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COMPLETION REPORT

OPERATION CASTLE

U. S. ATOMIC ENERGY COMMISSION — CONTRACT AT-(29-2)-20

PACIFIC PROVING GROUND • 1953 - 1954

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FOREWORD

The following report, by Holmes & Narver, Inc., under contract to the United States Atomic Energy Commission, summarizes the planning, engineering, design, construction, maintenance and operation of Pacific Proving Ground facilities over the eighteen month span of OPERATION CASTLE.

Purely a documentary report, it has been consciously abbreviated to features relevant from the Contractor's point of view as administratively significant to ultimate cause and effect. In this manner, much of the vital drama and import of this venture is not apparent in the report, although it was an important ingredient in the tireless enthusiasm of the men, and the generally high morale which characterized both the prolonged periods of tension and the brief emergencies.

As was to be expected, OPERATION CASTLE went more smoothly for us than did previous operations. Problems originally encountered, once unique to the engineer and the constructor, were now ordinary. Procedures originally exploratory were now adjusted, revised, and proven. Past forecasts, facing unknowns, contained uncertainties; present experience factors enabled most crises to be reliably provided for. Increased organizational efficiency resulted to our management.

However, the success of an operation of the magnitude and complexity of CASTLE demands more of any unit management than intrinsic efficiency; deeply involved are the broader aspects of effective liaison with other participating and supporting agencies. This requirement, arising, in part, from the large number and diversity of such other agencies, the experimental nature of the total mission, and the geographical isolation of the operational sites, was recognized at the outset as an important management consideration.

Sensitivity was encouraged in our supervisory people to the manner in which all components of the test operation must be integrated during the planning and construction period, so as to all focus at the proper times on an inflexible end date—shot time. The mechanics of doing this were not always simple and did not always yield readily to predictable procedures, since some of the elements of OPERATION CASTLE were, as an engineering, construction and management job, without precedent.

The perspective possible from serving two previous operations enables us to observe that the fact that OPERATION CASTLE, in spite of its complexities, proceeded through all of the pre-operational phases without serious delays and generally on schedule; and that the operational phase was successfully concluded in spite of unprecedented adversity, is a clear tribute to the outstanding cooperation between all of the diverse components of the JOINT TASK FORCE SEVEN, in a unit of which we proudly served.

TABLE OF CONTENTS

CHAPTER ONE

CHAPTER TWO

CHAPTER THREE

CHAPTER FOUR

CHAPTER FIVE

CHAPTER SIX

CHAPTER SEVEN

APPENDIX A

LIST OF ILLUSTRATIONS

CHAPTER I

CHAPTER II

LIST OF ILLUSTRATIONS (Continued)

LIST OF ILLUSTRATIONS (Continued)

LIST OF ILLUSTRATIONS (Continued)

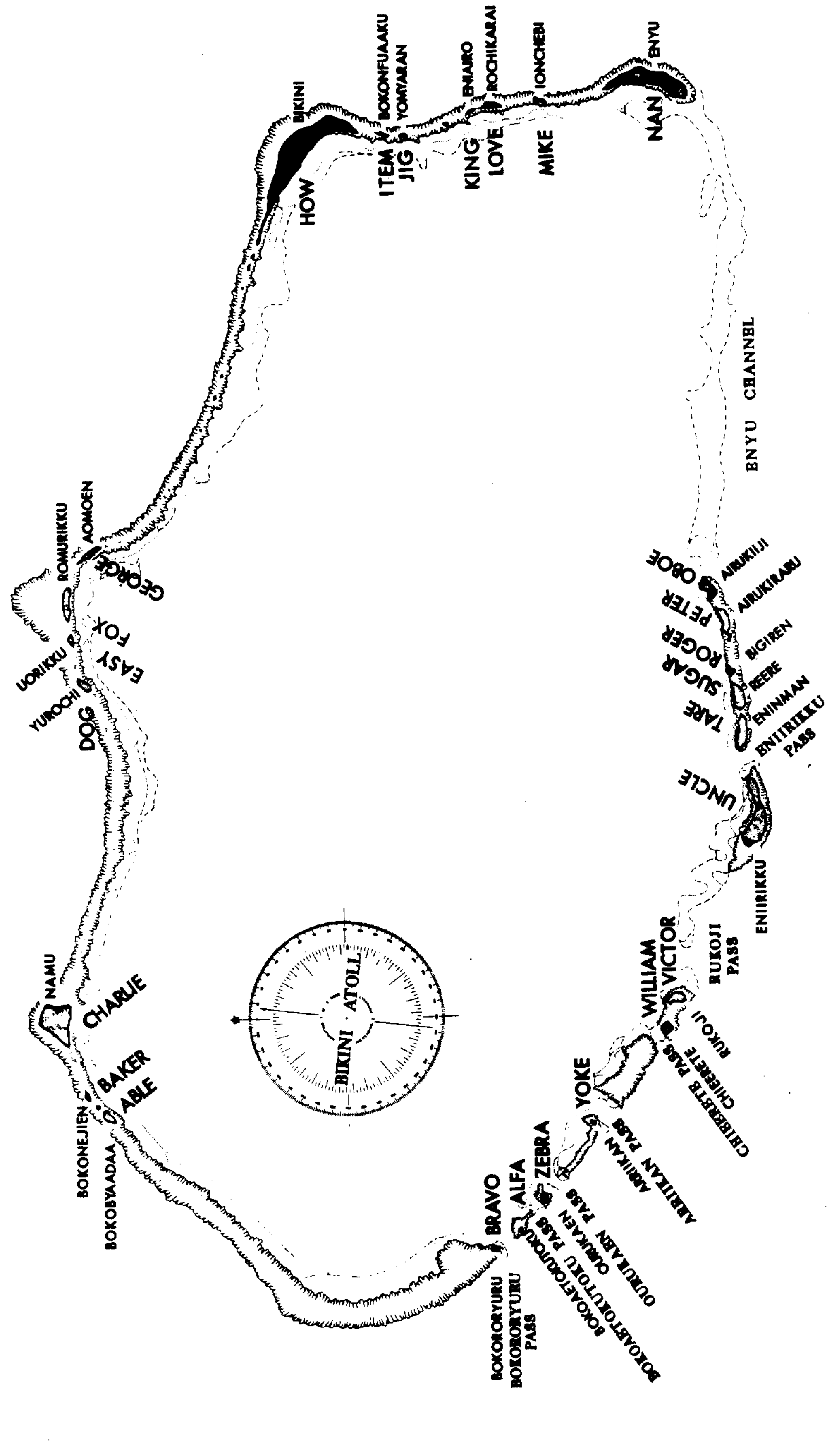
LIST OF ILLUSTRATIONS (Continued)

CHAPTER III

CHAPTER IV

CHAPTER VII

TABLES AND CHARTS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KING
LOVE
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FOX
EASY
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DOG
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BRAVO
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BOKORORYURU PASS
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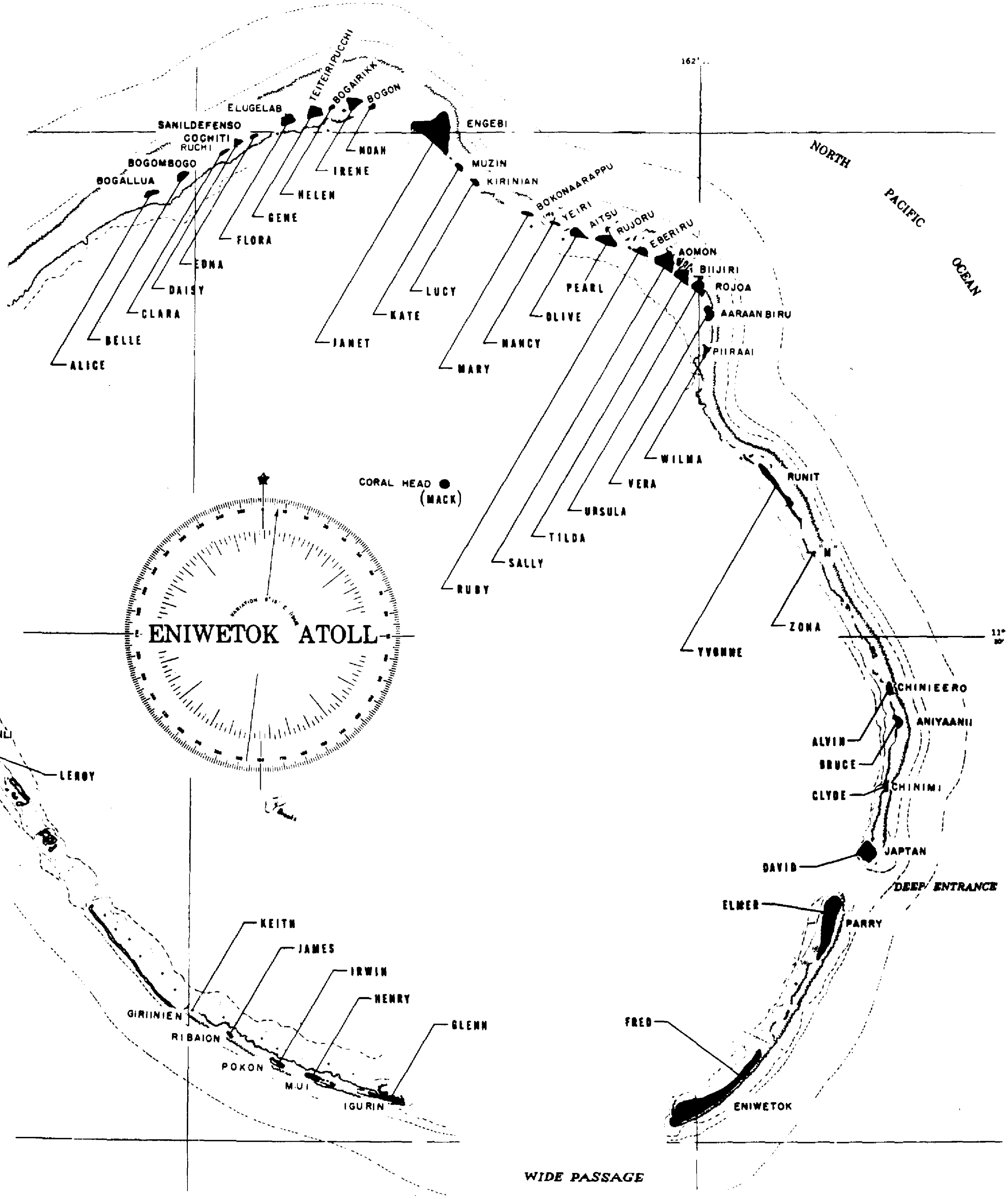


ENIWETOK ATOLL
NORTH PACIFIC OCEAN
WIDE PASSAGE
DEEP ENTRANCE
CORAL HEAD
(MACK)
162°
11°
ENGEBI
MUZIN
KIRINIAN
BOKONAARAPPU
YEIRI
AITSU
RUJORU
EBERIRU
AOMON
BIIJIRI
ROJOA
AARAANBIRU
PIIRAAI
RUNIT
CHINIEERO
ANIYAANII
CHINIMI
JAPTAN
PARRY
ENIWETOK
RIGILI
GIRIINIEN
RIBAION
POKON
MUI
IGURIN
ELUGELAB
TEITEIRIPUCCHI
BOGAIRIKK
BOGON
SANILDEFENSO
COCHITI
RUCHI
BOGOMBOGO
BOGALLUA
ALICE
BELLE
CLARA
DAISY
EDNA
FLORA
GENE
HELEN
IRENE
NOAH
JANET
KATE
LUCY
MARY
NANCY
OLIVE
PEARL
RUBY
SALLY
TILDA
URSULA
VERA
WILMA
YVONNE
ZONA
ALVIN
BRUCE
CLYDE
DAVID
ELMER
FRED
LEROY
KEITH
JAMES
IRWIN
HENRY
GLENN

INTRODUCTION
CHAPTER I

NARRATIVE SUMMARY
SECTION I

Engineering and Construction planning for OPERATION CASTLE, a test series consummated in early 1954, was first distinguished from its predecessors, IVY and GREENHOUSE, by the inclusion of Bikini Atoll as an auxiliary proving ground to Eniwetok Atoll.

Bikini Atoll is located in the northeasterly region of the Marshall Islands at approximately latitude 11 degrees 35 minutes north, longitude 165 degrees 25 minutes east. It lies 189 nautical miles east from Eniwetok Atoll.

The Field Manager, Eniwetok Field Office, U. S. Atomic Energy Commission, authorized Holmes & Narver, Inc., (H&N) in letter PG-1-612 dated on 12 June 1952, to make a preliminary reconnaissance and study of Bikini Atoll to determine the feasibility of using it as an auxiliary proving ground. The results of the study formed the basis of a report entitled "Auxiliary Proving Ground, Marshall Islands" which was submitted to the Field Manager, Eniwetok Field Office, on 2 August 1952. The report, finding the project preponderantly feasible, included estimates on the number and types of aircraft, ships, and landing craft that would be required, the cost for development of the sites, and the cost of the support services which would be needed.

Bikini was seen to be an elliptical lagoon 24 miles in length by 12.5 miles in width, enclosing an approximate area of 250 square statute miles within its coral reef ring. There are 29 land areas and numerous sandbars. The total combined land area is approximately 2.8 square statute miles. Two deep water passages are located in the southerly perimeter of the lagoon,

Figure 1-1. Typical Island Vegetation - Bikini Atoll

and navigable channels were swept from these passages to practicable ship anchorages in the lagoon.

When explored, most of the islands had a dense ground cover of vines and brush, as shown in Figures 1-1, 1-2, 1-10 and 1-11. Occasional trees were found, some 85 feet in height. The ground surface is generally flat, of coral sand and has an average elevation of less than ten feet above mean lower tide. With the exception of a few beaches, approaches to the islands by landing craft were not possible without dredging, due to the presence of a flat, shoal, coral-studded shelf, typical of atoll conformation.

Bikini Atoll is situated in an area dominated by the northeast trade winds, and weather conditions are comparable to Eniwetok Atoll. The mean wind velocity is 9.6 knots, 44% from the east and 34% from the northeast; the mean cloud cover is 4.1%; and the Atoll has an average of 14 rains per month with a total annual average of 81 inches.

The mean tide range is 3.0 feet, the mean high water spring tide rise is 5.5 feet, and mean low water spring tide is 0.6 feet.

It was determined that the best anchorage with shelter from the prevailing northeast winds was located about 1,400 yards from the beach on the inner side of Bikini Island (site How).

Bikini Island, the largest in the Atoll, is approximately 2.1 miles long by 0.5 miles wide at the widest point. A dense growth of palms and ground vegetation covered the Island. It had been used in 1946 for the base camp of OPERATION CROSSROADS and a few frame and canvas structures were found. Several concrete slabs still remained as did some supplies and equipment such as gasoline, diesel fuel, anchors and chain, dragline buckets, old stills, etc.; some of these items were salvable.

The original study was predicated upon the use of Eniwetok Atoll as a supporting base for the Bikini Atoll Auxiliary Proving Ground but assumed that, to accomplish the contemplated tests, the following minimum Bikini facilities would have to be provided:

A port-of-entry base camp to accommodate a total population of 250 men on Bikini Island.

A shot island camp for each experiment to accommodate 500 men.

An airstrip at the base camp suitable for C-45 and C-47 airplanes.

Liaison airstrips (minimum length 1200 feet) on each group of shot islands.

Figure 1-2. Typical Island Vegetation - Bikini Atoll

Limited facilities on Bikini Island for fueling liaison and transient aircraft.

Radio communications between Bikini Atoll and Eniwetok Atoll.

Beaching and docking facilities for Navy LCUs and LCMs at the port-of-entry base and the shot islands.

Scientific Stations of OPERATION IVY, Mike type, for each experiment.

Two ten-conductor signal cables and two 16-pair telephone cables between site Tare (Eninman Island) and the shot island groups.

The report "Auxiliary Proving Ground, Marshall Islands" contained, in addition to consideration of the foregoing data, the following basic recommendations:

A detailed reconnaissance be made on Bikini Atoll at an early date.

Orders for equipment and materials be placed as soon as possible.

An LST be assigned to the Operation prior to 1 October 1952, and remain throughout the construction, operation and roll-up periods.

The beachhead operation be started by 1 October 1952.

A horizontal control survey be started in October 1952.

Camp facilities be simple, with prefabricated wood buildings.

No laundry be provided at Bikini Atoll.

Utilities similar to those for OPERATION GREENHOUSE be provided on the shot islands.

The power plant on Bikini Island be a permanent concrete structure, blast proof and wave proof.

Diesel fuel be transported to Bikini Atoll in the tanks of the supporting LST and all other POL materials be supplied in drums.

Maximum use be made of the supporting facilities at Eniwetok Atoll, and shop and maintenance facilities at Bikini Atoll be kept to a minimum.

Criteria for the scientific programs be made available to the design engineers by 1 January 1953, and that the choice of the shot island group become known by 15 November 1952.

The Task Force provide frequent shuttle service between Eniwetok and Bikini Atolls, and approximately six L-13 (or similar) planes be assigned to Bikini Atoll.

The Task Force provide radio communications between Eniwetok and Bikini Atolls, using a frequency channel separate from that connecting Eniwetok Atoll and the Continental United States.

Based on assumptions in the submitted report, "Auxiliary Proving Ground, Marshall Islands", it was estimated that the facilities listed below would be required for OPERATION CASTLE:

Beachhead Operations	$ 210,000
Base Camp	$ 1,525,000
Shot Island Camp	$ 1,387,000
Scientific Stations	$ 2,260,000
Causeways	$ 2,600,000
New Construction Equipment	$ 1,000,000
Support of Scientific Using Agencies	$ 1,159,000
Features common to over-all programs such as boat pool operations, labor pool, submarine cable, control and signal facilities, maintenance and roll-up	$ 2,758,000
Total estimated cost of the Bikini Atoll Program	$ 12,899,000

On 11 September 1952, the Atomic Energy Commission, having concluded that utilization of Bikini Atoll for forthcoming tests was desirable from the standpoint of available land, geographic isolation, operational practicability and economy, approved the use of Bikini Atoll for OPERATION CASTLE and authorized Holmes & Narver, Inc. to proceed with planning for beachhead operations, proposed to begin on 1 October 1952. Field forces then at Eniwetok initiated planning for the organization of an advance party, using men, materials and equipment available from OPERATION IVY.

On 15 September 1952, the Project Engineer and Chief of Surveys proceeded via LST from Eniwetok to Bikini to initiate ground reconnaissance. Three days later they were joined by additional management and technical representatives of Holmes & Narver, the Atomic Energy Commission, and the Staff of Commander, Joint Task Force SEVEN. The general survey conducted by the augmented reconnaissance party resulted in the selection of a group of islands from Tare to Oboe as best suited for a base of operations and port-of-entry, rather than Bikini Island as originally proposed. It was then decided that the camp facilities would be placed on Tare, starting with a camp for 250 men with necessary facilities to be self-sustaining, including shelter, subsistence, power, fresh and salt water systems, recreation, medical and communication facilities.

Since this was to be the forward base of operations, sea and air accesses were a primary consideration. It was determined that a pier and approach channel would be necessary to off-load and transship materials by vessels of the LST class and other smaller craft, and that an airstrip and related air facilities would have to be constructed in the Peter-Oboe group, with a land connection to the Tare camp. Holmes & Narver, as the Contractor, then proceeded to mobilize the effort.

The first echelon of construction forces for the beachhead operation, comprised of 39 men with equipment, building materials and provisions, landed on Tare, at Bikini, on 2 October 1952. Additional men and materials were shipped by LST from the Elmer base at Eniwetok. The group was supported by air with occasional PBM flights from Eniwetok Atoll. As the construction of the camp progressed, the first detachment of personnel was augmented, and by 1 November there were 200 H&N employees on the site plus a small contingent of Army personnel who provided radio communication with Eniwetok Atoll. By 1 January 1953, a camp on Tare, though only 47% complete, was in operation and adequate for the needs at that time. The construction of the airport facilities was slightly ahead of schedule; the pier and channel, though only 65% complete, were being used to beach LSTs; and considerable essential survey work had been accomplished. Attention was then turned to the more remote reaches of the lagoon and to the determination of the shot islands.

As the scientific test program developed, it became apparent in the spring of 1953 that it would be necessary to build a 250-man camp at site Charlie to support a ground test in that area; a 250-man camp at site Fox to support three barge shots in the lagoon nearby; and on site Nan a 75-man camp to aid in the construction of a test control station, a tower, and related facilities. A fifth temporary 250-man camp, also to base a nuclear test, was planned for Ursula at Eniwetok Atoll.

The construction of temporary camp facilities at Charlie, Fox and Nan was accomplished by landing small groups of men, initially. Portable galleys and minimum housing facilities were provided while the temporary camps were being set up. In some instances, LCUs were outfitted as houseboats to provide living quarters until housing facilities could be established ashore. In addition to being useful in detached or inaccessible areas, this method was also necessary at Ursula, Eniwetok Atoll, because the camp area, due to high residual radioactivity, had to be decontaminated before men could be housed ashore.

As the scope of scientific requirements became more definite, it was necessary to reevaluate the size of the camps several different times, and by the end of 1953 the Bikini Atoll camps had to be expanded to accommodate the following population: Tare, 1,000 men; Charlie, 300 men; Fox, 250 men; Nan, 200 men.

Planning for the 250-man camp on Ursula, Eniwetok Atoll, called for reactivating the site previously used in OPERATION IVY. The camp proved adequate for the peak of 239 men, including TG 7.5 and all other JTF SEVEN personnel, which was reached in April 1954.

ENGINEERING-CONSTRUCTION

The engineering necessary for the temporary facilities included an evaluation of each site to determine the most suitable location for a camp, preferably adjacent to an accessible part of the beach in order that adjacent landing facilities could be provided with a minimum of cost, a minimum amount of channel excavation, and minimum shore transport. The camp was also to be in a location least likely to interfere with scientific requirements. Each camp was laid out to be self-contained. Power, fresh and salt water systems, sewage disposal, and recreational, medical and communication facilities were installed. At each of these sites there was also provided an area for landing helicopters plus facilities for handling materials and personnel from small craft. It was determined that because materials handling would play an important part in this Operation, a considerable amount of warehouse space and outside storage area would have to be provided at Tare as a redistribution point to all other sites at Bikini Atoll. It was also deemed necessary to provide an additional power plant at Ursula at Eniwetok Atoll. The existing facilities at Ursula were to be used where possible.

The preliminary design for an airstrip for Peter-Oboe, suitable for landing C-47s, was made at Elmer. The design was modified during construction to take advantage not only of the materials available at the site, but also the local terrain, in order to minimize the amount of fill required between islands and to provide a base course from available bank run or quarriable materials which would necessitate crushing only a minimum amount of coral for the gradations and conformations necessary to a well compacted wearing surface. The final design provided an unpaved strip made from native coral, using only water as a binder. Minor improvements to the strip approach zone later made it usable for larger aircraft, including C-54s.

Concurrent with the opening and consolidation of the Bikini frontier, a re-examination was made of the permanent proving ground facilities at Eniwetok to determine their adequacy as a base for the broadened and dispersed activity. The base facilities considered to be permanent for the Pacific Proving Ground are located on sites Elmer and Fred at Eniwetok Atoll. In order to provide accommodations for the anticipated population, including a new peak high of 3,000 men on Fred, it was determined that certain changes would have to be made to existing facilities. On Elmer these changes consisted of: additions to the laundry and mess hall, an engineering wing on the administration building, a personnel wing for the administration building, new barracks, an additional 1000 KW generator in the power house, additional distillation equipment, and a general revision to the power supply and distribution systems of both sites, including a submarine power cable between Elmer and Fred.

On site Fred, Eniwetok Island, the amount of actual additional facilities required was not agreed upon until rather late in the program, and during the summer and fall of 1953 this phase of the work assumed larger proportions. An important element affecting the work load was the decision to move the base of air operations from Kwajalein, where it had been in previous tests, to site Fred at Eniwetok. Because of this decision, it was necessary to expand the facilities; to improve the airstrip paving from the standpoint of both impact load and area; to furnish additional parking area, a decontamination pad, additional warehouse buildings; and to augment the electrical distribution system to that area. Task Group 7.2 required additional recreational facilities, administrative buildings, and general improvement in many of the camp areas. In addition, it became necessary to increase the water supply.

Also affecting the Eniwetok work load was "Typhoon Hester" which occurred on 29 December, 1952, and "Typhoon Doris" which occurred in December 1953; these storms made necessary the rehabilitation of many structures and areas, and pointed up the need for additional shore protection from storms, particularly on site Fred. This action was taken. Buildings in general, appeared adequate for storm wind pressures.

To engineer the added facilities on both Elmer and Fred, maximum use was made of prefabricated buildings for such structures as the laundry, administration buildings, barracks, and mess hall. Existing prefabricated buildings had proven their adaptability to this type of use and had a fine record for withstanding the climatic conditions, including the high winds encountered during typhoons. The new warehouses at both sites were of steel frame with aluminum siding. This was considered to be the most economical type of building suitable for warehouse structures in that climate. To resolve the problem of beach erosion on the ocean side of Fred, a seawall of poured concrete was designed, requiring a minimum cost for installation, to provide maximum protection against wave action resulting from storms. This wall was extended only in the areas which were observed to be most vulnerable and where existing facilities had suffered the most damage during "Typhoon Hester." The engineering design of airport facilities was coordinated with the Air Force in order that their needs for handling many types of aircraft during the Operation would be met. Approximately two-thirds of the airstrip was paved, including the taxiways which were provided, and improvements to the existing facilities were made, such as providing a concrete floor for the B-50 hangar. A new concrete pad was designed to provide an area for washing down contaminated planes.

