provide liaison on FW-4S problem.
	Provided a replacement Whittaker type gyro for the San Marco Program.
	Provided one set of flight batteries and electrolyte.
May	Prepared a document covering problem areas of the launch of San Marco vehicle S-153 with recommendations for improvement. Areas to be considered include communications, transportation, spares availability, shipping, support personnel and launch complex equipment. (Reference 48)

TABLE D-4
Sheet 3 of 3

SUPPORT TO SAN MARCO PROJECT
VOUGHT MISSILES AND SPACE COMPANY

NAS1-5880 Contract
November 1966 through November 1967

DATE	SUPPORT
1967	
May	Prepared a document covering recommended methods of preservation of San Marco Complex and methods of maintaining personnel proficiency. (Reference 49)
June	Provided listing and collection of drawings and procedures changes for S-163 and Sub Scout vehicles and necessary GSE changes with simplified instructions for incorporating these changes into San Marco Complex. (3 copies of lists and 2 copies of drawings) (Reference 50)
August	Provided document on Scout San Marco Complex long range spares recommendations. (Reference 51)
September	Provided one Electrical/Electronics Engineer to Mombasa, Malindi, Area of Kenya, Africa to furnish technical assistance to the Italian Space Commission for a period of two months.
November	Provided Project Engineer to attend San Marco C Working Group Meeting in Rome, Italy.
	Provided support to a team of Italian Space Commission personnel meeting at VMSC-T concerning fabrication of Scout vehicle hardware.

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TABLE D-5
Sheet 1 of 2

SUPPORT TO SAN MARCO PROJECT
VOUGHT MISSILES AND SPACE COMPANY

NAS1-5880 Mod 2
December 1967 through November 1968

DATE	SUPPORT
1967	
December	Prepared a Program Plan for fabrication of Scout vehicle hardware in Italy. (Reference 52)
1968	
January	Performed feasibility of utilization of despin system on "E" Section P/L interface drawings and new weight limitations. Provided the CRA with information concerning S-Band Telemetry.
February	Provided descriptive documentation for San Marco Complex concerning: (a) Current vehicle performance capabilities (b) Location (c) Transportation (d) Facilities and Housing (e) Communications Document developed was the San Marco Range User's Manual. (Reference 53)
March	Provided EGSE Engineering support to CRA team in Launch Complex checkout. Provided MGSE Engineer to support Launch Complex checkout. Prepared resources estimate to: (a) Incorporate San Marco despin system on Scout "E" Section (b) Refurbish two San Marco separation systems.

TABLE D-5
Sheet 2 of 2

SUPPORT TO SAN MARCO PROJECT
VOUGHT MISSILES AND SPACE COMPANY

NAS1-5880 Mod 2
December 1967 through November 1968

DATE	SUPPORT
1968	
June	Performed Environmental Study concerning air conditioning requirements for equipment on San Marco Range Platforms during periods of non-activity. (Reference 54)
	Performed Environmental Study for a Class II cleanroom for San Marco Complex. (Reference 55)
September	Project Engineer attended coordination meetings and GSFC review in Rome, Italy, and Kenya, Africa.
October	Refurbished San Marco Separation and despin systems S/N B-11 and B-12.

TABLE D-6
Sheet 1 of 1

SUPPORT TO SAN MARCO PROJECT
VOUGHT MISSILES AND SPACE COMPANY

NAS1-5880 Mod 3
December 1968 through March 1969

DATE	SUPPORT
1968	
December	Prepared a Shipping Procedure Report for potential San Marco Range users. (Reference 56)
	Provided data on Scout S-Band T/M system necessary to design ground station equipment for San Marco Range.
1969	
February	Procured services of Technical Representative of CCA Electronics to determine source of C/D transmitter interference. Vought Missiles and Space Company Engineer accompanied Tech. Rep. to San Marco Range, Kenya, Africa.
	Developed additional performance data to cover the spectrum of Scout orbital missions from the San Marco Range.
	Defined vehicle changes and resulting GSE changes created by S-178 and sub-configuration.
March	Procured services of Le Tourneau Corporation to perform mechanical and structural survey of the Santa Rita platform and crane. (Reference 10)
	Provided Vought Missiles and Space Company Engineer to participate in structural survey of Santa Rita platform and crane.
	Provided requirements for incorporating a Whittaker gyro into an S-163 and sub-vehicle for range safety requirements in lieu of "C" Band radar beacon.

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TABLE D-7
Sheet 1 of 2

SUPPORT TO SAN MARCO PROJECT
VOUGHT MISSILES AND SPACE COMPANY

NAS1-5880 Mod 5
April 1969 through March 1970

DATE	SUPPORT
1969	
April	Provided personnel and services to conduct refresher training for CRA personnel. Prepared a refresher training program plan. (Reference 57)
	Incorporated changes in the Preliminary Draft of the San Marco Shipping Manual and distributed copies.
May	Furnished one copy of S-173C vehicle configuration tab run and one complete set of drawings and EO's in accordance with the tab run.
	Reviewed recommendations from CCA Electronics Corporation concerning revisions and instructions for operation of C/D equipment at San Marco Range.
	Project Engineer attended San Marco Working Group Meetings in Rome and made an inspection visit to the San Marco Range.
June	Developed additional performance data to cover Scout orbital missions from the San Marco Range.
	Reviewed S-173C Logbook and processing history with CRA personnel following completion of CRA Training Program at Wallops Island.
	Provided technical support for shipment of vehicle and motors for San Marco C vehicle.
September	Provided one EGSE engineer to assist in the installation of S-163 configuration modifications and associated validation of the San Marco Range.
	Compiled in book form (spiral bound) the San Marco Functional Schematics.