Construction of the additional facilities on Elmer, at Eniwetok, was accomplished in the summer and fall of 1953 as time could be spared from the scientific program. Construction work proceeded without unusual incident. Site Fred construction was coordinated with the priorities established by the Using Agencies, and in many cases construction schedules were made contingent upon help supplied by TG 7.2 in the erection of buildings and other work requiring unskilled labor. Many prefabricated structures that had formerly been at Kwajalein were re-erected, using a large percentage of TG 7.2 labor. The paving of the airstrip and related items of work were correlated with air operations and were accomplished with a minimum of interruption to air traffic.

Construction work in this period progressed without abnormal incident, though the rather heavy work load, resulting from an accumulation of work orders, especially those involving preliminary electrical work requests, placed a burden on the scheduled construction at a time when the scientific program was at its peak, with the result that many items of work were not accomplished as promptly as would have been the case under normal conditions. The installation of a submarine power cable between the two sites solved a power problem and made it possible to supply site Fred with approximately 1000 KW from the Elmer power plant. The Fred power plant was then used as a source of standby power and, primarily, for furnishing power to the distillation plant during peak loads.

The site plans for all camps are shown in Figures 1-3 through 1-9 at the end of this chapter.

The scientific structures program, intimately identified with the primary mission of the proving ground development and always crucial to the logistics and completion schedule of the Contractor, had been gradually emerging concurrently with the design and construction of base facilities to support the test operation and its population. Planning and engineering heretofore described had been modified and extended by the character of the developing test program, and construction in place had reflected its then known requirements. Holmes & Narver Management, delegating most facilities design to Field Engineering forces, had devoted its Home Office Engineering staff to close scientific liaison and priority design of structures as quickly as criteria became firm.

The early concept of OPERATION CASTLE as it affected the scientific structures program was that it would consist of two ground shots with zero stations and related photographic and recording stations of the general magnitude of the Mike shot in OPERATION IVY. In addition, the decision was made to try a detonation using a barge anchored in the lagoon for the zero point. This concept was later expanded to include three ground zero detonations and three barge shots, and in the fall of 1953 another barge shot was added, making a total test program of seven shots.

Early in OPERATION CASTLE the H&N Engineering Division reviewed many of the major structures used in OPERATION IVY and, based on this review, prepared advance estimates of materials required for similar structures anticipated for OPERATION CASTLE. Procurement of standard materials from these advance estimates made it possible to start a flow of materials to the Atolls prior to completion of design. This technique often made it possible for the Field forces to start construction immediately upon receipt of approved design drawings.

The new design criteria developed at Los Alamos were transmitted by J-6 Division, and H&N worked closely at UCRL with their Project Engineers in development of criteria for the Laboratory's construction requirements.

Experience gained during OPERATION IVY with the 9000-foot plywood tunnel containing a controlled atmosphere envelope for observations taken on the Mike shot led to a decision to use pipe arrays in OPERATION CASTLE between the zero point and recording stations to accomplish the same general purpose.

The information gained from a UCRL-built test section of this pipe served as the basis for the design of pipe arrays used in each CASTLE ground shot. The pipe technique imposed rather tight alignment and vacuum retention specifications. Pipe was designed and fabricated early in the program and subsequent construction and alignment problems were successfully solved.

The proposal to use a barge as a zero point introduced a problem of maintaining stability but it was eventually determined that a zero point of this type would be feasible.

In order to outfit the 500-ton barges it was necessary to design a barge slip at Elmer with a traveling gantry crane which could be used for construction of the barge superstructure as well as for final installation of equipment by the Users. In addition, it was necessary to design an assembly area at Elmer where critical components might be stored and eventually assembled and moved onto the barges. This area incorporated facilities provided in previous operations by the USS Curtiss.

Organizing the test structures construction phase of OPERATION CASTLE required a considerable amount of logistical planning because of the large area over which the construction activities were conducted. In order to use as few men as possible on Bikini Atoll and to avoid duplication of facilities, it was decided that all materials would be shipped through the Elmer central warehousing and accounting facilities, and that only a limited warehousing activity would be set up at Tare to handle construction in that area and to act as a redistribution point for materials destined to other sites in the Bikini Lagoon. It was planned that the only exception to this would be those items, such as H-beam steel piling, structural steel, and equipment, which were of such size and of such an easily identifiable nature that logically they should be discharged at Tare. The assignment of an LST by TG 7.3 as the primary means of transporting materials and equipment between the two Atolls made it necessary to carefully evaluate in advance the needs for construction equipment in order that infrequent trips of a landing ship dock (floating drydock) might be used to transport equipment such as cranes which cannot be carried on an LST without dismantling.

One of the main construction problems involved in a program of this magnitude and compressed time tables was that of scheduling materials to avoid delays in the program. The normal procurement and shipping time on materials, and particularly on fabricated equipment and structures, was three to four months. Realizing that this had to be shortened for those Stations which were designed late in the program, it was necessary to take unusual action in all phases of the supply process. For example, in order to expedite fabrication for Zero Stations designed late in the program, it was necessary to obtain a line drawing from Engineering prior to actual design, and from this drawing the Procurement Department canvassed suppliers to determine where material was available, and time-and-material-type contracts were awarded based upon these forecasts. This succeeded in placing a hold on the material and allocating time in vendors' plants. As designs were firmed up, the vendors were allowed to proceed with fabrication, and by expediting movement of materials at all points, it was possible to decrease substantially the normal time required for supply. In many cases, changes were received too late to be incorporated during the initial fabrication, but it was possible to re-fabricate at the Jobsite without any serious loss of time.

All materials, supplies and equipment were packed for export, using where necessary the facilities of a commercial export packing firm at Oakland, California. These were transported to the Jobsite in U. S. Navy or MSTS vessels and were landed at either Tare or Elmer where they were warehoused and then distributed as needed to the various sites.

Exploration was made early in the program to determine suitable sources of coral aggregate at Bikini Atoll, and from samples tested by the Field Engineering Division possible reef locations were selected. As the program developed, estimates were made of tonnages of aggregate anticipated for various areas and a schedule was established for quarrying and for crusher plant operations at those locations. The same general procedure was followed in determining locations and timing for batch plant operations at different sites. This planning, plus the aquisition of a considerable amount of new construction equipment, made it possible to follow the construction program with minimum interference due to lack of equipment. The fact that Bikini Atoll had not been used in previous operations of this nature meant that some means had to be provided, either by channel clearance or by construction of causeways, to enable equipment and materials to be taken to each island containing a Scientific Station. The distance between Atolls and the difficulty of water transportation at Bikini Atoll, because of the roughness of the lagoon, added considerably to the transportation problem. The field problems encountered in construction of heavy precisely-located reinforced concrete structures of high strength design were of comparable complexity to those encountered in previous operations and required close control at all points. Concrete samples were picked up at various construction sites and were taken to Eniwetok for testing in the laboratory at that site.

In moving to Bikini Atoll, where the then existing survey data were inadequate, it was necessary to set up an extensive horizontal control network covering all major islands of the Atoll. Survey work was started early in the program and its progress required a considerable amount of brush and tree clearing on most islands as well as the rather difficult establishment of a rigid control point in mid-lagoon.

Limited transportation, security requirements and the frequent change in scope of work necessitated a careful balance of classifications of men at any one phase of the entire program and adequate forcasting of personnel needs. With the firming up of the requirements of the Operation, a rapid mobilization was effected through recruiting offices in Los Angeles, San Francisco, San Diego, Fresno and Honolulu. From the effective date of OPERATION CASTLE (1 January 1953) through 2 May 1954, a total of 3257 Travel Orders were processed covering single and multiple movement of personnel. The peak in contractual employees at the Jobsite was 2,313 and was reached on 7 December 1953.

As critical need arose for certain classifications, security clearances became a problem, particularily with respect to the long investigating and processing period that was required before an applicant or employee's services were available to the project. Such problems were partially resolved through liaison with the Los Angeles office of the Atomic Energy Commission and the Security Section of the office of the Eniwetok Field Manager. Two basic types of authority granting access to the PPG were used; namely, the "P" approval and the "Q" clearance. As the "P" approval did not authorize access to information classified "Restricted Data," it was necessary to send home all "P" approved personnel from the Proving Ground for the period of the test operations. This was accomplished by 24 January 1954.

MANAGEMENT

The Contract was a Fixed-Fee Architect-Engineer - Construction - Management Contract with the U. S. Atomic Energy Commission, administered by the Field Manager, Eniwetok Field Office, under the direction of the Manager, Santa Fe Operations Office. It was considered very effective for the purpose of this project. Within the framework of this Contract, the Atomic Energy Commission had wide latitude to change the scope of work or services to be performed by the Contractor and at the same time protect all the rights and interests of the Government as to control of expenditures of funds. The centralization of authority and responsibility for all features of the project by the execution of the single consolidated Contract permits simultaneous action on architect-engineer services, procurement of construction equipment and materials, recruiting and processing of manpower, construction, and operation; all of which are essential ingredients in planning a complex operation against a rigid end date.

The General Manager of Holmes & Narver, Inc., directly responsible to the President of the Company, was in charge of the over-all supervision of the Contract through the Controller, the Contract Administrator, Manager Construction-Operations Div., Chief Security Officer and Director of Engineering. The Manager, Construction-Operation Div., exercised supervision over the conduct of the operations at the Proving Ground through the Project Manager at the site. Sub-units of the organization were maintained at Honolulu, T. H., for recuiting and control of personnel traffic; at Oakland, California for coordinating transshipment of supplies and equipment; and at Travis Air Base at Fairfield, California, for liaison with personnel of the Military Air Transport Service in connection with air transportation of personnel and materials to the Jobsite.

The Contractor maintained a separate and distinct set of accounting records, which were kept in accordance with generally accepted accounting principles and directives issued by the Atomic Energy Commission. All purchases or charges, payrolls, taxes, petty cash, per diem, transportation and other authorized expenses were audited and processed for disbursement or entry and reimbursement and recorded in permanent books of account and record for completion of statements and reports.

Cost estimates were submitted to the Atomic Energy Commission for each item of work proposed. From these estimates, manpower requirements, engineering, procurement and construction schedules were formulated. The Atomic Energy Commission was kept informed of progress by weekly reports and monthly historical narratives which covered all features of the project.

Construction services were rendered to the various Governmental Agencies and/or Task Groups, which included three JTF SEVEN Task Groups and six Task Units together with 19 Scientific Programs and 53 Scientific Projects applicable thereto. Under the scope of work of the Scientific Structures Program, 269 stations were constructed.

The solutions to problems encountered in scheduling construction on OPERATIONS GREENHOUSE and IVY led to establishment in the spring of 1953 of an innovation in advance scheduling that proved to be very effective. All expendable construction was advance-scheduled by item. For example, before design criteria were firmed up for any Scientific Station, a realistic attempt was made to schedule a date when criteria would be available to the Engineering Department; engineering work was then scheduled; procurement and shipping of materials was scheduled; and finally, the actual construction period was shown. Although in many instances it became necessary to reschedule individual items because of changes in criteria, unavailability of materials, or a necessary change in schedules at Jobsite to meet local conditions, this over-all method of advance scheduling and the progress reporting resulting from it proved to be effective.

Within the Contractor's organization, schedules were most helpful in making it possible to do effective expediting on materials procured for Stations which had to be completed early in the program in order to eliminate interference with scheduled work that could not be designed until later in the program. This was also effective in reducing the amount of work which normally must be done during the last few weeks of a construction program due to late arrival of materials, and resulted in a minimum expenditure for premium payments for deliveries of equipment and materials.

During the period from 1 January 1953 to 30 April 1954, Holmes & Narver shipped 603,205 pounds via air freight. The two highest months were November and December, 1953, when air shipments reached 98,198 and 89,184 pounds respectively. Shipments of such large quantities of air freight were accomplished through close cooperation between Holmes & Narver representatives and Air Force Base personnel. However, temporary delays of air shipments from Travis Air Force Base occurred in a few instances due to priorities being given to Military materiel and personnel.

The over-all responsibility for radiological safety, including monitoring and reporting of exposures, was a Task Force function. The Atomic Energy Commission established a permissible exposure rate of an average of 300 millroentgens (mr) per week with a maximum of 3900 mr allowable during a 13-week period. Each person entering a contaminated area was required to carry a film badge. This badge was returned to Rad-Safe where it was evaluated and recorded. Accumulated exposures were reported to appropriate Task Group leaders in accordance with established procedure. In addition, the Rad-Safe group, provided a separate report of all personnel whose accumulated dosage had reached 2500 mr or over. This report acted as a warning to supervisory personnel responsibile for detailing men and work in contaminated areas. Due to the extent of the ultimate contamination, a heavy work load was imposed on the Rad-Safe group; as a result, there were times when the evaluation of film badges was not completed until several days after the exposure. Another problem existed in that the development of film badges and recording of exposures was accomplished on a vessel other than the one on which the Contractor's employees were housed. There were times when boating was so difficult that Rad-Safe information was delayed in arriving at the Contractor's offices. As a result, men were detailed to work in contaminated areas without current knowledge of their accumulated exposures and several TG 7.5 personnel received cumulative dosages in excess of 3900 mr per 13-week period. None of these overexposures, however, were excessive. Nevertheless overexposure was the cause of considerable concern because of the always present possibility that an employee may claim damages as a result of such overexposure.

CAMP OPERATIONS

Quarters, facilities and services were operated by Holmes & Narver to house, sustain and support all personnel of Joint Task Force SEVEN, except those who lived on site Fred and in Naval vessels. To accomplish this, temporary camps at Tare, Charlie, Fox, Nan and Ursula were provided and the permanent camp at Elmer was expanded. Each camp contained all necessary facilities for housing, messing, PX store, barber shop, refreshment bars, mail, laundry and utilities.

The total peak population (H&N supported), including all sites and all groups, was reached on 28 February, 1954, with a total of 3398. The breakdown of this figure is as follows:

Holmes & Narver (Permanent)	1804
Holmes & Narver (TDY)	11
Insurance Representative	1
Task Group 7.1	1010
Task Group 7.2	244
Task Group 7.3	88
Task Group 7.4	88
Task Group 7.5	19
JTF SEVEN	133
Total	3398

Furnishing water transportation for men, materials and equipment between the various sites of each Atoll was a considerable task. This was accomplished by operation of landing craft, water taxis, DUKWs, barges and tugs by the Holmes & Narver boat pool, augmented during the operational phase by craft from a U.S. Navy boat pool. Transportation between Atolls was supplied by Task Group 7.3 by means of regular LST trips with occasional trips of an LSD or other types of vessels.

Air transportation between Atolls was provided in the initial phase by means of PBMs which were made available on a non-scheduled basis. On 30 January 1953, a C-47 made the first landing on the Peter-Oboe airstrip, shown in plan drawing, Figure 2-47, Chapter II, and thereafter this type of plane was regularly scheduled. At the start, the schedules provided for two flights per week, but this frequency was increased as the need arose and eventually reached four flights per day. Intra-atoll air transportation at Bikini was provided by helicopters solely, thus eliminating the need for building airstrips at the various sites. The service provided by these craft proved of material assistance because of the helicopter's ability to land small working parties at isolated locations. Intra-atoll air transportation at Eniwetok was provided by small liaison planes of the L-13 class and by helicopters. Due to a shortage of pilots, this service was considerably curtailed during the months of June, July and August of 1953, necessitating additional water taxi service.

MAINTENANCE

The problem of preservation and maintenance of the facilities and structures was intensified by the rapid corrosion and deterioration of substantially all ferrous materials due to the tropical atmosphere and salt spray prevalent at both Atolls. Frequent chipping or sandblasting and painting of metal surfaces was necessary except on aluminum buildings, which were comparatively maintenance free.

Continuous preventative maintenance programs were established. Operating periods of equipment were recorded and overhaul was placed on a scheduled basis. Due to the distance of the Jobsite from the source of supply, it was essential that an adequate supply of spare parts be maintained at all times.

SUPPORT SERVICES

In accordance with Job IV of the Contract, support was provided to the Scientific agencies in assisting them in instrumentation and related work. This work was controlled by the initiation by the User of a Job IV work order, which required approval of the AEC Resident Engineer before the work could be undertaken. As of 1 June 1954, a total of 1479 Job IV work orders had been executed during OPERATION CASTLE.

Support Services - Job IV Subsidiary Accounts include a detailed account of support services rendered to the various Using Agencies and Task Groups. These included five JFT SEVEN Task Groups and 11 Task Units, together with 9 Scientific Programs and 52 Scientific Projects applicable thereto.

ROLL-UP and TEST OPERATIONS

Prior to the first detonation, the Charlie camp was completely rolled up and the camp at Fox was reduced to a size to support 75 men for 10 days. After the Bravo event, roll-up of the Tare and Nan camps proceeded under adverse working conditions. (Refer to Chapter VII, Section 2). Roll-up of the Scientific Stations not needed for test purposes proceeded as a parallel operation with the roll-up of all other facilities. With the cancellation of the Echo event, the roll-up of the camp on Ursula was accomplished. All equipment, materials and supplies not intended for post-test use were scheduled to be preserved, mothballed, and made ready for future use.

Precautionary measures against blast damage, wave action, and radioactive contamination were taken as dictated by probable test yields. However, after the initial shot (Bravo - Station 20) on 1 March 1954, all pre-test plans were greatly modified.

The unexpected destruction of facilities and the intensity of the residual radioactive contamination resulting from the Bravo detonation necessitated changes in the test program. Changes were made in the shot sequences; also, Station 90 was moved to the Charlie crater; Station 10 to the Flora crater; and a number of photographic and other recording stations had to be abandoned or added to meet the requirements for the changed zero stations. Radioactive contamination necessitated a new barge, Station 1840.01, on a reef near How, in lieu of Station 1820.02.

The principal resultant problem to the Contractor was the disposition of his forces, particularly the abrupt shift from a land-based to a ship-based operation at Bikini. The adaptation was successfuly made for the limited duration involved.

SECTION 2
CONCLUSIONS AND RECOMMENDATIONS

All of the foregoing narrative summary is extracted from text treated in more complete detail in following sections of this report.

The principal difficulties reported in OPERATION CASTLE appear to have been related, directly or indirectly, to the scheduling of the preoperational phases of construction. The problems derive from the nature of the project. The remoteness of the site, the lead time necessary for procurement and mobilization, the difficulty of effective distribution of men and equipment on widely dispersed areas, and transport over the considerable water separation, all contribute to a rather extended construction period. Yet, in the earlier phases of the preoperational period, few criteria are firm except the end date, which, being inflexible, demands careful planning. Detailed schedules based on firm scope are not possible until late in a program when they were often too late for effectiveness, and early schedules tend to be fragmentary. However, experience in the problems of GREENHOUSE and IVY has enabled the Contractor increasingly to anticipate and evaluate missing factors, and thus make realistic forecasts. The momentum of scientific progress, continuing to the moment of a test, makes most of the resulting engineering and construction problems inherent in the project. Although the operational phase was changed in scope as a result of the first detonation, the rapid solution of the problems which followed indicated that the existing procedural techniques and organizational set-up, were functional and flexible enough to accommodate not only an orderly progression in the operation, but also radical changes in plans. Therefore, extended recommendations do not appear to be indicated.

There are a few refinements, from the Contractor's standpoint, that might produce some saving of time and money in other operations. Accordingly, the following is offered for consideration in planning future test programs.

1. Experience gained during OPERATION CASTLE indicates the need for more direct control by the Contractor over contract employees in the matter of radiation exposure. It is therefore believed desirable to establish within Task Group 7.5 a non-military Rad-Safe unit which would be responsible for the regulation of safety measures within the Task Group.

2. In the development of design criteria, it is believed that the Contractor's personnel should work in close proximity with the actual design groups at the University of California Radiation Laboratory and Los Alamos Scientific Laboratory in order to expedite the development of criteria and, also, to help the Scientific Groups formulate design requirements along lines which could result in simplification or standardization of construction procedures and materials, thus resulting in over-all savings in time and money.

3. As a means of reducing the number of personnel in the advance elements of the Task Groups assigned to the Forward Area, consideration might be given to instructing the Contractor to assume additional responsibilities in the handling, processing, and billeting of personnel; in warehousing of User's equipment and supplies; and in other related functions at the Pacific Proving Ground which involve duplication of function, and for which the Contractor is already established.

CONTRACT HISTORY
SECTION 3

After completing the reconnaissance of Bikini Atoll as directed in the AEC Field Manager's letter of 12 June 1952, and reporting the findings of this reconnaissance in the report "Auxiliary Proving Ground, Marshall Islands," Holmes & Narver, Inc., was authorized to proceed with the design and construction of certain facilities at Bikini Atoll. This authorization was received from the Field Manager in letter MC 162 dated on 24 September 1952. Additional work was authorized by letter MC 231 dated on 17 November 1952.

It was apparent, in view of developments during the last half of the calendar year 1952, that Holmes & Narver's services would be required by the AEC beyond 30 June 1953 (the expiration date of Contract AT-(29-2)-20), and that the appropriated funds obligated under this contract were insufficient for the work contemplated. Therefore, on 29 and 30 December 1952, meetings were held in Los Angeles between representatives of the Atomic Energy Commission and Holmes & Narver, Inc.,for purposes of developing an appendix to the Contract which would extend the period of services, define the work to be accomplished, and negotiate a fixed fee.

Due to the lack of firm criteria for much of the program, however, it was determined that token amounts for scientific structures, submarine cables, and miscellaneous construction would be included in the appendix with the express understanding that these amounts were not firm or definitive of the work to be accomplished, and that the appendix would be subsequently modified when definitive criteria became available.

In addition to the above-mentioned items, the preliminary cost estimates for the construction of a camp on Tare and the filling of the crater on Ruby, transmitted on 20 November and 15 December 1952, were to be included in the appendix. It was estimated that approximately one month would be required by AEC divisions for the preparation of the appendix and the calculation of the fixed fee. In the meantime, as additional requirements became known, Holmes & Narver was to submit current cost estimates for inclusion in the appendix if possible. In the event the preparation of the appendix had proceeded to the point where it would be impractical to include current estimates, they were to be included in a subsequent contract modification.

In the early part of January 1953, it became apparent that the execution of a definitive appendix would require more than one month due to administrative reviews and processing. Therefore, on 15 January 1953, Modification 14, providing for an extension of the period of services under existing contracts beyond 30 June 1953 and an increase of obligated funds in the amount of $9,000,000, was executed.

A draft of the proposed Appendix "A" was received by Holmes & Narver, Inc. on 18 March 1953; it was acceptable to Holmes & Narver, as the Contractor, and the AEC was so advised. On 30 April 1953, effective 27 February 1953, Appendix "C" to Contract AT-(29-2)-20 was executed by the Contractor and returned to the AEC for execution, and a copy of the fully executed appendix was received in the Contractor's Home Office on 8 May 1953.

Modification 16 extended the period of services through 30 June 1954, defined a portion of the work required, and established a fixed-fee scale based on a composite rate of fee for Titles I, II, III and IV work under Job I, "Engineering, Design, Inspection and Construction." The work and services under each title had been defined, and in general terms were as follows:

Title I. Preliminary engineering work as surveys, studies, layout plans, and reports.

Title II. Design, specifications and estimates of cost.

Title III. Architect-Engineer supervision and inspection, "as - built" drawings, completion and monthly narrative reports.

Title IV. Construction with procurement of necessary materials, equipment and supplies.

The estimated cost, period of services and fixed fees for Jobs II, III, IV and V, "Camp Operation and Management," "Maintenance Services," "Support Services," and "Roll-up Services," respectively, were also established.

The scope of the work required for OPERATION CASTLE was increased throughout the construction and operational period, which necessitated subsequent modifications to the Contract. A schedule of contract modifications affecting work scope for OPERATION CASTLE is shown in the following table:

MODIFICATIONS INCREASING THE SCOPE OF WORK FOR OPERATION CASTLE

	Operation Castle	Budget 3028	Projects 4015	Equipment Not Included In Const.	Total
Modification 16	$ 7,170,020	$136,185	$		$ 7,306,205
Modification 23	2,500,000				2,500,000
Modification 26	10,904,585	353,240	749,392	286,250	12,293,467
Modification 31	6,216,561	237,550	858,530		7,312,641
Modification 36 (in negotiation)	1,831,949		679,380		2,511,329
	28,623,115	$726,975	$2,287,302	286,250	31,923,642
Jobs II, III, IV & V	8,278,000				8,278,000
	$36,901,115	$726,975	$2,287,302	$286,250	$40,201,642

Part III of Contract Modification No. 16 is included herein to provide an understanding of the basis for fee payments.

"A. *Job I - Engineering, Design, Inspection, and Construction.*

The contractor will be required to perform services for this portion of Job I under this contract, the amount of some of which are undeterminable at this time. However, the value of services under this item will be determined by the estimated cost reflected by the 'Current Estimate'. The term 'Current Estimate' as used herein is understood to mean the detailed estimate prepared from detailed final drawings which have been approved by the Field Manager, Eniwetok Field Office, and is prepared at the time such drawings are transmitted to the Jobsite for construction. 'Current Estimates' will be checked by the Eniwetok Field Office for accuracy and upon formal approval will be considered a portion of the scope of work to be added to the incremental scale set forth below and will be added to the contract by modification. Fixed fees have been established to cover engineering, design, inspection, and construction which may be authorized during the period October 1, 1952 to March 31 1954. Any construction projects authorized by the Government subsequent to March 31, 1954 will be considered new scope of work and will not be considered an additive to the established fee schedule

Estimated costs shown for all items set forth in Job I under Part I of the Appendix in Modification No. 16 are considered firm except Items 27, 29 and 33 which are so noted.

Payments will be made on a percentage of completion of construction applied against the fee set forth in the latest modification for Job I Engineering, Design, Inspection, and Construction, such fee to be computed from the fee scale set forth.

B. *Job I - Procurement*

Payments of fee for Job I - Procurement will be made on a percentage of completion of procurement services applied against the fee set forth for that portion of Job I.

C. *Job I - Special Engineering Report*

Payment of fee for Job I - Special Engineering Reports will be made upon request of the Contractor upon completion of the report.

D. *Jobs II, III, IV, and V - Camp Operation, Maintenance, Support, and Roll-up*

Payments of fee for Camp Operation, Maintenance, Support, and Roll-up services are to be made in twelve equal payments, the first payment to be made in July 1953, *and* *each month thereafter up to and including June 1954. It is understood and agreed by both parties that Job IV - Support and Job V - Roll-up cover a service period of eighteen months and fourteen months, respectively, but since the bulk of the work will be performed from July 1, 1953 to June 30, 1954, and in the interest of simplicity in accounting, payments will be deferred until July 1953 and will be made in twelve equal payments.*

Part IV of the Contract detailed completion dates as follows:

Job No.	Description	Completion Date
I	a. Engineering, Design, Inspection and Construction	March 31, 1954*
	b. Procurement of Construction and Operational Equipment	Dec. 31, 1953
	c. Special Engineering Reports	Oct. 15, 1952
II	Camp Operation in support of other than Holmes & Narver personnel	June 30, 1954
III	Maintenance	June 30, 1954
IV	Support	June 30, 1954
V	Roll-up	June 30, 1954

* As stated under Part III, Item 1A above, this date of March 31, 1954, is not necessarily the completion date for construction authorized before that date. However, any construction authorized after March 31, 1954, will be considered new scope of work and will be negotiated on that basis."

A discussion of the various modifications to Contract AT-(29-2)-20 as they affected OPERATION CASTLE will be limited to only those that do not pertain to additional scope of work since these have been previously tabulated.

Modification 17, dated 30 March 1953, effective 1 January 1953, provided that the allowance for employee benefits be increased from 11.646% to 13.05%. This change was the result of the annual review provided for in Paragraph 4, Section C, Part I of Appendix B, forming a part of Contract AT-(29-2)-20.

Modification 18, dated 2 June 1953, effective 18 October 1951, provided for the inclusion of stand-by time of engineers, draftsmen and designers, said stand-by time being the result of unforeseeable fluctuation in the Contractor's work requirements under the Contract, as a direct charge to allowable overhead under the Contract.

Modification 19, dated 17 June 1953, effective as indicated therein, provided for a revision of the wage and salary schedules contained in Appendix B and further provided for a leave of absence not to exceed two weeks for certain supervisory and administrative off-continent personnel.

Modification 20, dated 26 June 1953, increased obligated funds by $500,000 - from $28,482,000 to $28,982,000.

Modification 21, dated 17 July 1953, increased obligated funds by $2,500,000 - from $28,982,000 to $31,482,000.

Modification 22, dated 6 August 1953, effective as indicated therein, provided for the revision of wage rates for certain off-continent job classifications.

Modification 24, dated 1 September 1953, increased obligated funds by $2,500,00 - from $33,982,000 to $36,482,000.

Modification 25, dated 14 September 1953, increased obligated funds by $2,000,000 - from $36,482,000 to $38,482,000.

Modification 27, dated 7 October 1953, amended the first subparagraph of Paragraph (a) Section 3, Article III to provide for an annual audit rather than a semi-annual audit to determine the percentage to be paid for allowable overhead.

Modification 28, dated 2 November 1953, amended Article VI to provide for an annual audit of advanced fund disbursments rather than a quarterly audit.

Modification 29, dated 22 October 1953, effective 1 October 1953, provided for a revision to Paragraph 4, Section C, Appendix B, requiring prior review and written approval of the Commission for subsequent revisions of company policies which result in an increase in related costs under the Contract.

Modification 30, dated 15 January 1954, effective 15 November 1953, provided for the revision of certain wage rates for on-continent employees and the inclusion of additional classifications.

Modification 32, dated 12 April 1954, effective 1 January 1954, establishes a period of three years—after final payment under the Contract—in which the Comptroller General of the United States, or his representative, may have access and examine any books, documents, papers, and records involving transactions relating to the contract.

Modification 33, dated 1 May 1954, effective 18 February 1954, makes it possible for the contractor to effect a speedy settlement with overseas employees who have suffered injury, damage, or loss of property without any fault or negligence on the part of the employee.

Modification 34, dated 10 May 1954, effective 18 January 1954, requires the Contractor to include in all subcontracts and purchase orders above $1,000 a clause permitting the Comptroller General, or his representative, to have access and the right to examine any directly pertinent books, documents, papers, and records of the subcontractor involving transactions related to the subcontract until the expiration of three years after final payment under the subcontract.

Modification 35, dated 14 June 1954, extended the contract through 31 August 1954, and increased the obligated funds to $58,133,231.

SECTION 4
PARTICIPATING AGENCIES

The following agencies participated in OPERATION CASTLE. These are listed alphabetically and not in the order of participation or by the importance attached to the role each agency played in the over-all program. These agencies are generally referred to in other sections of this report as "Users" or "Using Agencies".

ACC	Army Chemical Corps
ACF	American Car Foundry
AFL	Applied Fisheries Laboratory, University of Washington
AFOAT-1	Air Force Office of Atomic Energy
AFSWP	Armed Forces Special Weapons Project
ARDC	Air Research and Development Center
CAMCO	Cambridge Corporation
CRL	Chemical and Radiological Laboratory
DBM	Division of Biology and Medicine, AEC
DIRX	Director Office Special Assignment
DOD	Department of Defense
DTMB	David Taylor Model Basin, U. S. Navy
EG&G	Edgerton, Germeshausen & Grier, Inc.
ESL	Evans Signal Laboratory
HIJ	Herrick L. Johnston
LASL	Los Alamos Scientific Laboratory
LML	Lookout Mountain Laboratory
NEL	Naval Electronics Laboratory
NOL	Naval Ordnance Laboratory
NRDL	Naval Radiological Defense Laboratory
NRL	Naval Research Laboratory
NRLS	Naval Research Laboratory - Stewart
ONR	Office of Naval Research
SAC	Strategic Air Command
SANDIA	Sandia Corporation
SCRIPPS	Scripps Institute of Oceanography
SRI	Stanford Research Institute
USCGS	United States Coast and Geodetic Survey
UCRL	University of California Radiation Laboratory
USFS	United States Forest Service
WADC	Wright Air Development Center

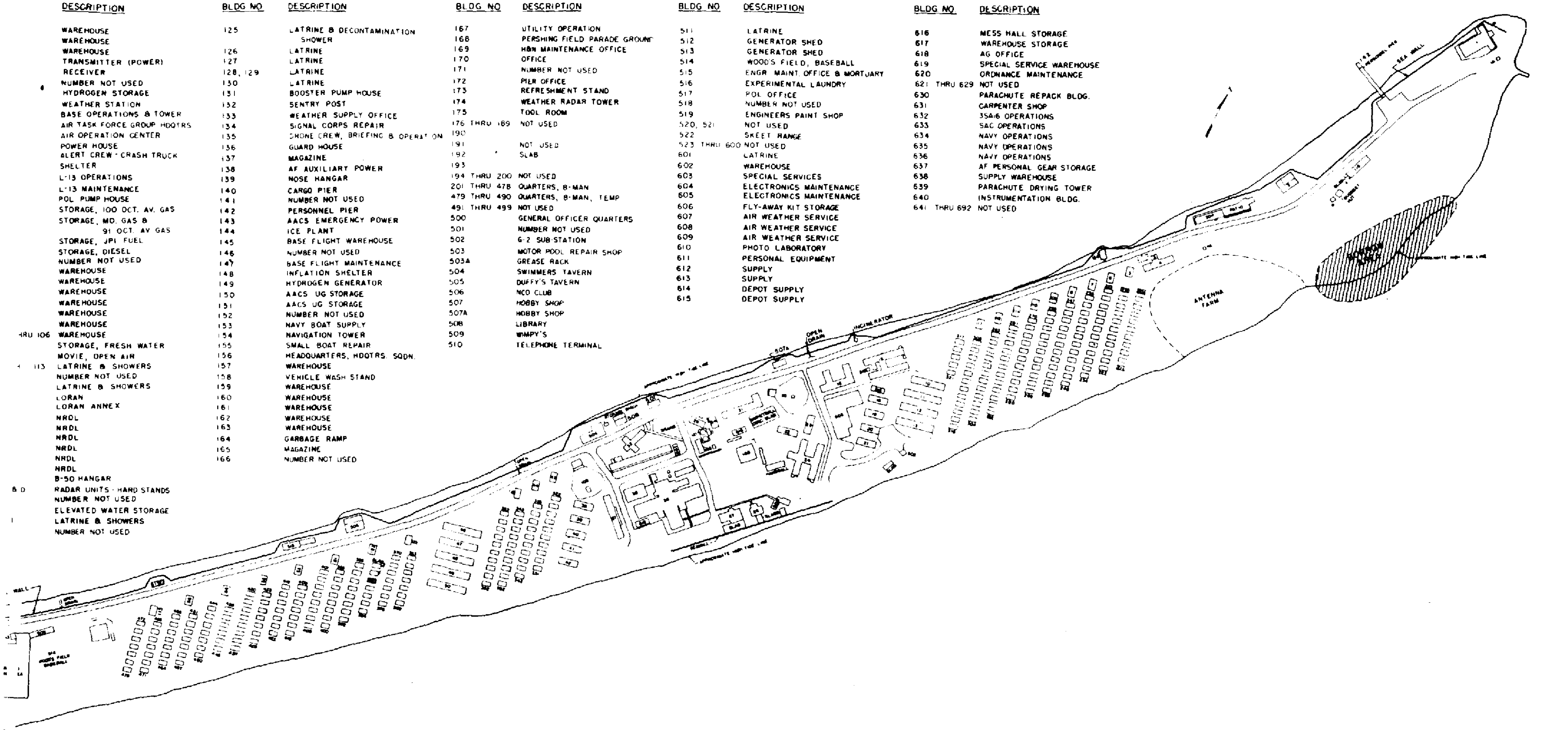
BLDG NO	DESCRIPTION
	WAREHOUSE
	WAREHOUSE
	WAREHOUSE
	TRANSMITTER (POWER)
	RECEIVER
	NUMBER NOT USED
	HYDROGEN STORAGE
	WEATHER STATION
	BASE OPERATIONS & TOWER
	AIR TASK FORCE GROUP HDQTRS
	AIR OPERATION CENTER
	POWER HOUSE
	ALERT CREW - CRASH TRUCK SHELTER
	L-13 OPERATIONS
	L-13 MAINTENANCE
	POL PUMP HOUSE
	STORAGE, 100 OCT. AV. GAS
	STORAGE, MO. GAS & 91 OCT. AV GAS
	STORAGE, JP1 FUEL
	STORAGE, DIESEL
	NUMBER NOT USED
	WAREHOUSE
	WAREHOUSE
	WAREHOUSE
	WAREHOUSE
	WAREHOUSE
	WAREHOUSE
HRU 106	WAREHOUSE
	STORAGE, FRESH WATER
	MOVIE, OPEN AIR
113	LATRINE & SHOWERS
	NUMBER NOT USED
	LATRINE & SHOWERS
	LORAN
	LORAN ANNEX
	NRDL
	NRDL
	NRDL
	NRDL
	NRDL
	NRDL
	B-50 HANGAR
8 D	RADAR UNITS - HARD STANDS
	NUMBER NOT USED
	ELEVATED WATER STORAGE
I	LATRINE & SHOWERS
	NUMBER NOT USED

BLDG NO	DESCRIPTION
125	LATRINE & DECONTAMINATION SHOWER
126	LATRINE
127	LATRINE
128, 129	LATRINE
130	LATRINE
131	BOOSTER PUMP HOUSE
132	SENTRY POST
133	WEATHER SUPPLY OFFICE
134	SIGNAL CORPS REPAIR
135	PHONE CREW, BRIEFING & OPERATION
136	GUARD HOUSE
137	MAGAZINE
138	AF AUXILIARY POWER
139	NOSE HANGAR
140	CARGO PIER
141	NUMBER NOT USED
142	PERSONNEL PIER
143	AACS EMERGENCY POWER
144	ICE PLANT
145	BASE FLIGHT WAREHOUSE
146	NUMBER NOT USED
147	BASE FLIGHT MAINTENANCE
148	INFLATION SHELTER
149	HYDROGEN GENERATOR
150	AACS UG STORAGE
151	AACS UG STORAGE
152	NUMBER NOT USED
153	NAVY BOAT SUPPLY
154	NAVIGATION TOWER
155	SMALL BOAT REPAIR
156	HEADQUARTERS, HDQTRS. SQDN.
157	WAREHOUSE
158	VEHICLE WASH STAND
159	WAREHOUSE
160	WAREHOUSE
161	WAREHOUSE
162	WAREHOUSE
163	WAREHOUSE
164	GARBAGE RAMP
165	MAGAZINE
166	NUMBER NOT USED

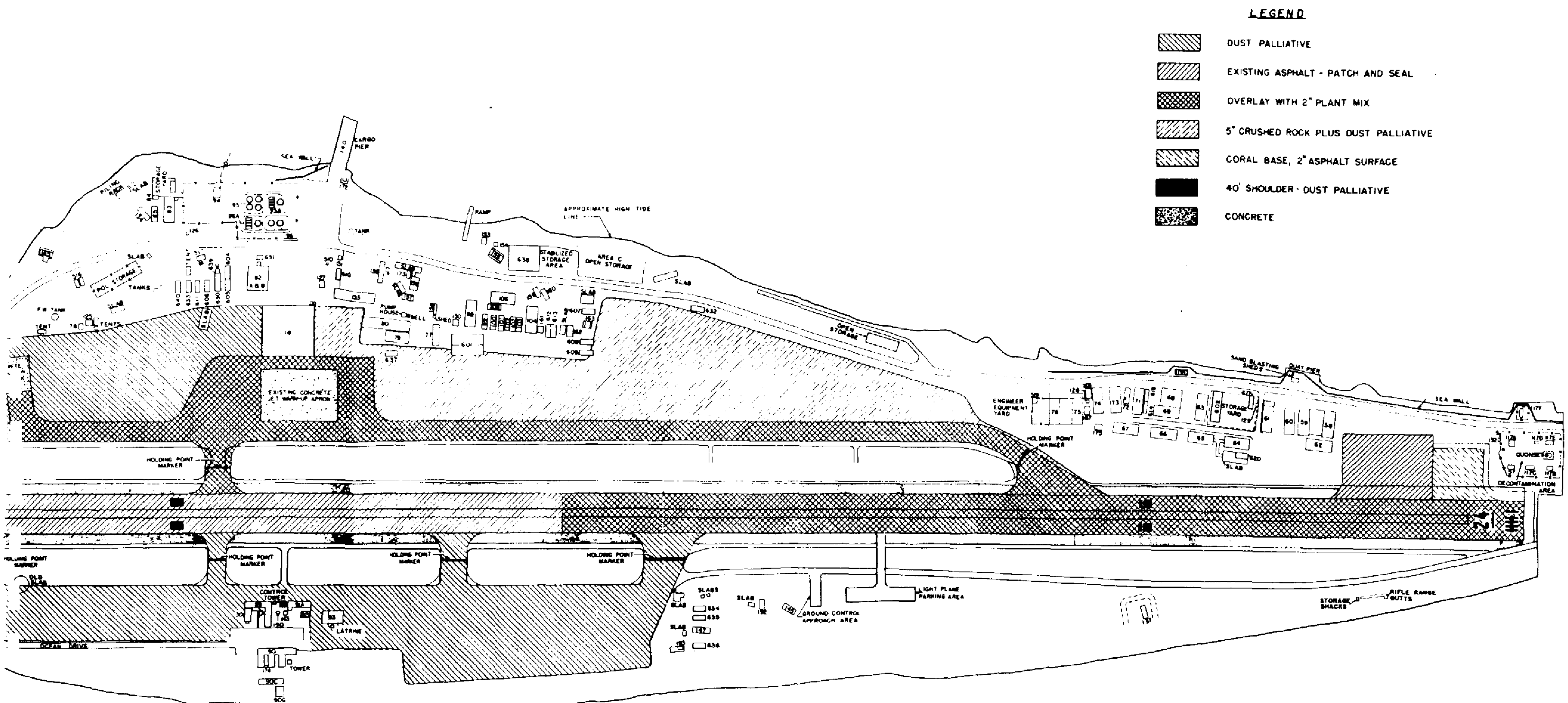
BLDG NO	DESCRIPTION
167	UTILITY OPERATION
168	PERSHING FIELD PARADE GROUND
169	H&N MAINTENANCE OFFICE
170	OFFICE
171	NUMBER NOT USED
172	PIER OFFICE
173	REFRESHMENT STAND
174	WEATHER RADAR TOWER
175	TOOL ROOM
176 THRU 189	NOT USED
190	
191	NOT USED
192	SLAB
193	
194 THRU 200	NOT USED
201 THRU 478	QUARTERS, 8-MAN
479 THRU 490	QUARTERS, 8-MAN, TEMP
491 THRU 499	NOT USED
500	GENERAL OFFICER QUARTERS
501	NUMBER NOT USED
502	G-2 SUB-STATION
503	MOTOR POOL REPAIR SHOP
503A	GREASE RACK
504	SWIMMERS TAVERN
505	DUFFY'S TAVERN
506	NCO CLUB
507	HOBBY SHOP
507A	HOBBY SHOP
508	LIBRARY
509	WIMPY'S
510	TELEPHONE TERMINAL

BLDG NO	DESCRIPTION
511	LATRINE
512	GENERATOR SHED
513	GENERATOR SHED
514	WOOD'S FIELD, BASEBALL
515	ENGR MAINT OFFICE & MORTUARY
516	EXPERIMENTAL LAUNDRY
517	POL OFFICE
518	NUMBER NOT USED
519	ENGINEERS PAINT SHOP
520, 521	NOT USED
522	SKEET RANGE
523 THRU 600	NOT USED
601	LATRINE
602	WAREHOUSE
603	SPECIAL SERVICES
604	ELECTRONICS MAINTENANCE
605	ELECTRONICS MAINTENANCE
606	FLY-AWAY KIT STORAGE
607	AIR WEATHER SERVICE
608	AIR WEATHER SERVICE
609	AIR WEATHER SERVICE
610	PHOTO LABORATORY
611	PERSONAL EQUIPMENT
612	SUPPLY
613	SUPPLY
614	DEPOT SUPPLY
615	DEPOT SUPPLY

BLDG NO	DESCRIPTION
616	MESS HALL STORAGE
617	WAREHOUSE STORAGE
618	AG OFFICE
619	SPECIAL SERVICE WAREHOUSE
620	ORDNANCE MAINTENANCE
621 THRU 629	NOT USED
630	PARACHUTE REPACK BLDG.
631	CARPENTER SHOP
632	35A16 OPERATIONS
633	SAC OPERATIONS
634	NAVY OPERATIONS
635	NAVY OPERATIONS
636	NAVY OPERATIONS
637	AF PERSONAL GEAR STORAGE
638	SUPPLY WAREHOUSE
639	PARACHUTE DRYING TOWER
640	INSTRUMENTATION BLDG.
641 THRU 692	NOT USED



Site Fred - Eniwetok Atoll - North-Eastern Section
(Sheet 1 of 2 Sheets)



wetok Atoll - Western Section
Sheets)

[redacted]

BLDG NO	DESCRIPTION
1 THRU 50	4-MAN QUARTERS
51 THRU 99A	8-MAN QUARTERS
100 THRU 110	36 MAN QUARTERS
111 THRU 116	18-MAN QUARTERS
117	INFIRMARY
118	NURSES QUARTERS & DENTIST
119	18-MAN QUARTERS
120	QUARTERS & LANAI
121 THRU 130	18-MAN QUARTERS
131 THRU 134	36 MAN QUARTERS
135 THRU 149	
150	GARBAGE CAN BUILDING
151	BEACH CLUB
152	BEACH CLUB
153 THRU 158	DIESEL FUEL STORAGE
159	
160	HOSE SHELTER
161	HOSE SHELTER
162	FIRE PUMP HOUSE
163	STATIONARY LOCKER
164	OPERATIONS BUILDING
165	LATRINE
166	RESERVOIR
167	CONCRETE
168	BATTERY & TIRE SHOP
169	
170	
*171	DISTILLATION REPAIR SHOP
*172	POWER PLANT REPAIR SHOP
*173	PLUMBING WAREHOUSE
174	MARINE RIGGING LOFT & MARINE WAYS OFFICE (A & B.)
175	CHAPEL
176	HOBBY SHOP
177	GUARD & CONSTRUCTION OFFICE
178	CAMP OFFICE
179	GYM
180	RADIO SHOP
181	SUPPLY FIELD OFFICE
182	WAREHOUSE - SUPPLY HARDWARE
183	WAREHOUSE
184	WAREHOUSE
185	AEC SUPPLY
186	SAW SHED
187	PIER GUARD SHELTER
188	H & N MOTOR POOL DISPATCHER
189	AEC MOTOR POOL DISPATCHER
190	BEACH CLUB
191	MARINE POL STORAGE
192	DIESEL FUEL STORAGE
193	GENERAL LABORATORY
194	SHOP WITH DEHUMID ROOM
195	SHOE SHOP
196	REEFER BANKS
197	REEFER BANKS
*198	MARINE ELECTRIC SHOP
199	SOFTBALL FIELD
200	OUTDOOR MOVIE
201	MESSHALL
202	BAKERY
203	BOILER HOUSE
204	P.O., PX & SNACK BAR
205	FIRE STATION
206	SECURITY HEADQUARTERS
207	STORAGE TENT - FIRE EQUIPMENT
208	H&N ADMINISTRATION
208A	H&N ADMINISTRATION
208B	H&N ADMINISTRATION
209	AEC ADMINISTRATION
210	PHOTO LABORATORY
211	INSTRUMENT LABORATORY
212 A,B&C	COUNTING & SAMPLING LABORATORY
213	GUARD POST
214	GUARD POST
215	LATRINE (MESS HALL)
216	DAY ROOM
217	REEFER
218	BIOLOGICAL LABORATORY
219	
220	FRESH & SALT WATER ELEVATED TANKS
221	TASK FORCE ADMINISTRATION
222	PASS & BADGE OFFICE
223 THRU 226	
227	LATRINE & SHOWERS
228	LATRINE & SHOWERS
229	TELEMETER & RECEIVER BLDG
230	COMMISSARY
231	LABORATORY
232	SHOP, SCIENTIFIC USERS
233 THRU 236	LATRINES & SHOWERS
237	RECREATION
238	CHILL STORAGE BUILDING
239	M P ORDERLY & SUPPLY TENT
240 THRU 249	
250	BASEBALL FIELD
251	ANNOUNCERS BOOTH
252	REFRESHMENT STAND
253	BARBEQUE PIT
254	GARBAGE CAN BUILDING
255	ACID HOUSE
256	EXPLOSIVE STORAGE
257	NITROGEN STORAGE
258	ACETYLENE STORAGE
259 THRU 299	
300	POL PUMP HOUSE
301	POWER & DISTILLATION PLANT
302A	BOILER HOUSE
302	LAUNDRY
303	ADDITION TO LAUNDRY
304	DIESEL FUEL STORAGE
305	DIESEL FUEL STORAGE
306	
307	GASOLINE STORAGE
308	WAREHOUSE, FOOD
309	MATERIAL TEST LABORATORY
310	
311	CONTROL BUILDING
312	FRESH WATER TANK
313	SUPPLY DIV OFFICE & WAREHOUSE
314	SHEET METAL SHOP
314A	PLUMBING & REFRIGERATION
315	ELECTRICAL SHOP
316	SHEET METAL SHOP
317	CARPENTER SHOP
318	OFFICE MACHINE REPAIR SHOP
319	WAREHOUSE
320	WAREHOUSE
321	WAREHOUSE
322	MARINE REPAIR SHOP
323	RADSAFE BUILDING
324	RADSAFE HUTMENT
325	
326	FRESH WATER TANK
327	
328	
329	LABORATORY
330	LABORATORY
331	SHELTER
332	GUARD POST
333	AC BUILDING CMR AREA
334	SHELTER
335	GUARD TOWER
336	GUARD TOWER
337	CALIBRATION STATION
338	
339	POWER PLANT
340	CYLINDER SHELTER
341	SHOP & STORAGE BUILDING
342	SHOP
343	
344	LABORATORY
345 A&B	CYLINDER RACKS
346	
347	SALT WATER INTAKE
348	
349	ELEVATED WATER STORAGE
350 THRU 359	
360	SEALRAFT REPAIR SHELTER
361 THRU 370	
371 THRU 375	DIESEL FUEL STORAGE
376 THRU 379	GASOLINE STORAGE
380 THRU 398	
399	IRON WORKER SHED
400	WAREHOUSE
401	PAINT SHOP & PARTS
402	TOOL CRIB & PARTS WAREHOUSE
403	HEAVY EQUIPMENT PARTS WAREHOUSE
404	HEAVY EQUIPMENT MACHINE SHOP
405	HEAVY EQUIPMENT REPAIR SHOP
406	MARINE OPERATIONS
407	
408	GUARD SHACK
409	REFRESHMENT BUILDING
410	SALT WATER PUMP HOUSE
411	ASSEMBLY BUILDING
412	HIGH EXPLOSIVE STORAGE BUILDING
413	MAGAZINE
414	GUARD HOUSE
415	SPECIAL TEMP STORAGE BUILDING
416	
417	
418	ASSEMBLY BLDG
418A	ASSEMBLY BLDG
419	BARGE SLIP
420	CEMENT WAREHOUSE
421	HEAVY EQUIPMENT REPAIR SLAB
422	OXYGEN STORAGE SHELTER
423	JTF RECREATION
424 THRU 500	
501	WAREHOUSE - ELECTRIC
502	WAREHOUSE - PLUMBING
503	WAREHOUSE - SHIPPING
504	WAREHOUSE - DRY STORES F Y 1954
505	WAREHOUSE - LIGHT & HEAVY DUTY PARTS F Y 1955
506	WAREHOUSE - REFRIGERATOR, MARINE, & POWER HOUSE F Y 1955
507	WAREHOUSE - CAMP SUPPLIES F Y 1954
508	WAREHOUSE - PROPERTY F Y 1954
509	WAREHOUSE - GENERAL STORES F Y 1955
510	TOOL CRIB & STATIONERY LOCKER F Y 1955
511	WAREHOUSE
512	WAREHOUSE
513 THRU 550	
551	LATRINE (WAREHOUSE)