TABLE D-7
Sheet 2 of 2

SUPPORT TO SAN MARCO PROJECT
VOUGHT MISSILES AND SPACE COMPANY

NAS1-5880 Mod 5
April 1969 through March 1970

DATE	SUPPORT
1969	
September	Furnished one clamp and two rings for separation system to be compatible with San Marco spacecraft.
	Defined vehicle changes and the resulting GSE changes created by the S-178 and sub-configuration. (Reference 58)
December	Implemented plan to provide technical launch support to the San Marco Range for San Marco C Program.
1970	
January	Provided technical support during range safety training of CRA personnel at Wallops Island. Included familiarization of radar and T/M antenna patterns for vehicle S-173.
	Provided document containing a concise description of Scout pyrotechnics including safety requirements for storage near inhabited areas, storage environmental limits, ICC and CG regulations or restrictions, etc. (Reference 59)
March	Provided Project Engineer to participate in the validation of the San Marco Range.
April	Reviewed cleanroom requirements for San Marco Range according to CRA design and procured A/C components and doors as prescribed.
	Developed a preliminary range maintenance logbook.
	Cleaned and passivated H_2O_2 parts being returned from the San Marco Range.

TABLE D-8
Sheet 1 of 1

SUPPORT TO SAN MARCO PROJECT
VOUGHT MISSILES AND SPACE COMPANY

NAS1-5880 Mod 6
April 1970 through October 1970

DATE	SUPPORT
1970	
May	Provided Project Engineer to attend Working Group Meeting at the San Marco Range.
July	Provided material and services to rework the S-153 motor shipping vans as necessary to make ready for use on the San Marco Program.
August	Provided a shipping container for vehicle S-175 Base "A" Section that is suitable for commercial air shipment.
	Prepared proposal for Scout propulsion system off-loading and storage in Formosa Bay. (Reference 60)
	Began preparation as a NASA report, a document on the development of the San Marco Range.
	Provided technical support to the CRA for the installation of H_2O_2 components and during the application of proof-load to GSE.
	Technical Support was provided the Range during October and November. Pyrotechnic support was provided during motor receiving inspection. Other support areas included an Operations Engineer, Guidance Engineer, Quality Engineer, GSE Engineer, Mechanical Technician, and Project Engineer.
	Began revision of the San Marco Manual according to inputs furnished by CRA and NASA.
September	Provided Project Engineer to inspect the Range and assist in delivery of vehicle S-175.
October	Supplied vehicle spares and range consumables as required to support NASA launch activity at the San Marco Range.

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Sheet 1 of 3

SUPPORT TO SAN MARCO PROJECT
VOUGHT MISSILES AND SPACE COMPANY

NAS1-10000 Contract
November 1970 through April 1971

DATE	SUPPORT
1970	
	The following items were a continuation from the NAS1-5880 Contract:
	Accumulated and periodically shipped to San Marco:
	(1) All change documentation for the Standard Scout Vehicle and Ground Support Equipment.
	(2) Two copies of change documentation of Vought Missiles and Space Company design data manuals, drafting procedures, and manual processing specifications.
	(3) One copy of standard operating procedures change documentation.
	Provided technical support to the CRA for the installation of H_2O_2 components and during application of proof-load to GSE.
	Compiled a report on the development of the San Marco Range.
	Revised the San Marco Manual according to inputs furnished by CRA and NASA.
	Supplied vehicle spares and range consumables required to support NASA launch activity at the San Marco Range.
November	The subsequent items were additional support provided:
	Updated 23-DIR-913 dated 31 July 1969, to provide Algol III configuration performance data in the same manner as for Algol II.

TABLE D-9
Sheet 2 of 3

SUPPORT TO SAN MARCO PROJECT
VOUGHT MISSILES AND SPACE COMPANY

NAS1-10000 Contract
November 1970 through April 1971

DATE	SUPPORT
1970	
November	Modified a fifth stage Vega 302C-3 radar beacon and forward to the range for radar system checkout. When checkout is completed, the beacon is to be returned to Dallas, restored to original configuration, and returned to stores.
	Authorized removal of T/M transmitter from vehicle S-170 for use on the Range to checkout the range telemetry system.
	Authorized Vought Missiles and Space Company to make available one IRP and one caging amplifier to the San Marco Range for backup units.
	Procured a second Scout propulsion system trailer van Hoist Sling Assembly from Atlantic Cordage and Supply Corporation.
1971	
January-December	Provided technical support and liaison through the LTV Electrosystem office in Rome, Italy.
February	Refurnished the motor shipment vans returned on the SS Hellenic Laurel.
	Provided technical support for San Marco Motor shipment (Scout vehicle S-173).
	Began preparation of an operational document defining range interface and operational requirements.
March	San Marco Project Engineer participated in Range Operations Working Group Meetings in Rome and the delivery of the propulsion system at the range.

TABLE D-9
Sheet 3 of 3

SUPPORT TO SAN MARCO PROJECT
VOUGHT MISSILES AND SPACE COMPANY

NAS1-10000 Contract
November 1970 through April 1971

DATE	SUPPORT
1971	
March	Provided photographic coverage of the propulsion system off-loading operation at the range.
	Shipped San Marco separation systems to the range.
	Provided Engineering technical support to the range during S-173C launch operations.
April	Provided technical support and photographic coverage of the propulsion system for Vehicle S-163.

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