* WRECKED & REMOVED

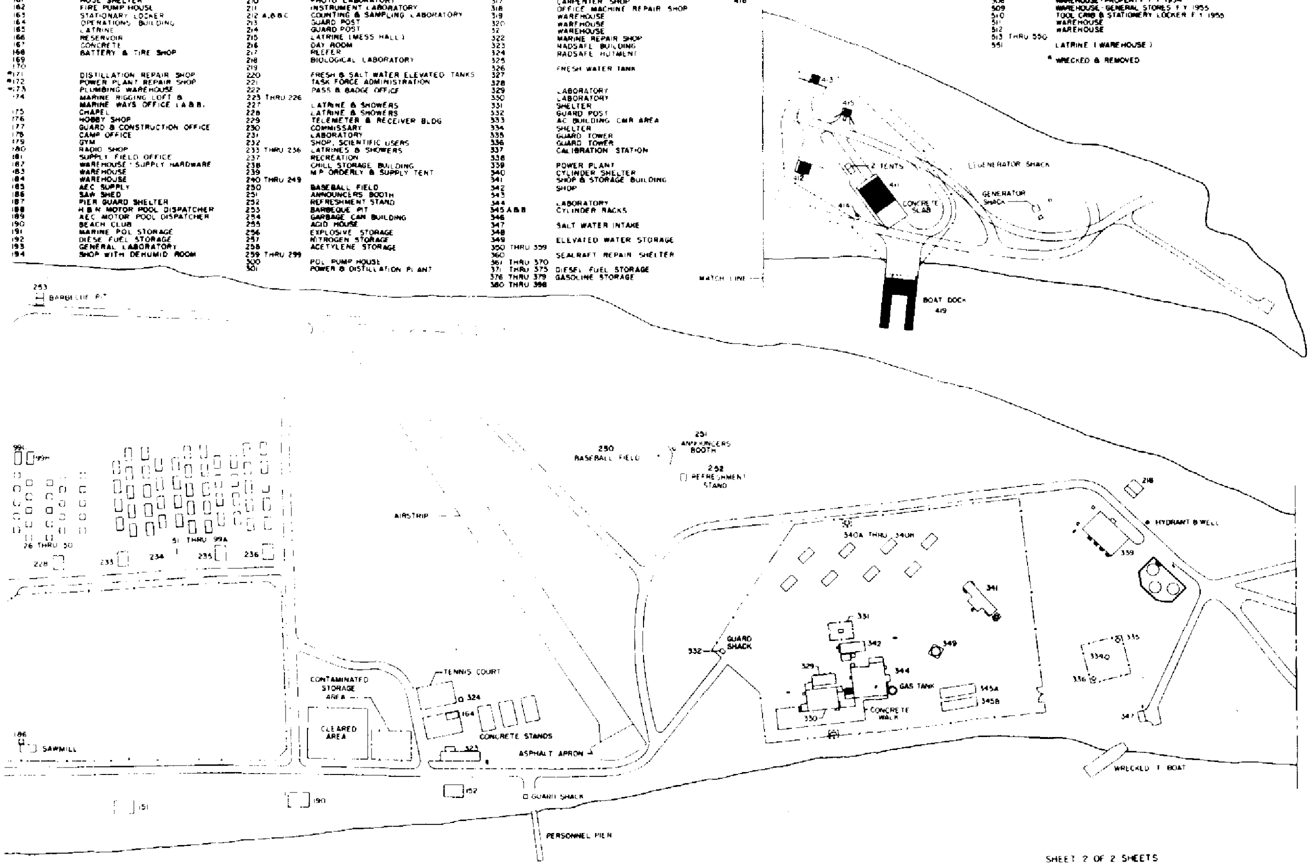


Figure 1-4B. Site Elmer - Eniwetok Atoll - Middle and Southern Sections

BUILDING SCHEDULE

BUILDING NO.	BUILDING DESCRIPTION
8-1 THRU 8-29	4-MAN TENTS
8-30 THRU 8-57	8-MAN TENTS
8-58 THRU 8-99	8-MAN TENTS
8-104 THRU 8-141	8-MAN TENTS
11 THRU 14	LATRINES
15	MOLE AREA
16 THRU 20	LATRINES
22	P.O. P.X. & BARBER SHOP
23	ADMINISTRATION BLDG.
24	INFIRMARY
25	FIRE STATION
26	REFRESHMENT CANTEEN
27	MESS HALL
28	WATER DISTILLATION PLANT
29	POWER PLANT
30A	HEAVY EQUIPMENT SHED
31	WAREHOUSE (BIN STORAGE)
32	WAREHOUSE (BULK STORAGE)
34	SAWMILL & CARPENTER SHOP
35	PLUMBING SHOP
36A	OFFICE FOR ELECTRICAL SHOP
36	ELECT. & REFRIG. SHOP
37	STEEL YARD (NEW)
38	A.V.R. BLDG. REPAIRS & STORAGE
40	MOVIE
41	BASEBALL FIELD
42	TIME & FISCAL BLDG
43	21,000 GAL TANK (GROUND STORAGE)
46	NAVY CUBE
47	LATRINE
48	LAUNDRY
49	WATER TOWER (EXISTING)
50	RECREATION AREA
51	P.O.L AREA & PIPE LINES
55	WAREHOUSE (DRY STORES)
56	WAREHOUSE (CEMENT)
57	FENCED AREA - CONTAMINATED STORAGE
58	2 8-MAN TENTS - A.E.C.
59	NAVY CUBE ON STAND & SHOWER FACILITIES
60	MARINE REPAIRS
61	WAREHOUSE - A.E.C.
62	CHAPEL
63	GYM
64	DAY ROOM
65	HORSESHOE COURTS
66	FUEL TANK
67	MARINE OPERATIONS
68	DISPATCHER (4-MAN)
69	HELICOPTER MAT
70	P.X. STORAGE (8-MAN TENT)
71	SHIPPING & RECEIVING OFFICE, (4 MAN TENT)
TA500	POWER PLANT (SCIENTIFIC)
TA502	A.E.C. BUILDING (NEW)

SCIENTIFIC PROGRAM

TYPE & NUMBER	
TYPE A	5
TYPE A*	1
TYPE A-1	2
TYPE A-2	6
TYPE A-3	1
TYPE B	4
TYPE B**	1
TYPE B-1	1
TYPE B-2	7
TRAILERS	9

NOTE SEE LEGEND

LEGEND

TYPE A	4-MAN WORK BENCH, CONCRETE FLOOR
TYPE A*	SAME AS TYPE A, EXCEPT WORKBENCHES ON BOTH SIDES
TYPE A-1	SAME AS TYPE A, EXCEPT FLOOR IS COMPACTED CORAL
TYPE A-2	4-MAN, CONCRETE FLOOR
TYPE A-3	SAME AS TYPE A-2
TYPE B	8-MAN WORKBENCH, CONCRETE FLOOR
TYPE B**	SAME AS TYPE B, EXCEPT WORKBENCHES ON TWO SIDES
TYPE B-1	SAME AS TYPE B
TYPE B-2	SAME AS TYPE B

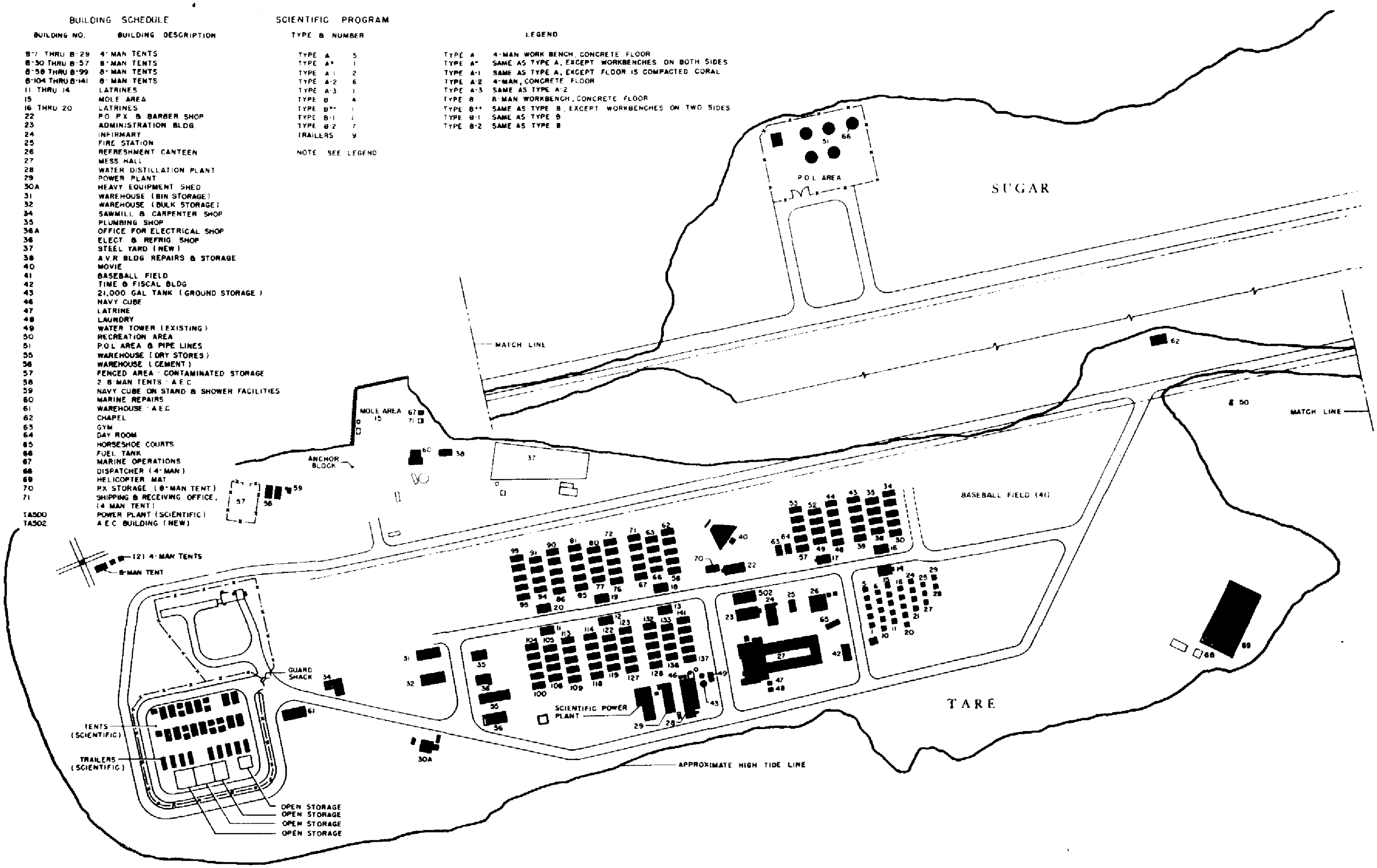


Figure 1-5. Map of Tare Camp and POL Area - Site Sugar, Bikini Atoll

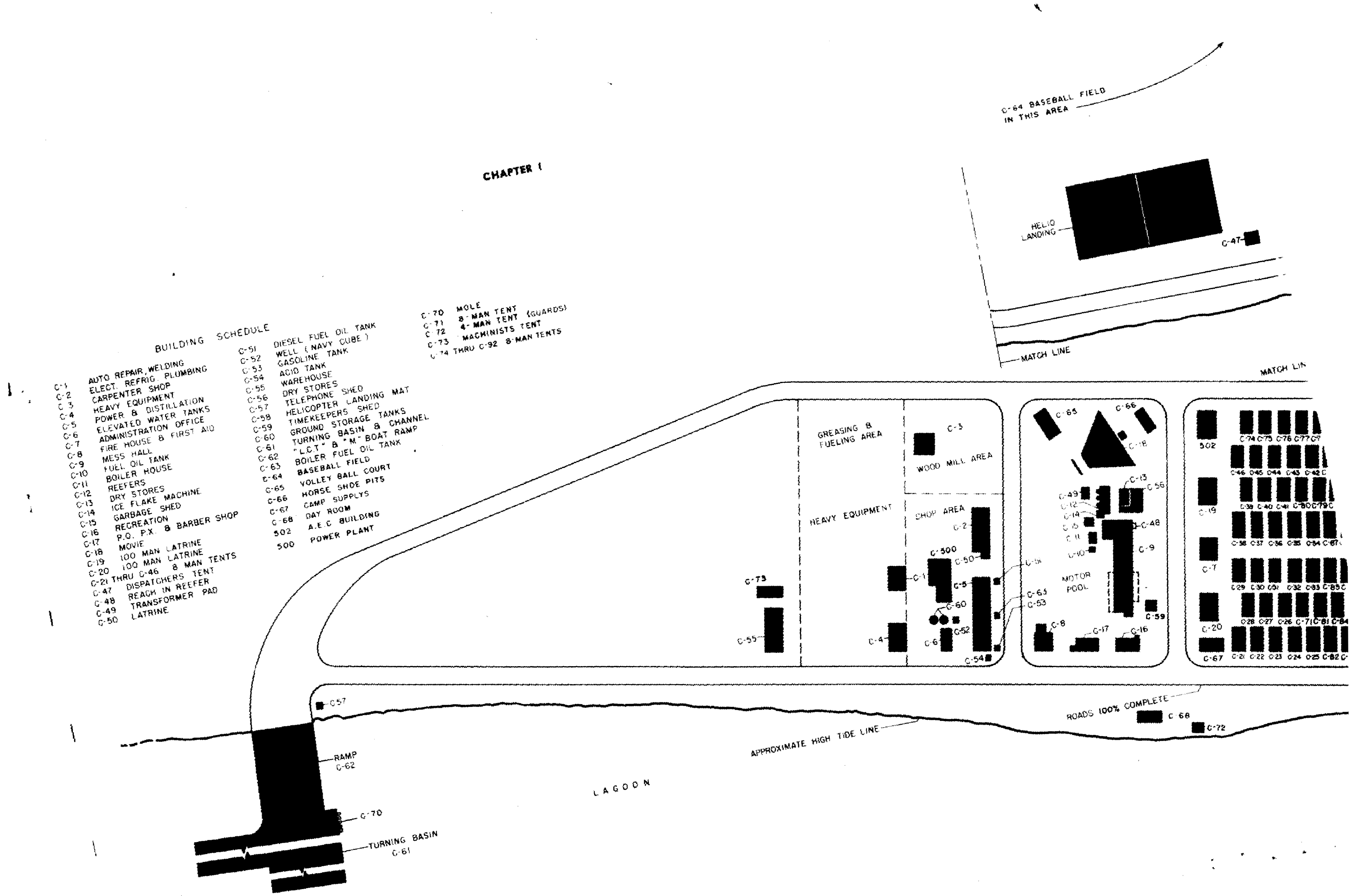


Figure 1-6. Map of Charlie Camp Site - Bikini Atoll

BUILDING SCHEDULE

1 THRU 50	4-MAN TENTS	111	GARBAGE SHED
51 THRU 99	NUMBERS NOT USED	112	BOILER HOUSE
100	MOVIE THEATER	113	DRY STORES
101	2 - 4200-GAL TANKS & TOWER	114	RECREATION SHELTER
102	SHOWER & LATRINES (100-MAN)	115	DISTILLATION PLANT
103	FIRE & FIRST AID	116	TANK, 4200 GAL.
104	MESS HALL	117	TANK, 4200 GAL.
105	ADMIN. OFFICE & READING ROOM	118	SOFTBALL FIELD
106	P.O. & P.X.	119	VOLLEY BALL COURT
107	SHOWER & LATRINES (100-MAN)	120	HORSESHOE COURTS
108	POWER BUILDING	121	CONC. LANDING RAMP (LCT)
109	ACID TANK	122	BARBER SHOP
110	HEAVY EQUIP., PLUMBING & ELECTRICAL SHOPS	123	REEFER SHELTER
		124	WAREHOUSE
		125	CARPENTER SHOP
		126	CARPENTER'S FIELD OFFICE
		127	GENERATOR SHED
		128	CANTEEN
		129	PUMP HOUSE

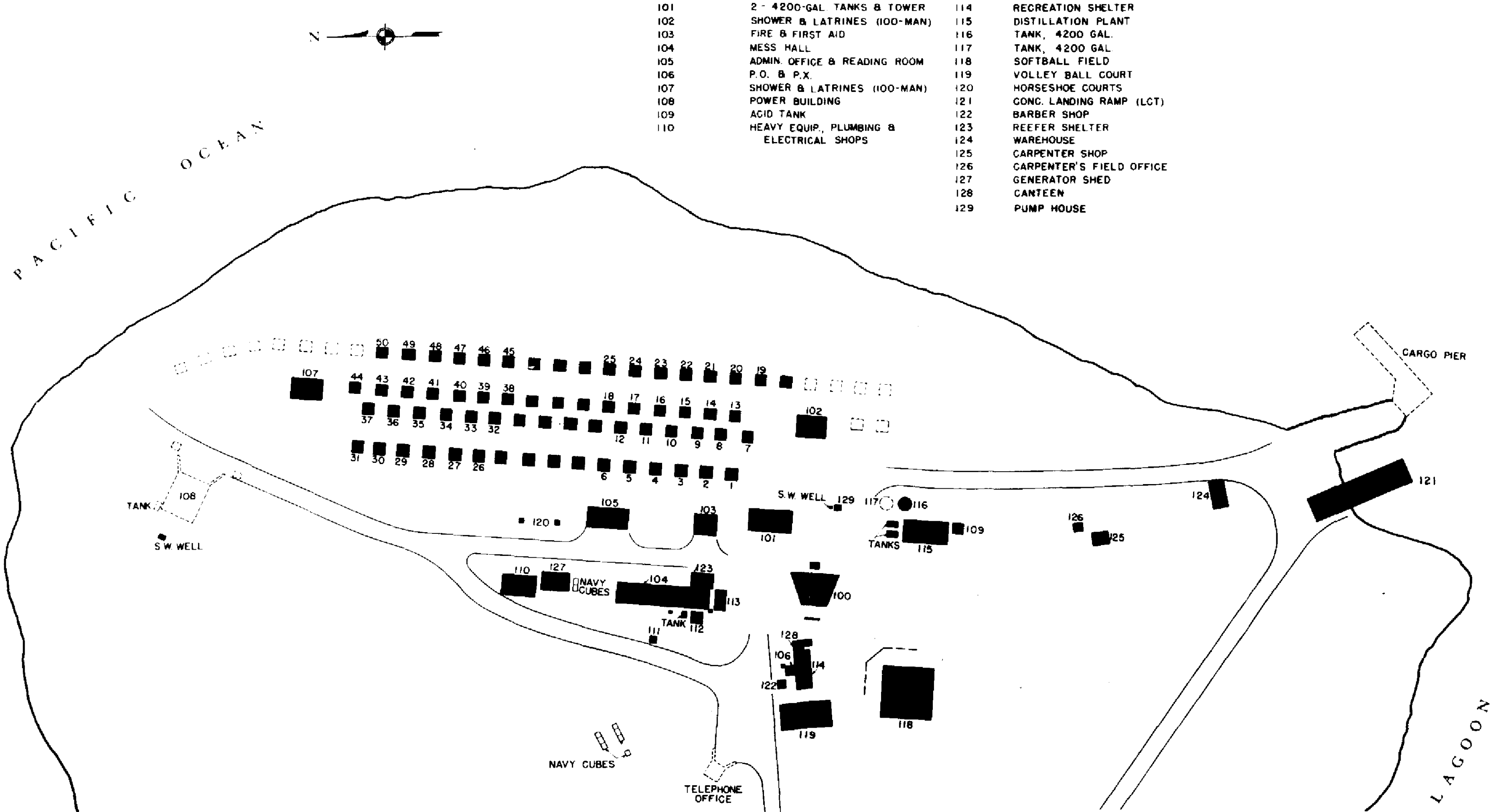
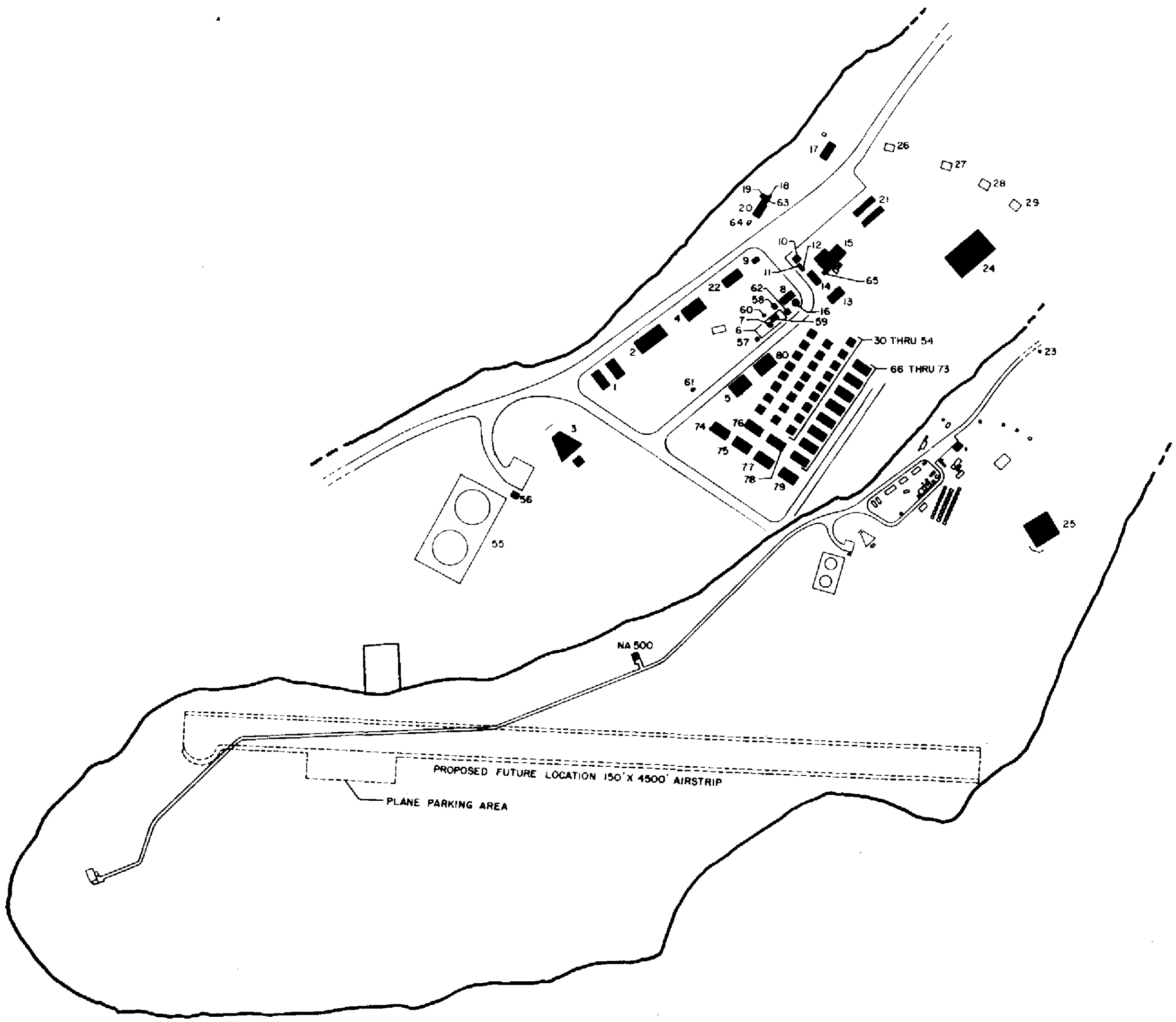


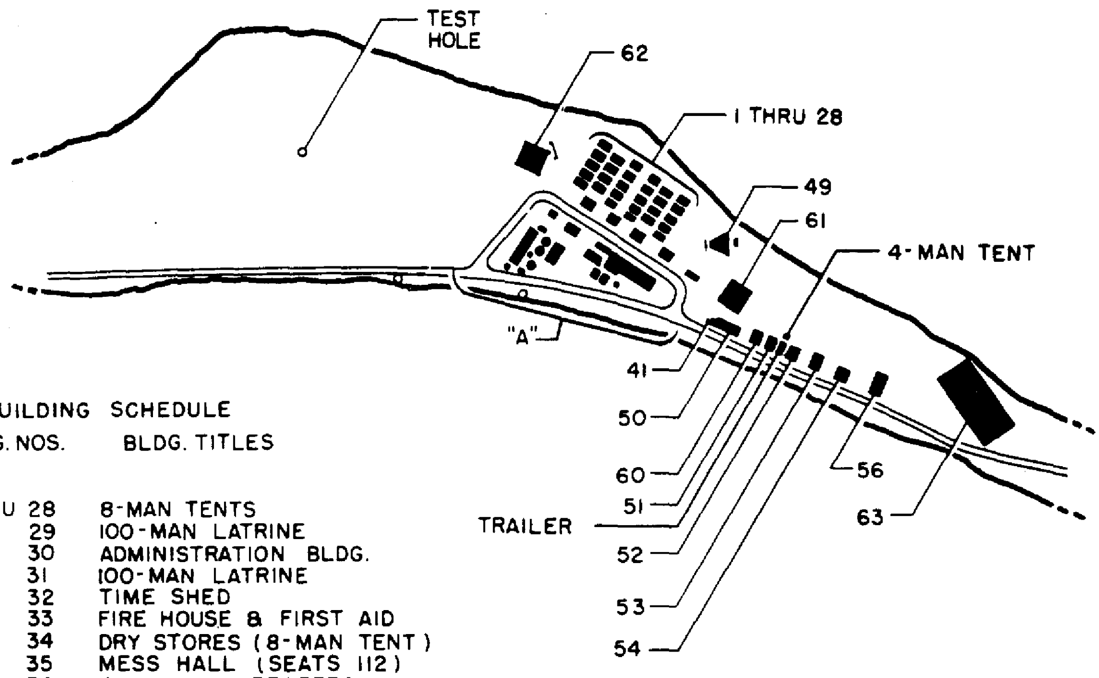
Figure 1-7. Map of Ursula Camp Site - Bikini Atoll



BUILDING SCHEDULE

BLDG NO.	BLDG. TITLE
1	WAREHOUSES
2	AUTO., ELECT., PLUMB. & REFRIG. SHOP
3	OUTDOOR MOVIE
4	ADMINISTRATION BLDG
5	LATRINE, 100-MAN
6	POWER & WATER DIST. BLDG.
7	SALT WATER WELL
8	GROUND STORAGE TANK (4200 GAL.)
9	TIMEKEEPERS SHED
10	GARBAGE SHED
11	BOILER SHELTER
12	FUEL TANK BLDG.
13	DRY STORES
14	REFRIGERATOR BLDG.
15	MESS HALL
16	GROUND STORAGE TANK (4200 GAL.)
17	DAY ROOM (8-MAN TENT)
18	FLAKE ICE MACHINE
19	REFRIGERATOR - 150 CU FT
20	CANTEEN
21	HORSE SHOE PITS
22	P.O., PX & BARBER SHOP
23	MARINE DISPATCHER'S SHED
24	VOLLEY BALL COURTS
25	SOFTBALL FIELD
26	TOWER (EXISTING)
27	TOWER (EXISTING)
28	TOWER (EXISTING)
29	TOWER (EXISTING)
30 THRU 54	4-MAN TENTS
55	HELICOPTER LANDING MAT
56	DISPATCHER'S TENT (4-MAN)
57	DIESEL OIL STORAGE (NAVY CUBE)
58	ACID TANK & PUMP
59	FIRE PUMP
60	FIRE HOSE SHELTER
61	FIRE HOSE SHELTER
62	GASOLINE STORAGE
63	CANTEEN LATRINE
64	LATRINE
65	FLAKE ICE MACHINE
66 THRU 73	8-MAN TENTS
74 THRU 79	8-MAN TENTS
80	100-MAN LATRINE
NA500	SCIENTIFIC POWER HOUSE

Figure 1-8. Map of Nan Camp Site - Bikini Atoll



BUILDING SCHEDULE

BLDG. NOS.	BLDG. TITLES
I THRU 28	8-MAN TENTS
29	IOO-MAN LATRINE
30	ADMINISTRATION BLDG.
31	IOO-MAN LATRINE
32	TIME SHED
33	FIRE HOUSE & FIRST AID
34	DRY STORES (8-MAN TENT)
35	MESS HALL (SEATS II2)
36	4-WALK-IN REEFERS
37	ICE FLAKE MACHINE
38	GARBAGE SHED
39	BOILER HOUSE
40	FUEL OIL (NAVY CUBE TANK)
41	ICE FLAKE MACHINE
42	2 4,200 GAL TANKS & TOWER
43	2 4,200 GAL TANKS - GROUND STORAGE
44	NAVY CUBE (BOILER FUEL OIL)
45	SALT WATER WELL
46	2 NAVY CUBES (GASOLINE TANKS)
47	POWER & WATER DIST. PLANT
48	2 NAVY CUBES (DIESEL FUEL)
49	MOVIE
50	RECREATION, SHELTER & CANTEEN
51	ELECT. & REFRIG. SHOP
52	CARPENTER SHOP
53	GEN. MOTOR REPAIRS
54	HEAVY EQUIPMENT SHOP
55	ACID TANK
56	WAREHOUSE (DRY STORES)
57	P.O. P.X. & BARBER SHOP
58	MARINE DISPATCH BLDG.
59	DAY ROOM
60	PLUMBERS SHOP
61	2 VOLLEY BALL COURTS
62	SOFT BALL FIELD
63	HELICOPTER LANDING MAT

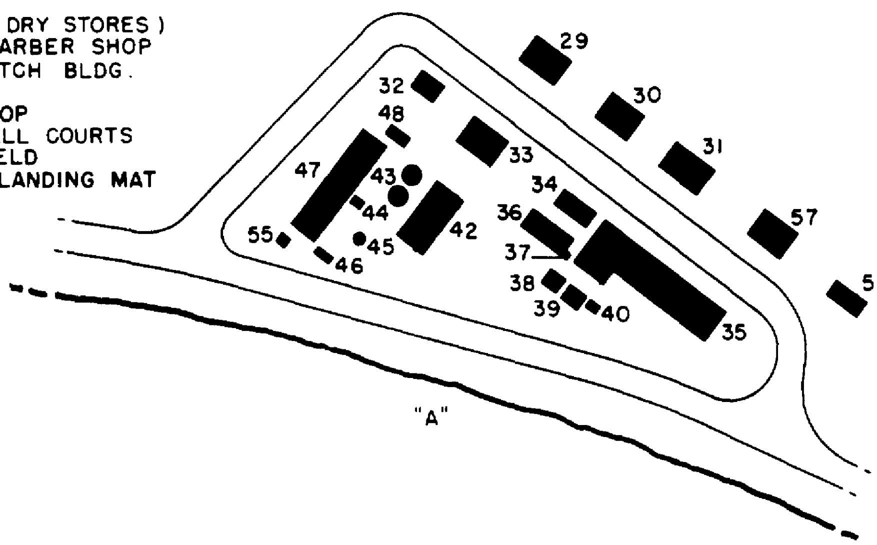


Figure 1-9. Site Fox, Bikini Atoll

Figure 1-10 Typical Island Vegetation - Bikini Atoll, (Leeward Side)

Figure 1-11 Typical Island Vegetation - Bikini Atoll, (Windward Side)

CHAPTER II
ENGINEERING — CONSTRUCTION

SECTION I
ENGINEERING

Preliminary estimates of scientific requirements available to the Holmes & Narver Engineering Division by January of 1953 indicated that OPERATION CASTLE would be approximately three times greater in magnitude than OPERATION IVY.

This concept indicated there would be increases in base camp operational population, resulting in the necessity for restudying total water and power potential; and it established, some months in advance of firm criteria by the Proving Ground's Using agencies, a scale and direction for important advance planning and scheduling of structures. Certain basic engineering analyses and design relating to access and occupation of Bikini Atoll and to the re-use of Eniwetok Atoll, were at this time well advanced, however, having been initiated in 1952.

DESIGN

The initial Engineering design work for OPERATION CASTLE was authorized on 15 September 1952. This preliminary work consisted of designing and preparing plans with resident forces at Eniwetok Atoll for the construction of a temporary 250-man Bikini camp on Tare, with a mole-type pier and a stabilized ramp, an earth-fill causeway linking all the islands from Tare to Oboe, and a 4500-foot airstrip at Peter-Oboe suitable for C-54 aircraft.

In a conference held at Los Alamos on 8 December 1952, the then contemplated scope of the Operation was outlined. At that time, Holmes & Narver was authorized to proceed with the following plans, studies and investigations: (1) Plans and estimates for a test barge outfitting pier at site Elmer; (2) studies of availability and cost of barges to be used as test platforms; (3) study of requirements for the re-use of Flora area; (4) electrical power study; (5) Bikini wave and anchorage study; and (6) subsurface investigations for footing and foundations on both atolls.

As the requirements for scientific facilities developed, it became important to maintain close engineering liaison between H&N, the AEC Divisions, and the Using Scientific Agencies. This served not only to expedite the mutual effort and the essential mutual understanding of the problems involved, but also contributed favorably to the distribution of work load and priorities of effort, procurement and mobilization forecasts, and sensitivity of design by H&N.

It was apparent in the early discussions that the University of California Radiation Laboratory (UCRL) would have a prominent part in the test program requirements. Close engineering liaison with UCRL was set up for the transmittal of design criteria as well as preparation of preliminary drawings and cost estimates. In November 1952, UCRL desired a separate contract with H&N so as to provide smoother operation with respect to planning. On 15 January 1953, AEC advised both UCRL and H&N to undertake the work under Contract 20. At that same time both parties were authorized to deal directly with each other for preliminary planning. In March, LASL (J-6) placed a liaison representative at UCRL and all H&N work was then cleared through him.

The original scope of UCRL activities included:

1. Pipelines. Two 8 5/8″ O. D. vacuum pipe arrays for diagnostic purposes - one 10,000 feet long consisting of two pipes, and the other, also 10,000 feet long, consisting of six pipes. As a consequence of a later substitution for the UCRL tower experiment, a third pipe array was ultimately included in the program. As the criteria developed, the following changes were approved.

   a. One two-pipe array, 2800 feet long

   b. One two-pipe array, 5600 feet long

   c. One twelve-pipe array, 7500 feet long

2. Towers. One test tower 200 feet high and two line-of-sight collimator towers. These towers were subsequently deleted.

3. Detector Station. Three expendable detector stations with travelling cranes.

4. Blockhouses. Three recording blockhouses of which only one required completely new facilities. IVY Station 200 and GREENHOUSE Stations 132 and 1326 were to be reactivated and re-used. In the final program, IVY Station 200 was not re-used and an additional blockhouse was required.

In January the preliminary requirements for Edgerton, Germeshausen & Grier, Inc. (EG&

G) were received from LASL and consisted of: (1) two towers, one 275 feet high on Elmer and the second 300 feet high on Nan; (2) a dehumidified timing and communications building at Nan; (3) and a small camp and helicopter mat at Nan. A requirement for the design of a hydrogen dual liquefaction plant complete with utilities and services was also received in January.

Increases in operational population at both Fred and Elmer were now apparent. Additional water and power requirements for these permanent base camps were investigated and studied. In March 1953, the recommended additional high-capacity, portable distillation units were authorized as temporary support facilities. A 1000 KW diesel generator at the CMR powerhouse on Elmer and a submarine power cable connecting Elmer and Fred were also recommended and authorized to absorb peak loads at Fred.

On 15 April 1953, the Field Manager, AEC, announced to the Users the necessity of having design criteria in final form by 1 May 1953. As a result, large quantities of data were received, but there were many subsequent major changes which modified a large percentage of this data, and in some cases there was a lack of sufficient information upon which to base completed designs at that time. The manner in which this is broadly inhibiting to the Contractor is illustrated by Scientific Station 20 - site Charlie, in which, pending only a column rearrangement, floor plans could not be laid out, structural steel could not be designed or ordered, and even field work could not be started until foundation and piling requirements were known.

As the original scope of UCRL facilities was revised, so also was the original scope of the EG&G program modified. The Hydrogen Dual Liquefaction Plant was deleted; the 275-foot tower on Elmer was deleted and four 75-foot towers were added; the Nan timing and communications building (Station 70) was greatly increased in size and a bunker type power plant added.

Incomplete data and revisions out of schedule have an impact on costs since they tend to compress the accomplishment time into such factors as overtime and unbalanced inventory. Experience has shown, however, that the momentum of scientific progress, the impulse to seek test perfection, and the necessary periodic re-evaluation of the test facilities in terms of constant refinement of data, appear to make such changes and revisions inherent in the approach to an Operation. The necessary adaption was made and by the end of September, the structural, mechanical and electrical design work was practically completed.

Minor changes of criteria were submitted and revisions to details of approved drawings were requested through October and into November. New designs were requested after 15 November, notably the transmitter building and antenna array on site Nan (Station 7400). Due to the time element, these Stations could only be constructed by designing around surplus and maintenance stores at the site. This was done.

The Home Office Engineering manpower required for the Scientific Structures Program is shown by the Engineering and Drafting Manpower and Progress Chart, Figure 2-1. It will be noted that the major work load for the four months of May, June, July and August, was more or less constant, with the peak load of 10,000 man hours per month being reached in July. The civil engineering peak load occurred in October when the final calculations were made to convert the Scientific Station co-ordinates, bearings, and distances to the precise Bikini Atoll survey grid.

FOUNDATION and SOIL INVESTIGATIONS. In order to design foundations properly for certain massive Scientific Structures, and to control the critical limits of settlement required, a series of test borings were made on critical islands: 13 borings on 10 islands of Bikini Atoll and two borings on islands of Eniwetok Atoll.

The drilling was accomplished by using rotary-wash type drilling equipment. Ten of the borings at Bikini Atoll extended to a depth of approximately 100 feet below the ground surface. The other three borings varied from 66 to 87 feet. The test drilling was started in March 1953 and completed in May 1953.

The borings indicated that only slight differences existed in the structure and sub-surface characteristics of various islands. Observation as well as test results from the field laboratory showed that none of the borings developed soil mechanics unsuitable from a foundation standpoint. These borings encountered no voids but did not rule out local void characteristics sometimes present.

Undisturbed core samples of the soils penetrated were extracted; also, representative loose samples were obtained during the course of the drilling for chemical analysis. All soils encountered were classified by visual and textural examination in the field; these classifications were supplemented by sieve tests and inspection of the samples in the test laboratory. These undisturbed core samples were subjected to a series of tests to determine the strengths, compressibilities, and physical characteristics of the soils. Direct shear, friction and consolidation tests were performed. In conjunction with these tests, the moisture contents and densities of the samples were determined. To aid in identification and classification of the soils, mechanical analysis was performed on the loose samples.

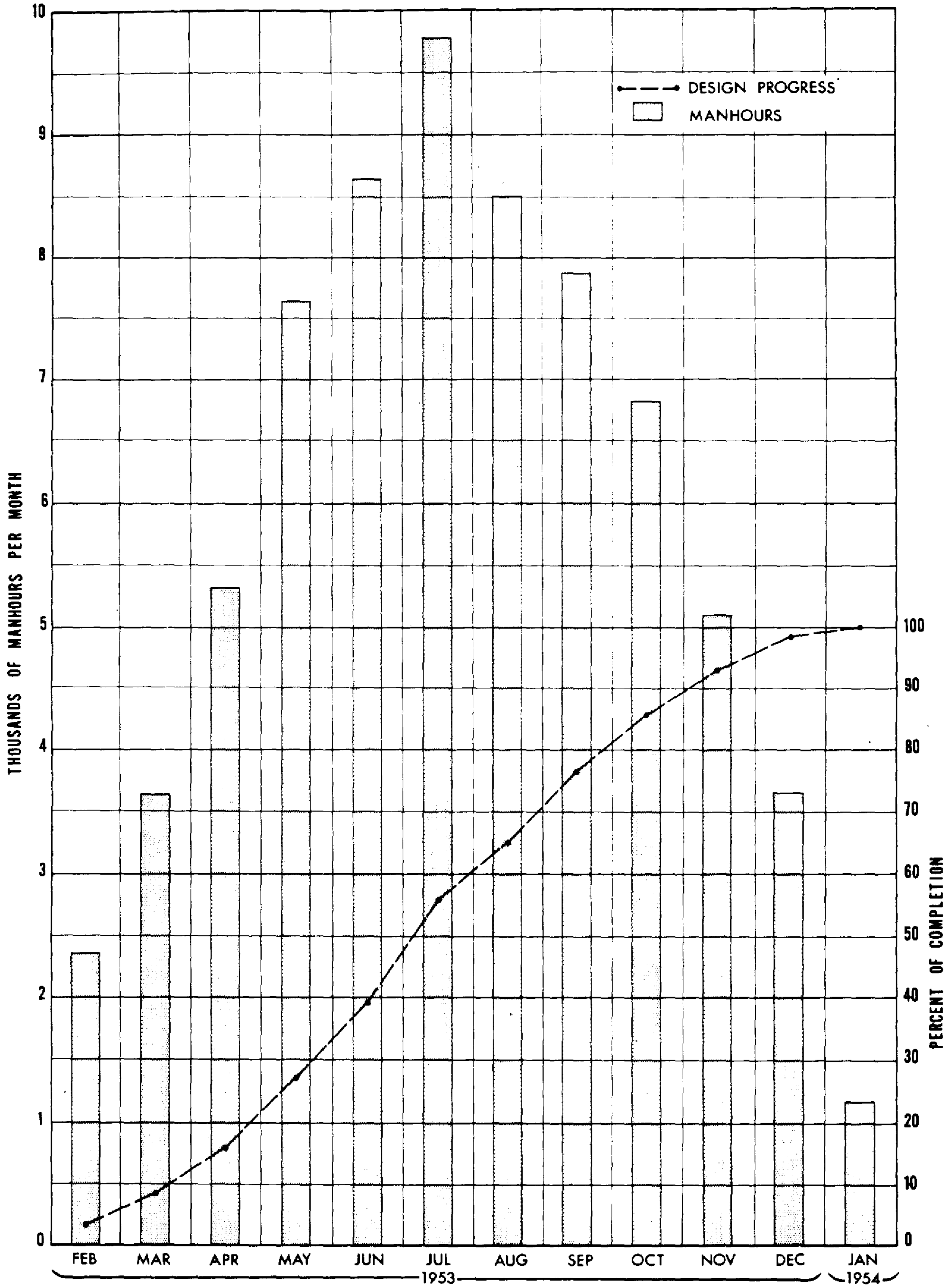


Figure 2-1. Home Office Engineering Manpower and Progress Chart

As a result of the exploration borings and laboratory tests, the following general criteria were set up:

(a) Structures which were not critical from a settlement standpoint were supported on conventional spread footings.

(b) For structures where allowable settlement was extremely critical, 12-inch steel H-piles from 40 to 80 feet in length were used.

Figure 2-2 shows 12-inch H-piles, 80 feet long, driven and capped. This foundation was used for Station 20.

Detailed design criteria subsequently used proved adequate; the final results showed there was no appreciable settlement of any of the structures beyond critical limits.

WAVE ACTION STUDIES. A survey was made of the Bikini Atoll early in April 1953 to determine wave conditions, wind conditions and the relationship between wind and waves. The study also included cloud cover and current observations.

Wave periods and heights were measured with a wave staff. This wave staff was of the type used by the U. S. Navy Hydrographic Office. The displacement of water on the staff from crest to trough was observed visually and logged as each wave passed. Wave periods and heights were recorded to the nearest half-foot.

Wind speeds were taken with a hand anemometer from the highest point on the bridge of an LST. Wind direction was ascertained to the nearest 16th point of the compass.

Currents in the lagoon were measured in the passes by computing the drift of wood blocks from an anchored vessel, and in the ocean by fixing the position of a free-floating wave staff over a period of several months.

Cloud cover was estimated visually by percentages in 10% increments.

The results showed that the wind regime was very stable, with the prevailing direction as ENE with extreme observed directions of NE and ESE. The wind speed was between four and 20 knots with the greater percentage between nine and 19 knots. The mean cloud cover during daylight hours was 3/10. Low cumulus was present nearly always with an average base height of 2,000 feet. It was found that the currents in all of the passes were approximately of the same velocity, the speed ranging between 0.5 knots and 1.5 knots, without change in direction at all tides.

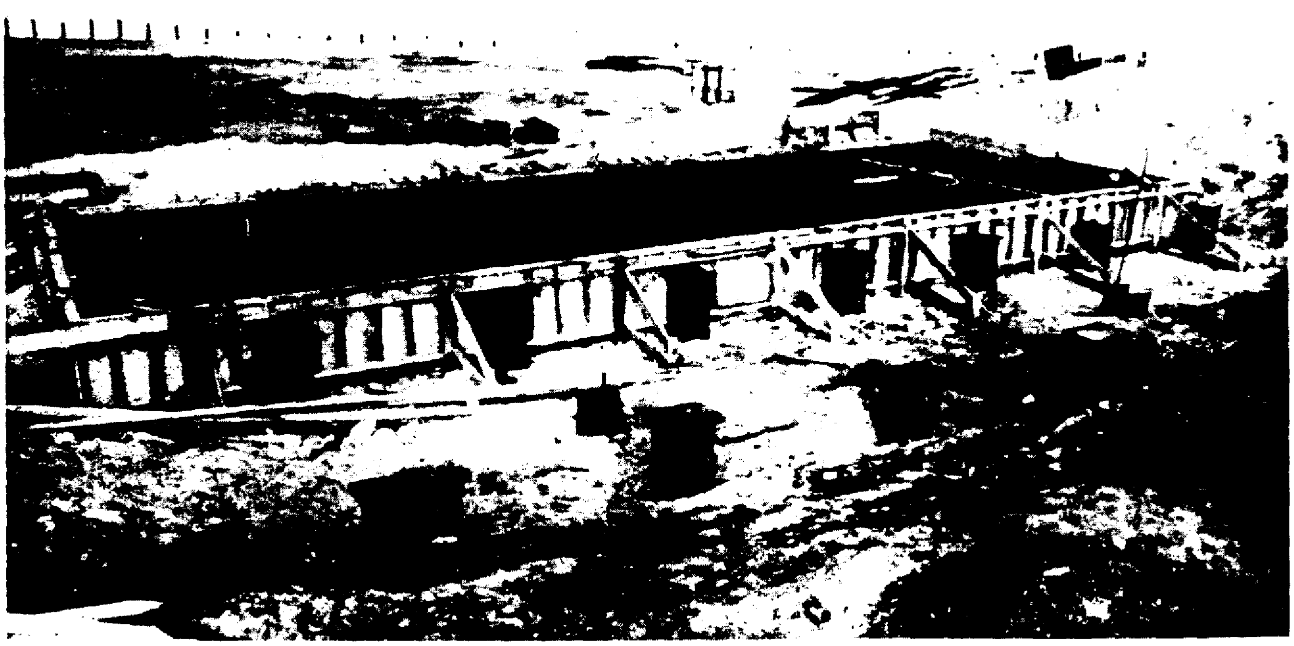


Figure 2-2. Typical H-pile Foundation

With the aid of this data it was possible to estimate the horizonal acceleration due to wave action and corresponding forces to be expected on proposed test barges. In many cases these wave forces were more critical than wind forces. The wave action and tide data were used in designing the barge anchorages.

FIELD ENGINEERING.

The Field Engineering Division at the site for this operation consisted of a Resident Engineer and a staff of assistants set up as a unit incorporating the following four sections, functioning parallel to the Home Office and acting as a field **arm**:

1. Office Engineering and Design Department.
2. Estimating, Reports and Analytical Department.
3. Survey Department.
4. Inspection and Test Department.

The Engineering Division at the PPG was responsibile for furnishing complete local engineering supervision and inspection of construction; for making topographic, hydrographic, control and construction surveys, for preparation of design and drawings for proposed work; for interpretation of plans and specifications; for design and approval of alterations and substitutions; for design and estimates on field-approved alterations and additions to permanent base camp facilities; for preparation of record and "as-built" drawings; for inspection of construction for compliance with plans and specifications; for inspecting and testing of construction materials; for submission of reports and estimates; and for maintaining a complete file of all drawings and other engineering data.

OPERATION CASTLE, being spread over two widely separated atolls, presented geographic problems of Engineering control at the seven construction areas and camps. All drawings and work orders were issued and all reports were prepared at the Engineering Office on site Elmer at Eniwetok where the Resident Engineer and an Assistant Resident Engineer were located. Activities of the area inspectors and survey field parties assigned to sites Elmer, Fred and Ursula were coordinated through the main office at site Elmer. An Assistant Resident Engineer was assigned to Bikini Atoll, with an office located on site Tare. Inspection and survey activities in the Tare, Nan, Fox and Charlie construction areas were coordinated through the Tare office. Altogether, the inspection and survey forces accounted for more than 75% of the field engineering manpower because of the dispersed nature of construction operations.

For a more detailed discussion of survey and inspection activities, see Sections 1A and 1B respectively.

OFFICE ENGINEERING AND DESIGN. A design force in the field, which reached a maximum of three engineers and seven draftsmen, was responsibile for the production of construction drawings on all temporary camp facilities; revisions to Home Office drawings incorporating approved changes, substitutions and additional User requests; alterations and additions, both major and minor, to permanent base camp facilities; and correcting all drawings to an "as-built" status. Construction camps were not designed in the Home Office as in previous Operations in order to relieve that office for the heavy and tightly scheduled work load on Scientific Stations as well as to utilize field construction experience and to design around stocks of locally available material.

During this operation, Field Engineering Division designed and prepared 863 Field Sketches, 159 miscellaneous drawings and made "as-built" corrections to over 1200 drawings.

The Home Office Engineering Department furnished Field Engineering with a print and one reproducible of all drawings made by Home Office Engineering, which enabled the Field Reproduction Department to process and make proper distribution of prints in direct response to optimum requirements at construction areas. In previous operations, almost all reproduction of prints had been accomplished by the Home Office. Because OPERATION CASTLE was much larger and more dispersed, the requirements for prints grew to such an extent that in August 1953 a new Ozalid Super Type "B" printer was installed at Elmer to handle the average weekly run of approximately 6000 prints. During the first half of February 1954, which was the period of peak load, 63 rolls of printing paper were used and a total of 8753 prints were processed in one week during this period. A total of 106,911 prints were processed during the 18-week period from October 1953 thru 1 February 1954.

ESTIMATES, REPORTS AND ANALYSES. As a matter of control, all Field Engineering designs or major revisions to Home Office designs required the preparation of estimates for approval. In general, all these estimates were prepared at Jobsite, as well as analyses in connection therewith. Cost control was maintained by a monthly review of accrued costs on all open work orders, and completion cost estimates were submitted in accordance with established procedure. Preparation of weekly progress reports, monthly narrative reports, and historical installments was likewise a function of this department. Manpower requirements for reporting were minimized by utilizing reports made by field inspectors to the greatest extent possible. The weekly progress report detailed activity on open construction work orders which reached a maximum number of 337 on the Eniwetok Atoll and 339 on the Bikini Atoll for a total of 676.

SECTION 1A
SURVEYS

Surveys by Holmes & Narver at the Pacific Proving Ground were initiated at Eniwetok Atoll in February 1949 with the topographic mapping of project islands for design purposes. As additional personnel arrived, the activities of the department expanded to include a horizontal control network, additional topography, hydrography, construction layout, and special surveys to satisfy scientific requirements and to provide assistance to Users. Surveys at Eniwetok were a continuation and expansion of these activities to fit the special needs of three test operations.

With the expansion of the PPG to include Bikini Atoll, a survey program was initiated in this area following the same general pattern of surveys previously performed in the Eniwetok Atoll area. The majority of the survey personnel were stationed at Bikini Atoll during the CASTLE program with a maximum of six field parties and supporting office personnel. The smaller program at Eniwetok Atoll was served by two field parties with some transfer of personnel between areas to meet peak work loads.

The sequence of surveys at both areas was dependant on priorities for the services of the department. As construction layout proceeded simultaneously with design and control surveys, it was not possible to follow the normal procedure of first establishing horizontal and vertical control and then proceeding in sequence through design surveys and construction layout. This condition did not permit maximum efficiency in performing the design and control surveys, but as construction layout was kept on a current basis at all times, the procedures used were justified. The earlier surveys were covered in detail in reports of OPERATIONS GREENHOUSE and IVY, and the following is primarily a description of survey activities at Bikini Atoll through the CASTLE program. In view of the recoverability of the work and its probable future value in any use of the area, however, sufficient historical summary is given to evaluate its cartographic significance.

HORIZONTAL CONTROL — ENIWETOK ATOLL

A horizontal control scheme was established in 1949-50 covering the eastern portion of the Atoll. This scheme was expanded in 1951 and 1952 to include the entire Atoll and consisted of primary network of second order triangulation stations supplemented with third order stations at locations of lesser importance. Test operations destroyed some of the original stations and new stations were established, as required, by expansion from the remaining portions of the network. Records of these surveys are included in the completion reports for OPERATIONS GREENHOUSE and IVY.

PREVIOUS SURVEYS. A study of previous surveys within the Atoll was made and some features of these surveys were utilized in establishing the scheme. The available records of these surveys are included in "The Report of the Engineer, Joint Task Force SEVEN, Part 2," dated 1948.

The earliest survey was completed in 1944 by the USS Bowditch to control the hydrographic mapping of the Atoll. This survey was of third order accuracy, and as most of the stations were not on project islands it was not adaptable to requirements of this project. However, the Bowditch geographic position of Station North Base on Runit Island and the azimuth of the line Station North Base-Station Sand became the origin of position and azimuth for the later surveys.

A survey was completed in 1947-48 by Joint Task Force SEVEN, consisting of a limited scheme covering the eastern portion of the Atoll. The scheme was reported to be of first order accuracy but it was only because of its limited extent that it could be considered to be of such high order. As the south end of the original (USS Bowditch) base line had been destroyed, a new base line, North Base-Runit, was established and the azimuth of this line was computed from its relation to the line North Base-Sand. Expansion of this scheme involved re-occupation of all of its existing stations and it became obvious that to meet project requirements, a substantially new and stronger scheme was necessary which could be expanded as required.

1949-50 HORIZONTAL CONTROL SURVEY. This scheme was designed to meet the control requirements of OPERATION GREENHOUSE and to be adaptable to future expansions. It consisted of 16 stations covering the eastern portion of the Atoll from site Alice to site Fred and included five stations of the previous surveys. As it was determined that Station North Base had been disturbed, it was necessary to measure a new base line, North Base #2-Runit, to second order accuracy. The network expanding from this base line was executed to second order specifications and procedures of the U. S. Coast and Geodetic Survey. The geographical position of Station Runit and the azimuth of the line Runit-Coral, as determined by the JTF SEVEN survey, were adapted as the origin of position and azimuth. A detailed description of the survey was included in the completion report for OPERATION GREENHOUSE, Volume V.

1951 EXPANSION. An expansion of the survey was necessary to meet additional requirements which could not be anticipated earlier. Several additional islands were located by local triangulation, and photo tower and zero station locations were determined. Local control traverses were established on all project islands. The accuracy of these controls depended on the scientific requirements and was generally of third order. The zero lines and some traverses for location of instrumentation were established to first order traverse specifications.

An independent plane coordinate grid was established at each of the zero areas for location of Scientific Stations. While satisfactory results were obtained, it brought out the desirability for an over-all atoll grid.

1952 EXPANSION AND ADJUSTMENT. Requirements for OPERATION IVY resulted in expansion of the scheme to include the entire Atoll. Some stations of the scheme had been destroyed by test operations and additional stations were required. Fifteen stations were established, replaced, or more precise values determined. As the expansion permitted closing the survey around the Atoll to the Runit base line, a check on the previous work was obtained. The closing error of the survey, before adjustment, was determined to be approximately 1:25,000. An additional check was obtained by inclusion of the zero line traverse in the Flora-Gene area. This indicated a closing error of approximately 1:70,000 before adjustment of the adjacent quadrangle.

In order that the values of a station would remain the same, independent of the direction of computation through the net, an adjustment was applied to the triangulation figures. This consisted of a side equation adjustment which resulted in slight changes in the values previously reported but of little consequence in computations made from the earlier data.

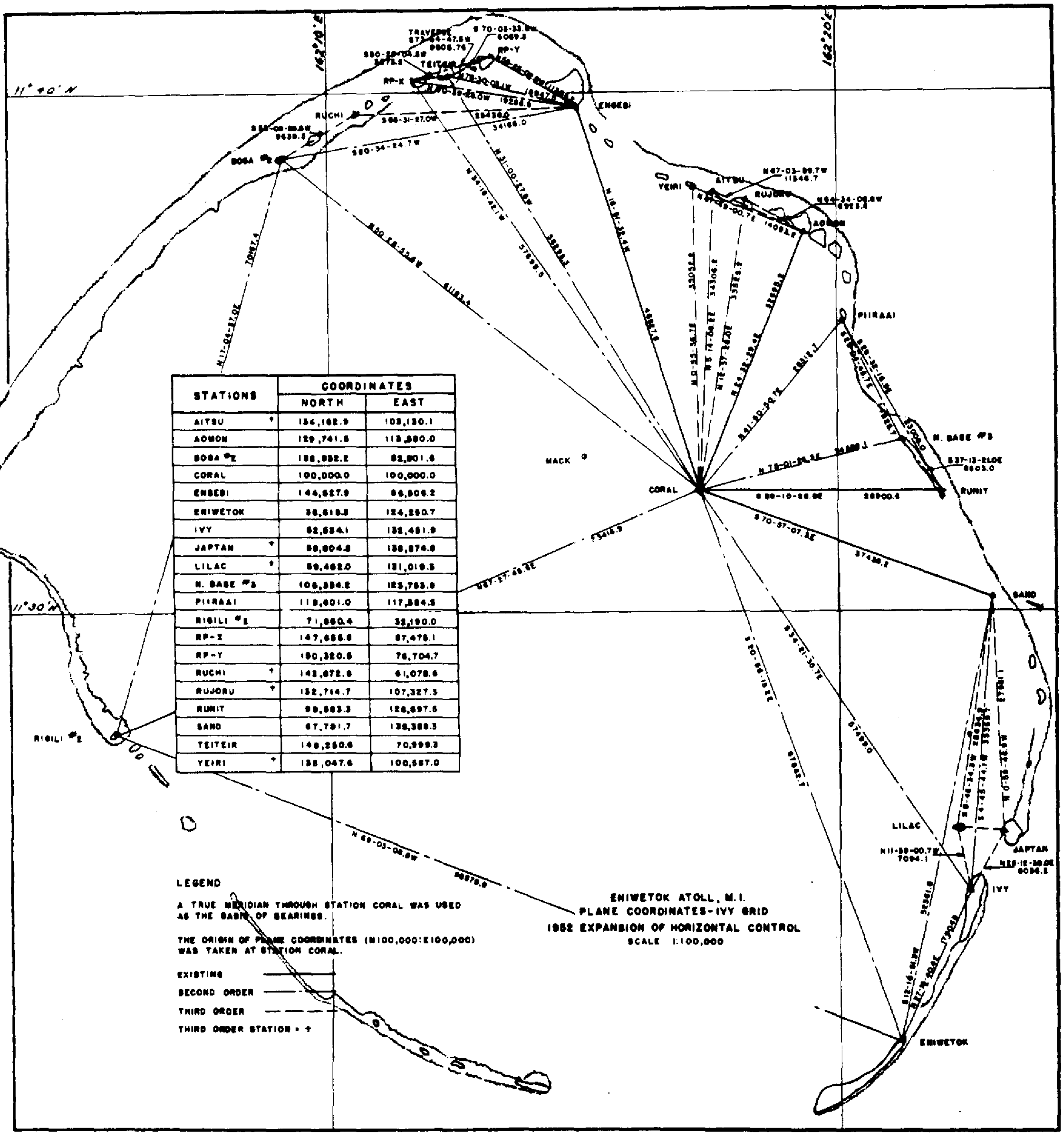
PLANE COORDINATE SYSTEM (IVY GRID). A plane coordinate system was established and is common to all stations within the limits of the Atoll. The origin of coordinates is a plane through triangulation Station Coral with assumed value of N 100,000 — E 100,000 at this station. A true meridian through this station was used as the basis of bearing and was determined by computing through the base expansion figure from the adopted azimuth of the Runit base line.

SPECIAL SURVEYS, GREENHOUSE AND IVY OPERATIONS. Horizontal control requirements included precise surveys to determine the interrelation between Scientific Stations within local areas. The relation to zero of some stations was determined to first order traverse specifications, and precise measurements were taken to determine the blast effects on certain structures. An unusual feature of the survey program was the alignment requirements of the 203 series stations. This included measurement of a zero line to a linear tolerance of 1:25,000 and establishment of a 9,000-foot line of sight to a tolerance of plus or minus one quarter inch. Vertical control was accomplished by establishing a series of bench marks by precise differential leveling and applying a correction for curvature of the earth's surface. Horizontal control stations were established with precise equipment by night operations to avoid heat wave distortion and refraction and procedures were developed to produce the required accuracy. The alignment of the stations was accomplished by offset measurements from these controls to a previously established working point on each station.

1954 EXPANSION (ENIWETOK ATOLL). No major expansion of horizontial control was required in this area for OPERATION CASTLE. The locations of Stations 60 and 2211 were determined to second order by local triangulation from stations of the primary network and connected by a first order traverse. The location of Station 10 was determined by expanding from local controls which were recovered in the general area. The accuracy of location was consistent with scientific requirements. Existing horizontal control was satisfactory for the location of all other Scientific Stations. Figure 2-3 and Tables 2-1 through 2-12 list the survey expansion geographic positions, plane coordinates and horizontal control stations.

HORIZONTAL CONTROL - BIKINI ATOLL

The requirements for horizontal control at Bikini Atoll were essentially the same as for the network previously established at Eniwetok Atoll. The requirements included a primary network established to second order specifications of the U. S. Coast and Geodetic Survey supplemented by third order stations in locations of lesser importance.



STATIONS	COORDINATES	
	NORTH	EAST
AITSU +	134,162.9	103,130.1
AOMON	129,741.5	113,880.0
BOGA #2	138,852.2	82,801.6
CORAL	100,000.0	100,000.0
ENGEBI	144,527.9	84,606.2
ENIWETOK	38,618.3	124,280.7
IVY	62,534.1	132,481.9
JAPTAN +	58,604.8	138,874.6
LILAC +	59,462.0	131,019.5
N. BASE #3	106,334.2	123,753.9
PIIRAAI	119,601.0	117,884.5
RIGILI #2	71,660.4	32,190.0
RP-X	147,656.6	67,475.1
RP-Y	150,320.5	76,704.7
RUCHI +	142,672.9	61,078.6
RUJORU +	132,714.7	107,327.3
RUNIT	99,583.3	126,897.5
SAND	67,791.7	138,388.3
TEITEIR	148,250.6	70,999.3
YEIRI +	138,047.6	100,567.0

Figure 2-3. 1954 Survey Expansion of Horizontal Control - Eniwetok

SECOND ORDER TRIANGULATION

1952 ADJUSTED HORIZONTAL CONTROL

STATION	LATITUDE LONGITUDE	AZIMUTH	BACK AZIMUTH	TO STATION	DISTANCE		
					Logarithm Meters	METERS	FEET
CORAL	N 11-32 20.254	129-41-52.7	309-40 17.5	BOGA #1	4.2705281	18643.53	61166.3
	E 162 17-10.944	129-31-02.4	309-29 26.9	BOGA RM #1	4.2706480	18648.68	61183.2
		148-59-32.7	328-58-34.0	TEITEIR	4.2344880	17158.84	56295.3
		163-08-27.6	343-08-00.2	ENGEBI	4.1517267	14181.64	46527.6
		174-25-39.2	354-25-31.9	BOKON	4.0480186	11169,11	36644.0
		204-32-29.4	24-32-56.8	AOMON	3.9985000	9965.52	32695.2
		221-50-49.3	41-51-24.7	PIIRAAI	3.9041728	8019.97	26312.2
		255-01-20.1	75-02-07.9	N. BASE #2	3.8747531	7494.68	24588.8
		270 49-34.0	90-50-32.2	RUNIT	3.9449227	8808.92	28900.6
		289-02-52.7	109-04-03.8	SAND	4.0573309	11411.19	37438.2
		289-36-26.5	109-36-57.4	PINNACLE	3.6959717	4965.60	16291.3
		300-55-07.1	120-56-28.4	ANIYAANII	4.1585639	14406.68	47265.9
		324-04-06.3	144-05-12.6	PARRY	4.2360559	17220.90	56498.9
		339-03-46.3	159-04-34.6	ENIWETOK	4.3156450	20684.65	67862.9
BOGA RM #1(*)	N 11-38-46.350	260-32 45.8	80 33-54.3	ENGEBI	4.0176138	10413.91	34166.3
	E 162-09-15.995						
BOGA #1 (D)	N 11-38-47.717	260-44-15.9	80-45-24.1	ENGEBI	4.0156200	10366.21	34009.8
	E 162-09-17.362	316-28-22.2	136-29-29.9	PHOTO	4.1706752	14814.10	48602.6
TEITEIR (*)	N 11-40-18.862	258-27-43.4	78-27-52.5	BOGON	3.1418165	1386.17	4547.8
	E 162-12-19.091	283-29-00.2	103-29-31.7	ENGEBI	3.6867033	4860.75	15947.3
BOGON (+)	N 11-40-27.884	292-43-25.9	112-43-48.3	ENGEBI	3.5625318	3652.06	11981.8
	E 162-13-03.934						
ENGEBI	N 11 39-41.964	298-38-00.7	118-38-55.7	AOMON	3.9732496	9402.64	30848.5
	N 162-14-55.151	309-01-56.1	129-02-16.3	BOKON	3.5909476	3898.95	12791.8

(+) - Third Order station. (*) - Refer to 1952 Expansion for new values. (D) - Station destroyed.

Table 2-1. Eniwetok Geographic Positions

SECOND ORDER TRIANGULATION | 1952 ADJUSTED HORIZONTAL CONTROL

STATION	LATITUDE LONGITUDE	AZIMUTH	BACK AZIMUTH	TO STATION	DISTANCE Logarithm Meters	METERS	FEET
BOKON	N 11-38-22.046	291-26-06.9	111-26-41.7	AOMON	3.7491192	5612.02	18412.1
	E 162-16-35.139						
AOMON	N 11-37-15.283	336-29-53.5	156-30-14.0	N. BASE #2	3.8906172	7773.51	25503.6
	E 162-19-27.584	46-21-58.4	226-21-03.5	PHOTO	4.0588260	11450.54	37567.3
PIIRAAI	N 11-35-34.679	334-55-44.2	154-55-56.7	N. BASE #2	3.6491059	4457.65	14624.8
	E 162-20-07.552						
N. BASE #2 (D)	N 11-33-23.267	322-47-25.7	142-47-36.1	RUNIT	3.4136308	2591.9749	3503.84
	E 162-21-09.893	327-56-55.7	147-57-19.1	SAND	3.8247869	6680.16	21916.5
RUNIT	N 11-32-16.080	324-15-31.1	144-15-35.8	REEF	3.0899898	1230.24	4036.2
	E 162-22-01.621	331-25-38.3	151-25-48.5	ISLET	3.5087397	3226.56	10585.8
PINNACLE (D)	N 11-31-26.010	249-34-07.6	69-34-34.9	RUNIT	3.6442258	4407.84	14461.4
	E 162-19-45.307						
REEF	N 11-31-43.581	335-48-18.6	155-48-24.1	ISLET	3.3035870	2011.81	6600.4
	E 162-22-25.335						
ISLET	N 11-30-43.856	102-51-49.8	282-51-12.1	PINNACLE	3.7649170	5819.92	19094.2
	E 162-22-52.543						
SAND	N 11-30-18.986	3-49-51.5	183-49-47.0	PARRY	4.0104083	10242.55	33604.1
	E 162-23-06.870						
ANIYAANII	N 11-28-19.253	19-02-01.8	199-01-47.0	PARRY	3.8400452	6919.03	22700.2
	E 162-23-58.730						

(D) - Station destroyed

Table 2-2. Eniwetok Geographic Positions

SECOND ORDER TRIANGULATION 1952 ADJUSTED HORIZONTAL CONTROL

STATION	LATITUDE LONGITUDE	AZIMUTH	BACK AZIMUTH	TO STATION	LOG. METERS	DISTANCE METERS	DISTANCE FEET
PARRY (D)	N 11-24-46.373	26-48-35.1	206-48-17.4	ENIWETOK	3.7796816	6021.18	19754.5
	E 162-22-44.295						
ENIWETOK (*)	N 11-21-51.466	159-04-34.6	339-03-46.3	CORAL	4.3156450	20684.65	67862.9
	E 162-21-14.726						
MUZIN	N 11-39-20.189	145-35-54.3	325-35-51.3	ENGEBI	2.9089619	810.89	2660.4
	E 162-15-10.277	138-25-32.6	318-25-23.5	E-ZERO	3.3139747	2060.51	6760.2
KIRINIAN (+)	N 11-38-55.831	138-53-27.5	318-53-19.2	ENGEBI	3.2744627	1881.32	6172.3
	E 162-15-35.991	300-05-13.2	120-05-25.1	BOKON	3.3160962	2070.60	6793.3
LUCY (+)	N 11-36-28.384	139-28-05.6	319-28-05.6	AOMON	3.2778200	1895.92	6220.2
	E 162-20-08.256	133-17-25.0	313-17-09.8	V-ZERO	3.4956067	3130.45	10270.5
PHOTO	N 11-32-58.088	180-09-03.1	0-09-03.3	ENGEBI	4.0937522	12409.44	40713.3
	E 162-14-54.072						
RIGILI #1(D)(+)	N 11-27-40.914	216-44-34.6	36-46-24.0	ENGEBI	4.4417415	27652.94	90724.7
	E 162-05-48.977	249-19-20.6	69-22-24.3	N. BASE #2	4.4745754	29824.65	97849.7
		The following refer to "Greenhouse" stations					
E-ZERO (D)	N 11-40-10.356	313-48-51.6	133-48-57.7	ENGEBI	3.1003843	1260.04	4133.985
	E 162-14-25.132						
V-ZERO (D)	N 11-37-38.242	303-58-46.6	123-58-53.6	AOMON	3.1011110	1262.15	4140.9
	E 162 18-53.034						
C-ZERO (D)	N 11-33-21.519	107-20-32.0	287-20-30.9	N. BASE #2	2.2558030	180.22	591.27
	E 162-21-15.570						

(+) - Third Order Station (*) - Refer to 1 52 Expansion for New Values (D) - Station Destroyed

Table 2-3. Eniwetok Geographic Positions

STATION	LATITUDE LONGITUDE	AZIMUTH	BACK AZIMUTH	TO STATION	DISTANCE Logarithm Meters	METERS	FEET
CORAL	N 11-32-20.254	129-31-04.4	309-29-29.0	BOGA #2	4.2706495	18648.74	61183.4
	E 162 17-10.944	148-59-32.2	328-58-33.4	TEITEIR	4.2344880	17158.84	56295.3
		163-08-27.6	343-08-00.2	ENGEBI (ELGIN)	4.1517265	14181.64	46527.6
		180-55-36.7	0-55-37.8	YEIRI	4.0287311	10683.93	35052.2
		185-14-06.1	5-14-12.4	AITSU	4.0193859	10456.49	34306.0
		192-37-28.0	12-37-42.8	RUJORU	4.0093871	10218.50	33525.2
		204-32-29.4	24-32-56.8	AOMON	3.9985000	9965.52	32695.2
		221-50-50.7	41-51-26.1	PIIRAAI	3.9041814	8020.13	26312.7
		255-01-26.3	75-02-14.1	N. BASE #3	3.8747583	7494.77	24589.1
		270-49-34.0	90-50-32.2	RUNIT	3.9449227	8808.92	28900.6
		289-02-52.7	109-04-03.8	SAND	4.0573309	11411.19	37438.2
		325-38-24.3	145-39-29.2	IVY	4.2436761	17525.73	57499.0
		339-03-44.8	159-04-33.2	ENIWETOK	4.3156469	20684.59	67862.7
		67-27-45.6	247-25-29.6	RIGILI #2	4.3498120	22377.52	73416.9
BOGA #2	N 11-38-46.355	281-57-14.0	101-57-33.1	RUCHI	3.4680710	2938-13	9639.5
	E 162 09-15.997	260-32-49.1	80 33-57.5	ENGEBI	4.0176101	10413.82	34166.0
		17-03-22.1	197-02-40.6	RIGILI #2	4.3301513	21387.07	70167.4
RUCHI (+)	N 11-38-26.544	252-36-05.9	72-36-55.2	ENGEBI	3.8894648	7752.91	25436.0
	E 162-10 50.892						
RP-X	N 11-40-12.980	260-26-58.4	80 27-05.6	TEITEIR	3.0371076	1089.20	3573.5
	E 162-11-43.625	253-53-41.4	73-54-00.2	RP-Y	3.4665470	2927.84	9605.76
TEITEIR	N 11-40-18.861	250 02-34.7	70-02-46.3	RP-Y	3.2671553	1849.93	6093.3
	E 162-12-19.089	283-28-58.0	103-29-29-6	ENGEBI	3.6867087	4860.81	15947.5

(+)- Third Order station

Table 2-4. Eniwetok Geographic Positions

STATION	LATITUDE LONGITUDE	AZIMUTH	BACK AZIMUTH	TO STATION	DISTANCE		
					Logarithm Meters	METERS	FEET
RP-Y	N 11-40-39.409	300-34-09.8	120-34 29.8	ENGEBI	3.5403592	3470.22	11385.2
	E 162-13-16.502						
ENGEBI	N 11-39-41.964	343-08-00.2	163-08-27.6	CORAL	4.1517265	14181.64	46527.6
	E 162-14-55.151						
YEIRI (+)	N 11-38-07.928	292-11-00.4	112-11-26.8	AOMON	3.6317906	4283.42	14053.2
	E 162-17-16.650						
AITSU (+)	N 11 37-59.151	292-56-06.5	112-56-27.7	AOMON	3.5388853	3458.48	11346.7
	E 162-17-42.440						
RUJORU (+)	N 11-37-44.783	295-26-06.2	115-26-18.8	AOMON	3.3243483	2110.32	6923.6
	E 162-18-24.672						
AOMON	N 11-37-15.283	24-32-56.8	204-32-29.4	CORAL	3.9985000	9965.52	32695.2
	E 162-19-27.584						
PIIRAAI	N 11-35-34.682	334-55-49.6	154-56-02.1	N. BASE #3	3.6491323	4457.92	14625.7
	E 162-20-07.557						
N. BASE #3	N 11-33-23.262	322-47-26.8	142-47-37.2	RUNIT	3.4135881	2591.72	8503.0
	E 162-21-09.898						
RUNIT	N 11-32-16.080	90-50-32.2	270-49-34.0	CORAL	3.9449227	8808.92	28900.6
	E 162-22-01.621						
SAND	N 11-30-18.986	359-01-24.0	179-01-24.9	JAPTAN	3.9308808	8528.66	27981.1
	E 162-23-06.870	4-46-55.0	184-46-49.1	IVY	4.0326473	10780.71	35369.7
		8-47-45.2	188-47-36.5	LILAC	3.9409113	8727.93	28634.9

(+) - Third Order station

Table 2-5. Eniwetok Geographic Positions

STATION	LATITUDE LONGITUDE	AZIMUTH	BACK AZIMUTH	TO STATION	DISTANCE Logarithm Meters	DISTANCE METERS	DISTANCE FEET
JAPTAN (+)	N 11-25-41.449	25-13-49.8	205-13-43.0	IVY	3.3890668	2449.44	8036.2
	E 162 23-11.664						
LILAC (+)	N 11 25-38.264	348-22-01.5	168-22 04.3	IVY	3.3349139	2162.29	7094.1
	E 162 22-22.842						
IVY	N 11-24-29.334	27-16-45.2	207-16-28.9	ENIWETOK	3.7369778	5457.30	17904.5
	E 162-22 37.224						
ENIWETOK	N 11-21-51.469	110-57-39.0	290-54-35.8	RIGILI #2	4.4777861	30045.96	98575.8
	E 162-21-14.730						
RIGILI #2	N 11-27-40.883	197-02-40.6	17-03-22.1	BOGA #2	4.3301513	21387.07	70167.4
	E 162-05-49.036						
WP-60	N 11-37-39.493	302-01-31.8	122-01-39.7	AOMON	3.1469710	1402.72	4602.1
ENIWETOK	E 162-18-48.326	16-44-25.3	196-44-15.8	CORAL	4.0104251	10242.95	33605.4
WP-10	N 11-40-13.89	279-44-59.6	99-45-37.7	ENGEBI	3.7625757	5788.63	18991.5
ENIWETOK	E 162-11-46.79						

(+)= Third Order Station

Table 2-6. Eniwetok Geographic Positions

1952 ADJUSTED HORIZONTAL CONTROL

		STATION	COURSE	DISTANCE	COSINE	SINE	LATITUDE	DEPARTURE	COORDINATES		
									NORTH	EAST	
	1	CORAL TO							100,000.0	100,000.0	1
	2	BOGA RM #1 *	N 50-28-57.5W	61183.2	63631200	77143181	+38931.6	-47198.6	138,931.6*	52,801.4*	2
D	3	BOGA #1	N 50-18-07.2W	61166.3	63874096	76942185	+39069.4	-47062.7	139,069.4	52,937.3	3
	4	TEITEIR *	N 31-00-27.2W	56295.3	85709938	51515110	+48250.7	-29000.6	148,250.7*	70,999.4*	4
	5	ENGEBI	N 16-51-32.4W	46527.6	95702136	29001744	+44527.9	-13493.8	144,527.9	86,506.2	5
	6	BOKON	N 5-34-20.8W	36644.0	99527421	09710425	+36470.8	-3558.3	136,470.8	96,441.7	6
	7	AOMON	N 24-32-29.4E	32695.2	90966067	41535223	+29741.5	+13580.0	129,741.5	113,580.0	7
	8	PIIRAAI *	N 41-50-49.3E	26312.2	74492867	66714412	+19600.7	+17554.0	119,600.7*	117,554.0*	8
D	9	N. BASE #2	N 75-01-20.1E	24588.8	25844392	96602626	+6354.8	+23753.4	106,354.8	123,753.4	9
	10	RUNIT	S 89-10-26.0E	28900.6	01441786	99989606	-416.7	+28897.6	99,583.3	128,897.6	10
D	11	PINNACLE	S 70-23-33.5E	16291.3	33557262	94201434	-5466.9	+15346.7	94,533.1	115,346.7	11
	12	SAND	S 70-57-07.3E	37438.2	32635970	94524565	-12218.3	+35388.3	87,781.7	135,388.3	12
	13	ANIYAANII	S 59-04-53.0E	47265.9	51381995	85789805	-24286.1	+40549.3	75,713.9	140,549.3	13
D	14	PARRY	S 35-55-53.8E	56498.9	80971801	58681918	-45748.1	+33154.6	54,251.9	133,154.6	14
	15	ENIWETOK *	S 20-56-13.9E	67862.9	93397269	35734438	-63382.1	+24250.4	36,617.9*	124,250.4*	15
	16										16
	17	BOGA RM #1 TO							138,931.6*	52,801.4*	17
	18	BOGA #1	N 44-35-42.8E	193.62	71208459	70209368	+137.8	+135.9	139,069.4	52,937.3	18
D	19	TEITEIR *	N 62-53-00.1E	20445.4	45580341	89008047	+9319.1	+18198.0	148,250.7*	70,999.4*	19
	20	ENGEBI *	N 80-34-21.5E	34166.3	16379707	98649406	+5596.3	+33704.8	144,527.9	86,506.2	20
	21										21
	22	BOGA #1 TO							139,069.4	52,937.3	22
D	23	PHOTO	S 43-30-02.5E	48602.6	72536603	68836337	-35254.7	+33456.3	103,814.7	86,393.6	23
	24	TEITEIR	N 63-03-18.6E	20261.7	45313239	89144323	+9181.3	+18062.1	148,250.7	70,999.4	24
	25	ENGEBI	N 80-45-51.3E	34009.8	16049709	98703631	+5458.5	+33568.9	144,527.9	86,506.2	25
	26										26
	27	TEITEIR to							148,250.7	70,999.4	27
	28	BOGON	N 78-28-42.2E	4547.8	19973753	97984943	+908.3	+4456.2	149,159.0	75,455.6	28
	29	ENGEBI	S 76-30-01.0E	15947.3	23344065	97237105	-3722.8	+15506.8	144,527.9	86,506.2	29

D-Station Destroyed

*Refer to 1952 Expansion for New Values

Table 2-7. Eniwetok Plane Coordinates

1952 ADJUSTED HORIZONTAL CONTROL

		STATION	COURSE	DISTANCE	COSINE	SINE	LATITUDE	DEPARTURE	COORDINATES		
									NORTH	EAST	
	1	ENGEBI TO							144527.9	86, 506.2	1
	2	BOGON	N 67-15-44.4W	11981.8	38651244	92228419	+4631.1	-11050.6	149, 159.0	75, 455.6	2
	3	AOMON	S 61-21 31.8E	30848.5	47932256	87763881	-14786.4	+27073.8	129, 741.5	113, 580.0	3
	4	BOKON	S 50-57-36.4E	12791.8	62986128	77670764	-8057.1	+9935.5	136, 470.8	96, 441.7	4
D	5	N. BASE #2	S 44-17-48.1E	53334.2	71573302	69837380	-38173.1	+37247.2	106, 354.8	123, 753.4	5
	6	PHOTO	S 0- 09-30.6W	40713.3	99999617	00276634	-40713.2	-112.6	103, 814.7	86, 393.6	6
D	7	E-ZERO	N 46-10-34.9W	4133.985	69244090	72147460	+2862.5	-2982.6	147, 390.4	83, 523.6	7
	8										8
	9	AOMON TO							129, 741.5	113, 580.0	9
	10	BOKON	N 68-33-45.8W	18412.1	36548247	93081823	+6729.3	-17138.3	136, 470.8	96, 441.7	10
D	11	N. BASE #2	S 23-30-33.9E	25503.6	91699452	39889979	-23386.7	+10173.4	106, 354.8	123, 753.4	11
	12	PHOTO	S 46-21-31.0W	37567.3	69014249	72367351	-25926.8	-27186.4	103, 814.7	86, 393.6	12
D	13	V-ZERO	N 56-01 33.8W	4140.9	55881583	82929178	+2314.0	-3434.0	132, 055.5	110, 146.0	13
	14										14
D	15	N. BASE #2 TO							106, 354.8	123, 753.4	15
	16	PIIRAAI*	N 25-04-51.2W	14624.8	90571024	42389735	+13245.9	-6199.4	119, 600.7	117, 554.0	16
	17	RUNIT	S 37-13-22.1E	8503.84	79628921	60491612	-6771.5	+5144.2	99, 583.3	128, 897.6	17
	18	SAND	S 32-03-52.0E	21916.5	84745152	53087279	-18573.1	+11634.9	87, 781.7	135, 388.3	18
D	19	PARRY	S 10-13-41.2E	52944.4	98410861	17756759	-52102.9	+9401.2	54, 251.9	133, 154.6	19
D	20	PINNACLE	S 35-25-03.3W	14506.1	81494999	57953129	-11821.7	-8406.7	94, 533.1	115, 346.7	20
D	21	C-ZERO	S 72-40-16.9E	591.3	29785206	95461204	-176.1	+564.5	106, 178.7	124, 317.9	21
	22										22
	23	RUNIT TO							99, 583.3	128, 897.6	23
	24	REEF	S 35-45-27.1E	4036.2	81149722	58435629	-3275.0	+2358.6	96, 308.0	131, 256.2	24
	25	ISLET	S 28-35-19.9E	10585.8	87807370	47852116	-9295.1	+5065.5	90, 288.2	133, 963.1	25
D	26	PINNACLE	S 69-33-36.7W	14461.4	34922313	93703959	-5050.2	-13550.9	94, 533.1	115, 346.7	26
	27										27
	28	REEF TO							96, 308.0	131, 256.2	28
	29	ISLET	S 24-12-44.3E	6600.4	91203205	41011893	-6019.8	+2706.9	90, 288.2	133, 963.1	29
D	30	PINNACLE	S 83-38-03.5W	16008.2	11087390	99383448	-1774.9	-15909.5	94, 533.1	115, 346.7	30

D - Station Destroyed. * - Refer to 1952 Expansion for new values.

Table 2-8. Eniwetok Plane Coordinates

1952 ADJUSTED HORIZONTAL CONTROL

		STATION	COURSE	DISTANCE	COSINE	SINE	LATITUDE	DEPARTURE	COORDINATES		
									NORTH	EAST	
D	1	PINNACLE to	S 77-09-18.8E	19,094.2	22231053	97497591	-4244.9	+18616.4	94,533.1	115,346.7	1
	2	ISLET							90,288.2	133,963.1	2
	3										3
D	4	PARRY TO	N 3-48-40.5E	33604.1	99778844	06646982	+33529.8	+2233.7	54,251.9	133,154.6	4
	5	SAND	N 19-00-40.5E	22700.2	94545463	32575380	+21462.0	+7394.7	87,781.7	135,388.3	5
	6	ANIYANNII							75,713.9	140,549.3	6
	7										7
	8	ENIWETOK to	N 26-47-28.8E	19754.5	89265401	45074260	+17634.0	+8904.2	36,617.9*	124,250.4*	8
D	9	PARRY							54,251.9	133,154.6	9
	10										10
	11	MUZIN TO	N 34-23-41.3W	2660.4	82516472	56489220	+2195.3	-1502.8	142,332.6	88,009.0	11
	12	ENGEBI	N 41-34-03.0W	6760.2	74817457	66350193	+5057.8	-4485.4	144,527.9	86,506.2	12
D	13	E-ZERO							147,390.4	83,523.6	13
	14										14
	15	KIRINIAN TO	N 41-06-13.3W	6172.3	75352100	65742384	+4650.9	-4057.8	139,877.0	90,564.0	15
	16	ENGEBI	S 59-54-27.6E	6793.3	50139399	86521852	-3406.2	+5877.7	144,527.9	86,506.2	16
	17	BOKON	S 13-18-46.5E	40978.2	97312699	23026912	-39877.0	+9436.0	136,470.8	96,441.7	17
	18	CORAL							100,000.0	100,000.0	18
	19										19
	20	LUCY to	N 40-32-21.8W	6220.2	75995931	64997079	+4727.1	-4043.0	125,014.4	117,623.0	20
	21	AOMON	N 46-43-10.6W	10270.5	68556921	72800746	+7041.1	-7477.0	129,741.5	113,580.0	21
D	22	V-ZERO							132,055.5	110,146.0	22
	23										23
	24	LOC. M to	S 35-06-13.3E	65.27	81811264	57505801	-53.3	+37.5	96,361.3	131,218.6	24
	25	REEF	N 35-06-13.3W	12000.0	81811264	57505801	+9817.4	-6900.7	96,308.0	131,256.2	25
D	26	C-ZERO							106,178.7	124,317.9	26
	27										27
	28	RIGILI #1 TO	N 69-21-37.0E	97849.7	35249052	93581538	+34491.09	+91569.25	71,863.7	32,181.1	28
	29	N. BASE #2	N 36-46-51.3E	90724.7	80093084	59875687	+72664.21	+54322.04	106,354.8	123,753.4	29
	30	ENGEBI							144,527.9	86,506.2	30

D - Station Destroyed

* Refer to 1952 Expansion for New Values

Table 2-9. Eniwetok Plane Coordinates

	STATION	COURSE	DISTANCE	COSINE	SINE	LATITUDE	DEPARTURE	COORDINATES NORTH	COORDINATES EAST	
1	CORAL TO	N 50-28-55.6W	61183.4	63631911	77142595	+38932.2	-47198.5	100,000.0	100,000.0	1
2	BOGA #2	N 34-18-42.1W	57699.5	82598326	56369465	+47658.8	-32524.9	138,932.2	52,801.6	2
3	RP-X	N 31-00-27.8W	56295.3	85709788	51515360	+48250.6	-29000.7	147,658.8	67,475.1	3
4	TEITEIR	N 16-51-32.4W	46527.6	95702136	29001744	+44527.9	-13493.8	148,250.6	70,999.3	4
5	ENGEBI	N 0-55-36.7E	35052.2	99986916	01617608	+35047.6	+567.0	144,527.9	86,506.2	5
6	YEIRI	N 5-14-06.2E	34306.0	99582876	09124188	+34162.9	+3130.1	135,047.6	100,567.0	6
7	AITSU	N 12-37-28.0E	33525.2	97582361	21855958	+32714.7	+7327.3	134,162.9	103,130.1	7
8	RUJORU	N 24-32-29.4E	32695.2	90966067	41535223	+29741.5	+13580.0	132,714.7	107,327.3	8
9	AOMON	N 41-50-50.7E	26312.7	74492414	66714918	+19601.0	+17554.5	129,741.5	113,580.0	9
10	PIIRAAI	N 75-01-26.3E	24589.1	25841489	96603403	+6354.2	+23753.9	119,601.0	117,554.5	10
11	N. BASE #3	S 89-10-26.0E	28900.6	01441786	99989606	-416.7	+28897.5	106,354.2	123,753.9	11
12	RUNIT	S 70-57-07.3E	37438.2	32635970	94524565	-12218.3	+35388.3	99,583.3	128,897.5	12
13	SAND	S 34-21-35.7E	57499.0	82550854	56438963	-47465.9	+32451.9	87,781.7	135,388.3	13
14	IVY	S 20-56-15.2E	67862.7	93397044	35735027	-63381.7	+24250.7	52,534.1	132,451.9	14
15	ENIWETOK	S 67-27-45.6W	73416.9	38328534	92362999	-28139.6	-67810.0	36,618.3	124,250.7	15
16	RIGILI #2							71,860.4	32,190.0	16
17										17
18	BOGA #2 TO	N 59-09-59.8E	9639.5	51254333	85866136	+4940.6	+8277.0	138,932.2	52,801.6	18
19	RUCHI	N 80-34-24.7E	34166.0	16378117	98649659	+5595.7	+33704.6	143,872.8	61,078.6	19
20	ENGEBI	S 17-04-57.0W	70167.4	95588278	29374838	-67071.8	-20611.6	144,527.9	86,506.2	20
21	RIGILI #2							71,860.4	32,190.0	21
22										22
23	RP-X to	N 73-54-47.5E	9605.76	27709339	96084309	+2661.7	+9229.6	147,658.8	67,475.1	23
24	RP-Y							150,320.5	76,704.7	24
25										25
26	ENGEBI TO	S 88-31-27.0W	25436.0	02575530	99966828	-655.1	-25427.6	144,527.9	86,506.2	26
27	RUCHI	N 80-39-28.0W	19286.9	16233101	98673636	+3130.9	-19031.1	143,872.8	61,078.6	27
28	RP-X	N 76-30-03.1W	15947.5	23343075	97237343	+3722.7	-15506.9	147,658.8	67,475.1	28
29	TEITEIR	N 59-25-02.9W	11385.2	50877891	86089721	+5792.6	-9801.5	148,250.6	70,999.3	29
30	RP-Y							150,320.5	76,704.7	30

Table 2-10. Eniwetok Plane Coordinates

1952 EXPANSION OF HORIZONTAL CONTROL

	STATION	COURSE	DISTANCE	COSINE	SINE	LATITUDE	DEPARTURE	COORDINATES NORTH	COORDINATES EAST	
1	TEITEIR TO	S 80-28-04.5W	3573.5	16560464	98619303	-591.8	-3524.2	148250.6	70999.3	1
2	RP-X	N 70-03-33.6E	6069.3	34104685	94004630	+2069.9	+5705.4	147658.8	67475.1	2
3	RP-Y							150320.5	76704.7	3
4										4
5	AOMON TO	N 67-49-00.7W	14053.2	37756831	92598174	+5306.1	-13013.0	129741.5	113580.0	5
6	YEIRI	N 67-03.59.7W	11346.7	38966115	92095830	+4421.4	-10449.9	135047.6	100567.0	6
7	AITSU	N 64-34-08.6W	6923.6	42942295	90310350	+2973.2	-6252.7	134162.9	103130.1	7
8	RUJORU							132714.7	107327.3	8
9										9
10	PIIRAAI TO	S 29-32-16.9E	23008.0	87002868	49300112	-20017.7	+11343.0	119601.0	117554.5	10
11	RUNIT	S 25-04-45.7E	14625.7	90572155	42387319	-13246.8	+6199.4	99583.3	128897.5	11
12	N. BASE #3							106354.2	123753.9	12
13										13
14	N. BASE #3	S 37-13-21.0E	8503.0	79629243	62491186	-6770.9	+5143.6	106354.2	123753.9	14
15	RUNIT							99583.3	128897.5	15
16										16
17	SAND TO	S 0-59-46.9E	27981.1	99984880	01738891	-27976.9	+486.6	87781.7	135388.3	17
18	JAPTAN	S 4-45-44.1W	35369.7	99654778	08302127	-35247.6	-2936.4	59804.8	135874.9	18
19	IVY	S 8-46-34.3.W	28634.9	98829186	15257523	-28299.7	-4369.0	52534.1	132451.9	19
20	LILAC	S 12-16-51.3W	52361.6	97711647	21270495	-51163.4	-11137.6	59482.0	131019.3	20
21	ENIWETOK							36618.3	124250.7	21
22										22
23	IVY TO	N 11-39-00.7W	7094.1	97939871	20193601	+6948.1	-1432.6	52534.1	132451.9	23
24	LILAC	N 25-12-38.0E	8036.2	90474860	42594598	+7270.7	+3423.0	59482.0	131019.3	24
25	JAPTAN							59804.8	135874.9	25
26										26
27	ENIWETOK TO	N 69-03-08.8W	98575.8	35751327	93390806	+35242.1	-92060.7	36618.3	124250.7	27
28	RIGILI #2	N 27-15-40.4E	17904.5	88892744	45804803	+15915.8	+8201.2	71860.4	32190.9	28
29	IVY							52534.1	132451.9	29
30										30
31	WP-60	S 57-58-47.7E	4602.11	53021649	84786230	-2440.12	+3901.96	132181.66	109678.03	31
32	AOMON	S 16-44-15.8W	33605.41	95763310	28799016	+32181.66	+9678.03	129741.54	113579.99	32
33	CORAL							100000.00	100000.00	33

Table 2-11. Eniwetok Plane Coordinates

TABLE 2-12
LIST OF HORIZONTAL CONTROL STATIONS
ENIWETOK ATOLL

ISLAND	IVY CODE	STA. NAME	ORDER	REMARKS
Bogallua	Alice	Boga #1	2nd	Destroyed 1951
Bogallua	Alice	Boga #2	2nd	Destroyed 1952
Bogombogo	Belle	Bogom	3rd	Destroyed 1952
Ruchi	Clara	Ruchi	3rd	Destroyed 1952
Cochiti	Daisy	Cochiti	3rd	Destroyed 1952
Santildefenso	Edna	Santil	3rd	Destroyed 1952
Elugelab	Flora	RP-X	2nd	Destroyed 1952
Teiteirpucchi	Gene	Teiteiripucchi	2nd	Destroyed 1952
Bogairikk	Helen	—	—	None
Bogon	Irene	Bogon	2nd	Destroyed 1952
Bogon	Irene	RP-Y	2nd	Destroyed 1952
W. of Engebi	Noah	Noah	3rd	Not Recovered
Engebi	Janet	Engebi (Elgin)	2nd	Recovered 4-54
Muzinbaarikku	Kate	Muzin Pl #1	3rd	Recovered 4-54
Kirinian	Lucy	Kirinian	3rd	Recovered 4-54
Bokonaarappu	Mary	Bokon	2nd	Recovered 4-54
Yeiri	Nancy	Yeiri	3rd	Recovered 4-54
Aitsu	Olive	Aitsu	3rd	Recovered 4-54
Rujoru	Pearl	Rujoru	3rd	Recovered 4-54
Eberiru	Ruby	Sta. 60	2nd	Estab. 1953
Aomon	Sally	Aomon	2nd	Recovered 4-54
Biijiri	Tilda	Biijiri	3rd	Destroyed
Rojoa	Ursula	Jake	3rd	Recovered 4-54
Aaraanbiru	Vera	Lucy	3rd	Recovered 4-54
Piiraai	Wilma	Piiraai	2nd	Recovered 4-54
Runit	Yvonne	N. Base #2	2nd	Destroyed 1951
Runit	Yvonne	N. Base #3	2nd	Destroyed 1952
Runit	Yvonne	Runit	2nd	Recovered 4-54
So. of Runit	Zona	Loc. M	2nd	Recovered 4-54
So. of Runit	—	Reef	2nd	Recovered 4-54
So. of Runit	—	Islet	2nd	Recovered 4-54
Lagoon				
Lagoon Photo Tower	Mack	Photo	3rd	—
Lagoon Tri. Sta.	Oscar	Coral	2nd	Recovered 4-54
Lagoon Tri. Sta.	—	Pinnacle	2nd	Destroyed 1951
Chinieero	Alvin	—	—	None
Aniyaanii	Bruce	Aniyaanii (Kodak)	2nd	Recovered 4-54
Chinimi	Clyde	—	—	None
Jieroru	—	Lilac	3rd	Recovered 4-54
Japtan	David	Japtan	3rd	Recovered 4-54
Parry	Elmer	Parry	2nd	Destroyed 1951
Parry	Elmer	Ivy	2nd	Recovered 4-54
Eniwetok	Fred	Eniwetok (Privilege)	2nd	Recovered 4-54
Igurin	Glen	Lantana	3rd	USS Bowditch Sta.
Mui	Henry	—	—	None
Pokon	Irwin	—	—	None
Ribaion	James	—	—	None
Giriinein	Keith	—	—	None
Rigili	Leroy	Rigili #1	3rd	Destroyed 1951
Rigili	Leroy	Rigili #2	2nd	Recovered 4-54

For second order triangulation surveys, the allowable discrepancy in the length of any line of the scheme cannot exceed 1:10,000 and for third order 1:5,000. The base line, from which a second order survey expands, can have a probable error of not to exceed 1:500,000.

PREVIOUS SURVEYS. The available records of earlier surveys of Bikini Atoll consist of Chart No. 6032 published in 1944 by the U. S. Hydrographic Office, and the adjusted data of third order surveys completed in 1946 by the USS Sumner and USS Bowditch. A geodetic report on the preparation of the chart and adjustment of the 1946 surveys was obtained from the U. S. Hydrographic Office.

U. S. Hydrographic Office chart, No. 6032, as prepared in 1944 and with only minor changes in the later editions, is stated to be a photo transfer of Japanese Chart No. 458. Although records of hydrographic and geodetic surveys, made by the Japanese in 1919, were obtained by the U. S. Hydrographic Office, none of these surveys were recovered. The datum of all charting in the area was based on a scaled value from the Japanese Chart and this value was adopted for the origin of surveys in the area.

The 1946 survey by the USS Sumner and the USS Bowditch consisted of two surveys expanding from independent base lines and covering the eastern portion of the atoll. Three triangulation stations were common to both surveys, permitting consolidation of the surveys by a least square adjustment. The apparent purpose of the surveys was to establish the interrelation of Scientific Stations which were used in OPERATION CROSSROADS.

As the scheme was stated to be of third order accuracy and the geometry of the scheme was not consistant with requirements of CASTLE, it was not considered practical to expand from these surveys. Most of the stations of these surveys were recovered and their relation to the new second order network determined. They were also used for preliminary location and orientation of island traverses furnishing basic information for design of project features.

SUMMARY OF GENERAL FEATURES

OUTLINE OF SCHEME. A triangulation network encompassing the Atoll was established by expanding through a series of check figures from a base line on the south perimeter of the Atoll. The base line extended from Oboe to Sugar. The survey was for purposes of coordinating local surveys on the project islands and determining the interrelation of the various project areas.

The scheme was designed to provide horizontal control throughout the Atoll, with primary stations established where necessary to meet project requirements and consistent with the geometrical specifications for strength of figures.

Secondary stations were established at locations of lesser importance by expansion from the primary net and by local triangulation at project areas. The permanency of the station marks was considered in locating the stations, and all stations were referenced with the exception of a station located on a coral pinnacle in the lagoon. References independent of the station structure could not be established for this station.

Standard procedure and specifications of the U. S. Coast and Geodetic Survey for second order triangulation were carefully followed in executing the survey. The geometry of the scheme was strengthened by construction of a station in the lagoon which became the hub of the network and resulted in all figures being well above minimum strength.

DISTRIBUTION OF CONTROL POINTS. The scheme consisted of ten primary stations established to second order specifications, nine of which were on the perimeter of the lagoon and the tenth was the lagoon station. Figure 2-4 shows a typical survey tower, located on site Able. Seven additional stations were established to third order specifications. Six stations of the earlier USN Surveys were incorporated into

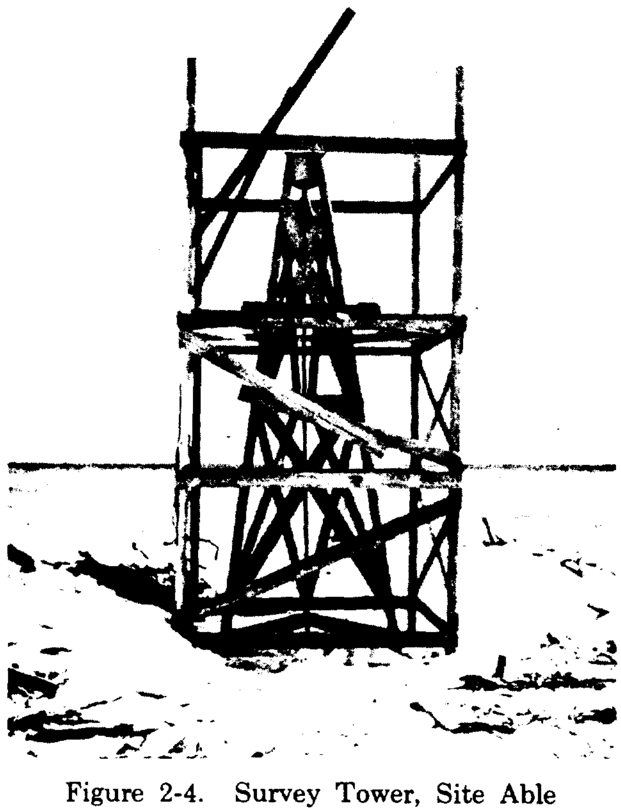


Figure 2-4. Survey Tower, Site Able

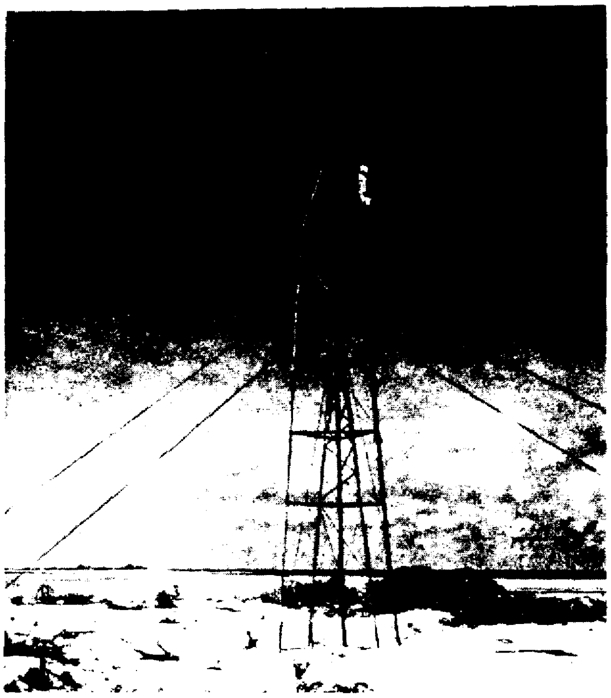


Figure 2-5. Survey Tower, Site How

the scheme, and the relation to the scheme of six additional USN stations was determined. Figure 2-5 shows one of these earlier stations on site How. Other stations were established to second and third order specifications at various locations by local triangulation and traverse. The distribution of the stations of the completed network was such that destroyed stations can generally be replaced with a minimum of field work by observing a single triangle using the known line between two existing stations as a base. Where practical, to simplify reference to the stations, they were given the island code name of the location.

FIELD PROCEDURE. A tentative layout of the scheme determining the locations where stations would be required was made from a study of the Atoll chart. The location of the base line, including a lagoon station to obtain a strong base expansion figure, resulted from this study. A field reconnaissance of these locations was made and station markers established. The stations were located inland from high tide line, sacrificing some convenience to reduce the possibility of damage or destruction from wave action.

The height of the observing towers was determined so as to provide a minimum of ten feet vertical clearance over any obstruction or over the surface of the lagoon, in a long over-water sight line. Bilby steel towers were erected at locations requiring a tower height of over 20 feet. Lower towers were constructed of wood. The towers were adequately braced and guyed but some difficulty from wind vibration was experienced during much of the survey. Station Coca in the lagoon consisted of four steel pilings driven in the top of a coral pinnacle, cross-braced, and decked with a wooden platform and instrument stand. As the pinnacle was approximately 24 feet below the surface of the lagoon, it was necessary to observe at low tide to minimize vibration. Figure 2-6 shows this station completed. The first two attempts to drive piles failed, the trouble experienced during construction being due primarily to heavy seas and high wind velocities. The third attempt was successful. A prefabricated platform was erected and the station was completed in April 1953.

All observing was accomplished at night using lights for targets. A Wild T-2 theodolite was used for observing and proved very satisfactory. Station lights were constructed using the reflectors and lenses from U. S. Navy battle lamps. The lights were equipped with rheostats which permitted dimming the lights to the correct intensity for a sharp target. Continuous interstation communication was considered necessary due to the remote location of the stations.

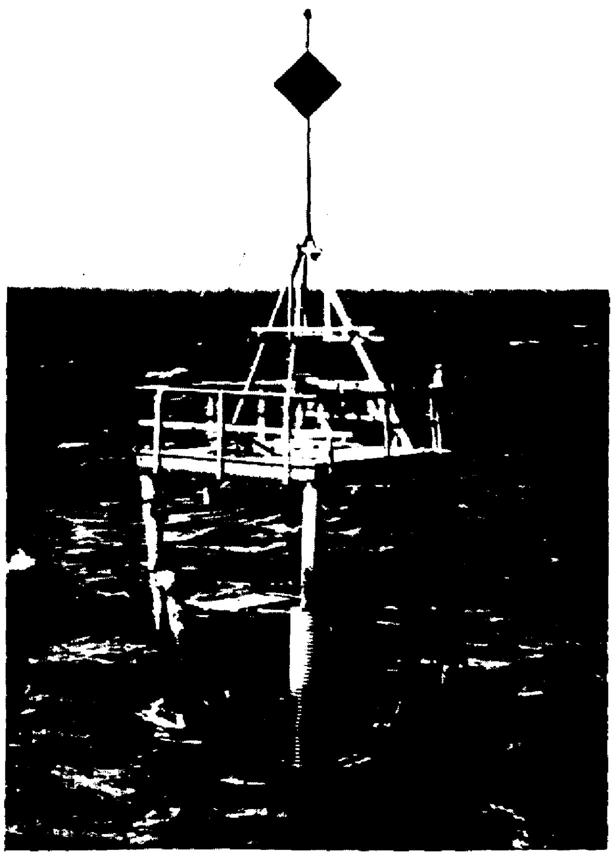


Figure 2-6. Coco Head Triangulation Station

Portable radios were used for this purpose and increased the efficiency in observing as the intensity of the target lights could be adjusted instantly and changes in plans could be transmitted to the observing personnel. This was often necessary due to weather conditions and permitted communication when light signals would have failed.

The observing program started in May 1953. The observing party consisted of an observer, recorder and a varying number of light tenders. The personnel operated from camps at site Tare and site Charlie and were quartered on an LSU for observing in the eastern portion of the lagoon. Considerable time was lost due to rain and high wind velocity and the program was delayed by the priority of other surveys. Transportation was adequate but water transportation by LCM, DUKW and LCU was necessarily slow. Helicopters were not available until late in the observing program. It was generally necessary to distribute the personnel late in the afternoon and return them to their base of operations the following morning. The value of the helicopter was demonstrated during the latter part of the survey.

The observing was started as early in the evening as practical. The intensity of the target lights was adjusted to the minimum which could be observed, thereby obtaining the most refined pointing. One or more sets of eight positions each were observed. When the results obtained were within specifications of the U. S. Coast and Geodetic Survey no attempt was made to obtain further refinement.

OBOE-SALT BASE LINE. The base line for the network extended from Station Oboe on Oboe to Station Salt on Sugar. Due to the configuration of the island, it was necessary to establish a broken base consisting of two sections, Oboe-Piper and Piper-Salt.

Standard procedure of the U. S. Coast and Geodetic Survey for second order base line measurement was followed. Angles were measured with the Wild T-2 theodolite and the measurement was made with three Lovar tapes using thermometers and stretcher apparatus of an approved type. Stakes were set at 50 meter intervals for chaining bucks, and the tapes were alternated so that in completing the forward and backward measurements all three tapes were used in each direction.

The computed probable error of total measurement is one part in 2,800,000.

FIRST ORDER TRAVERSE. The relations between Stations 50 and 2210 at site Tare and 20 and 1201 at site Charlie were required to a tolerance of not to exceed 1:25,000. This requirement was accomplished by first order traverse measurement following standard procedure of the U. S. Coast and Geodetic Survey and with Lovar tapes and chaining bucks similar to the Oboe-Salt base line measurement. A base line for local triangulation was established to first order traverse specifications on site Fox.

Due to the velocity of wind in the area, it was generally necessary to provide a windbreak in order to obtain accurate results. The windbreak used consisted of a 36-inch strip of canvas approximately 55 meters in length, which was held parallel to the line on the windward side as each measurement was made.

GEOGRAPHIC POSITION. The origin of geographic position of the USN Survey, completed in 1946, is based on scaled values from a Japanese chart. As the accuracy of this chart was considered satisfactory for publication of a hydrographic chart of the Atoll and for origin of position for the USN Survey, the refinement which could be obtained by astronomic observations for geographic position was not considered to justify the additional expense to the survey.

USN Station Air on site Oboe is common to both the USS Sumner and USS Bowditch surveys. As this station was recovered and was in a desirable location for this purpose, it was adopted as the origin of geographic position for this survey. The USN adjusted values for the station are latitude 11-30-24.906 North, longitude 165-24-55.168 East.

GEODETIC AZIMUTH. Examination of the USN Survey records shows that three stations-Air, South, and Enyu are common to both the USS Sumner and USS Bowditch networks. The two surveys were combined in an adjustment which adopted a stellar azimuth observed by the USS Sumner as the origin of geodetic azimuth. It was intended to include a triangle formed by these three stations in the network of the new survey and accept a mean value obtained from the directions Air-South and Air-Enyu as the origin of azimuth. However, as Station South was not recovered, the USN value for the forward azimuth of the line Air-Enyu was adopted as the basis of geodetic azimuth. A check triangle including Station Kans of the USN Survey resulted in a computed difference of directions at Station Air of 0.4″. This was considered to be within project requirements for orientation of the scheme. The USN adjusted value for the forward azimuth of the line Air-Enyu is 268-00-01.4 or N88-00-01.4E.

SCIENTIFIC AZIMUTH. Geodetic azimuths are computed in a clockwise direction from south. The azimuths used in the description of Scientific Stations are computed in a clockwise direction from north.

PLANE COORDINATES-CASTLE GRID. A plane grid has been established common to the entire Atoll from which the interrelation of structures and areas and their location can be specified. Due to the limited area incorporated within the survey, the slight additional refinement obtained by computing a transverse Mercator grid would not be justified.

The origin of plane coordinates N103,872.0, E128,879.0 was taken at Station Air of the US Navy Survey which has also been adopted as the origin of geographic position.

The basis of bearings for this grid is a true meridian through the USN Station Air determined by adopting the adjusted value of that survey for the forward azimuth of the line USN-Air to USN-Enyu 268-00-01.4 or N88-00-01.4E.

The adjusted length of the line USN-Air to USN-Enyu, as determined by expansion from the new Oboe-Sugar base line, is 51473.8 feet. The USN Survey value is 4.8 feet more, or 51478.6 feet. While this difference was within the specifications for second order triangulation, it was believed to be mainly accounted for by the stronger figures of the new survey made possible by inclusion of the lagoon Station Coca.

The adjusted length and direction of the line Oboe-Nan (USN-Enyu) as determined from its relation to the line USN Air-USN Enyu was adopted as the initial line for computation of geodetic and plane coordinates for this survey.

TRIANGULATION ADJUSTMENT. The computed closing error of the triangulation net, before adjustment and using the observed angles plus or minus one-third of the closing error of a triangle, was less than 1:25,000. As the closure was well within second order specifications, and considering the size of the network, the additional refinement obtained by a least square adjustment could not be justified. To satisy the requirements of a plane coordinate grid, the value of a station should remain the same independent of the direction of computation through the net. This was accomplished by applying a side equation adjustment which, while approximate, satisfied the requirement.

Plane and geodetic coordinates were computed for all primary stations based on this adjustment. The geodetic coordinates of the recovered USN Survey stations were computed as a means of comparison between the surveys. Table 2-13, Figures 2-7 thru 2-12 and Tables 2-14 thru 2-23 list the plane coordinates, station locations and geographic positions.

DESIGN. Surveys to obtain information required for design of project features were initiated on arrival of the beachhead party at Bikini Atoll in October 1952. Only a small survey group could be supported at that time and top priority was given to the surveys for design and construction of the camp and airstrip at site Tare. Surveys were initiated on the other project islands as rapidly as personnel and transportation facilities were available. The location of the high tide line of an island was the first objective, followed by more detailed surveys of the interior of the islands where required.

HIGH TIDE LINE SURVEYS. The first requirement for site planning was to determine the configuration and extent of the land areas of the project islands. The procedure was to establish a third order traverse around the perimeter of an island, the elevations of the high tide line by relation to a preliminary vertical datum, and locate this line by stadia observations from the traverse points. The results of the survey were plotted, thereby obtaining an outline of the island.

TOPOGRAPHIC MAPPING. As site planning progressed, more detailed surveys were required to determine the relative elevations and location of terrain conditions which would influence design. This work was accomplished by plane table mapping, generally at scales of 1″ to 50′ or 1″ to 100′ and one-foot contours, or by profiles and cross sections of an area.

HYDROGRAPHY. The design of causeways and beaching areas for landing craft required surveys to determine the contour of the lagoon or reef bottom in these areas and location of underwater obstructions. This was generally accomplished by soundings taken from surface craft and the location of the soundings determined by intersection of angles from shore stations. Assistance was given to the Marine Department in locating channel markers and mooring buoys.

BARGE STABILITY STUDIES. The requirement to moor Scientific Station test barges in the lagoon within specified tolerances resulted in surveys to determine the yaw, roll, pitch, and horizontal motion of a barge around a fixed point. To determine this information, observations were taken over a period of several weeks to obtain actual measurements of the various movements of the barges. In addition, the length, period, height, and azimuth of waves were measured and a record was kept of the direction and velocity of the wind.

WAVE AND CURRENT STUDIES. Support was given to representatives of the USN Hydrographic Office in determining wave and current studies within the lagoon and seaward from the channels through the reef. A survey party assisted by locating the observation points by sextant angles to shore stations.

CHANNEL LOCATION. Support was also given a USN Hydrographic Office group in determining the locations of channels within the lagoon for deep draft vessels. The wire dragging of these areas was located from controls established by this department and department personnel assisted in the operations.

TABLE 2-13

LOCATION OF PRIMARY HORIZONTAL CONTROL STATIONS
BIKINI ATOLL

ISLAND	CODE	CASTLE STATIONS 2nd ORDER	CASTLE STATIONS 3rd ORDER	U. S. N. STATIONS	REMARKS
Bokobyaadaa	Able				
Bokonejien	Baker				
Namu	Charlie	Charlie			
Yurochi	Dog			Chi	USN-CHI Destroyed
Uorikku	Easy				
Romurikku	Fox	Fox			
Aomoen	George			Mon*	
Aomoen	George			Gell*	
Reef				Bik	USN-BIK Destroyed
Bikini	How	N. How		Kans*	
Bikini	How	S. How		Base*	
Bikini	How			Line*	
Bikini	How			North	
Bokonfuaaku	Item				
Yomyaran	Jig		Jig	South	USN-SOUTH Destroyed
Reef				Five	USN-FIVE Destroyed
Eniairo	King				
Rochikarai	Love		Love	Rock*	LOVE=USN-ROCK
Ionchebi	Mike		Mike	Ebi*	
Enyu	Nan	Nan		Enyu*	NAN=USN-ENYU
Enyu				Cent	
Airukiiji	Oboe	Oboe		Air*	
Airukirabu	Peter				
Bigiren	Roger			Ren*	
Reere	Sugar	Salt			
Eninman	Tare				
Eniirikku	Uncle	Uncle		Rik	USN-RIK Destroyed
Rukoji	Victor		Victor	Ruji*	VICTOR=USN-RUJI
Chieerete	William			Chi	USN-CHI Destroyed
Arriikan	Yoke	Yoke		Aran*	
Ourukaen	Zebra		Zebra	Oruk*	ZEBRA=USN-ORUK
Bokoaetokutoku	Alfa		Alfa	Boku*	ALFA=USN-BOKU
Bokororyuru	Bravo		Bravo	Boro*	BRAVO=USN-BORO
Lagoon	Coca	Coca			

* = USN Stations Recovered

SUPPORT TO USERS. The department was a source of information on available control and field conditions to all Users and considerable effort, both field and office, was expended in this direction. In addition to assistance in wave and current studies and in channel location surveys, checks were made on equipment layout, changes in location of minor stations and many other Users' requests were satisfied.

A complete set of records of the horizontal and vertical control surveys at Bikini Atoll was submitted to the USN Hydrographic Office for their analysis and use in revising the Atoll hydrogrophic chart.

Extensive cooperation was given the Army Mapping Service in furnishing records of horizontal and vertical control and establishing additional control for mapping purposes. Sets of control records for Eniwetok and Bikini Atolls were furnished to this organization.

Automatic tide gages were maintained and serviced at sites Tare and Charlie during the test period for the USN Hydrographic Office.

Assistance was provided in the trimming of the test barges and in the positioning of the Users' equipment on these barges.

STATION	PLANE COORDINATES	
	NORTH	EAST
CHARLIE	171,297.20	82,923.80
POL-2	166,638.92	70,946.42
WP-1341	166,286.77	70,040.99
ABLE	166,919.64	70,935.69
WP-20	170,617.16	76,163.98
WP-1201	173,198.61	83,205.72
STAKE 35	172,577.51	81,511.49
WP-90	170,635.05	75,950.43

NO SCALE

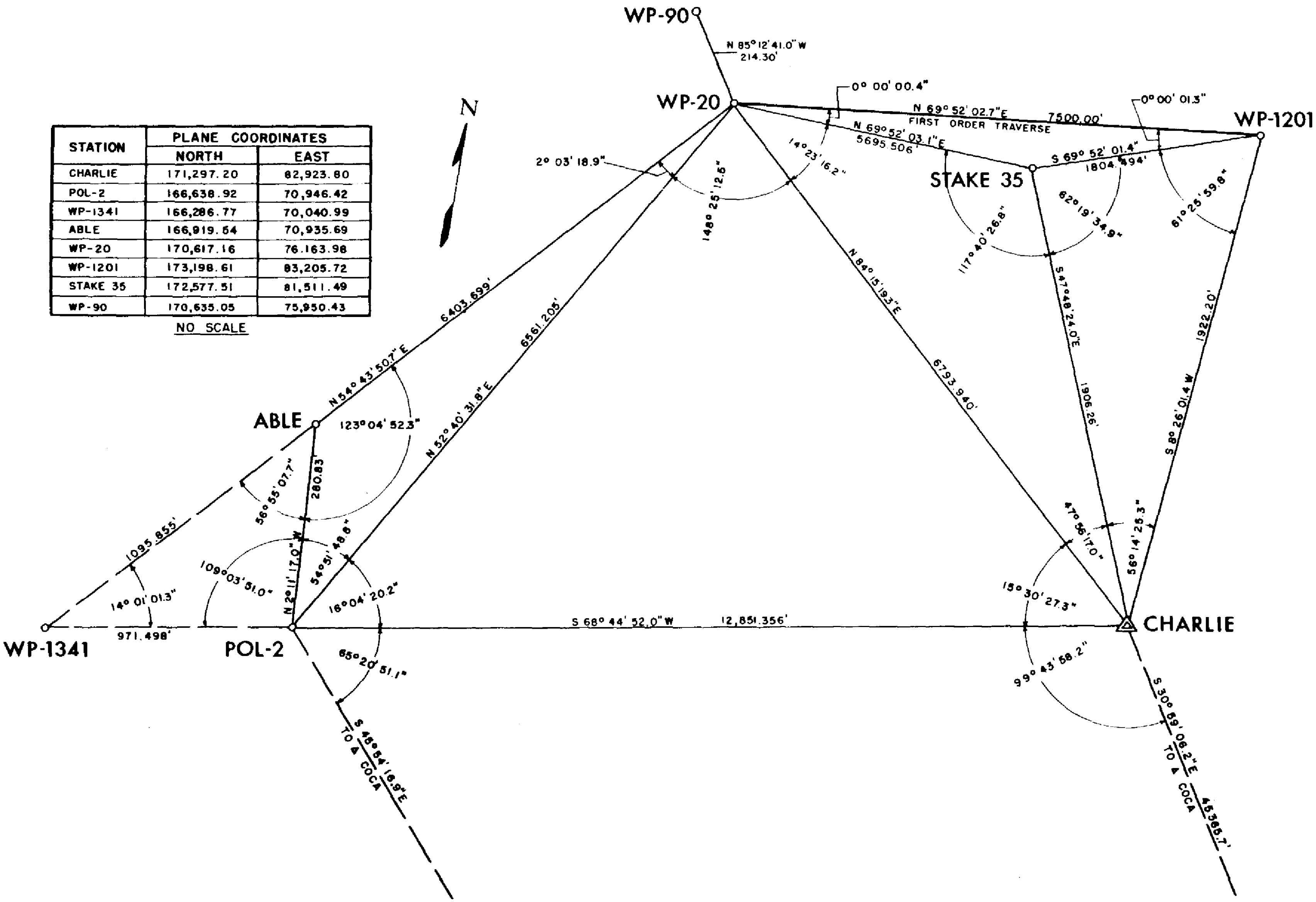


Figure 2-7. Orientation Traverses Able to Charlie

STATION	PLANE COORDINATES	
	NORTH	EAST
FOX	170,640.40	124,002.70
MON	167,499.29	131,458.21
DOG	168,501.86	116,888.35
PI-1 DOG	168,266.19	116,595.59
POL	168,420.47	116,617.59
PI-13 EASY	170,073.48	121,947.39
PI-1 FOX	170,549.66	123,682.61
PI-13 GEORGE	167,338.08	131,435.83

NO SCALE

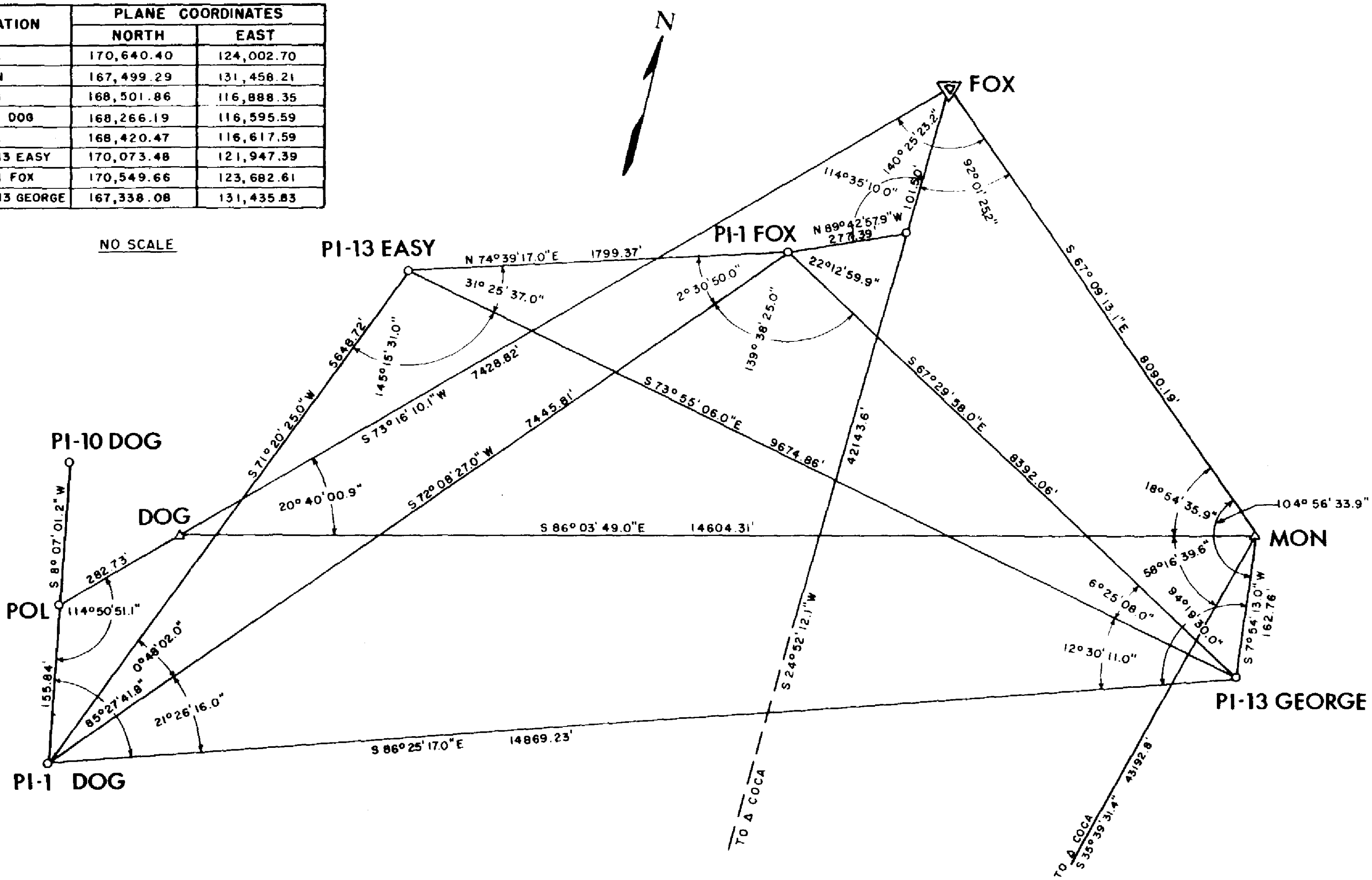
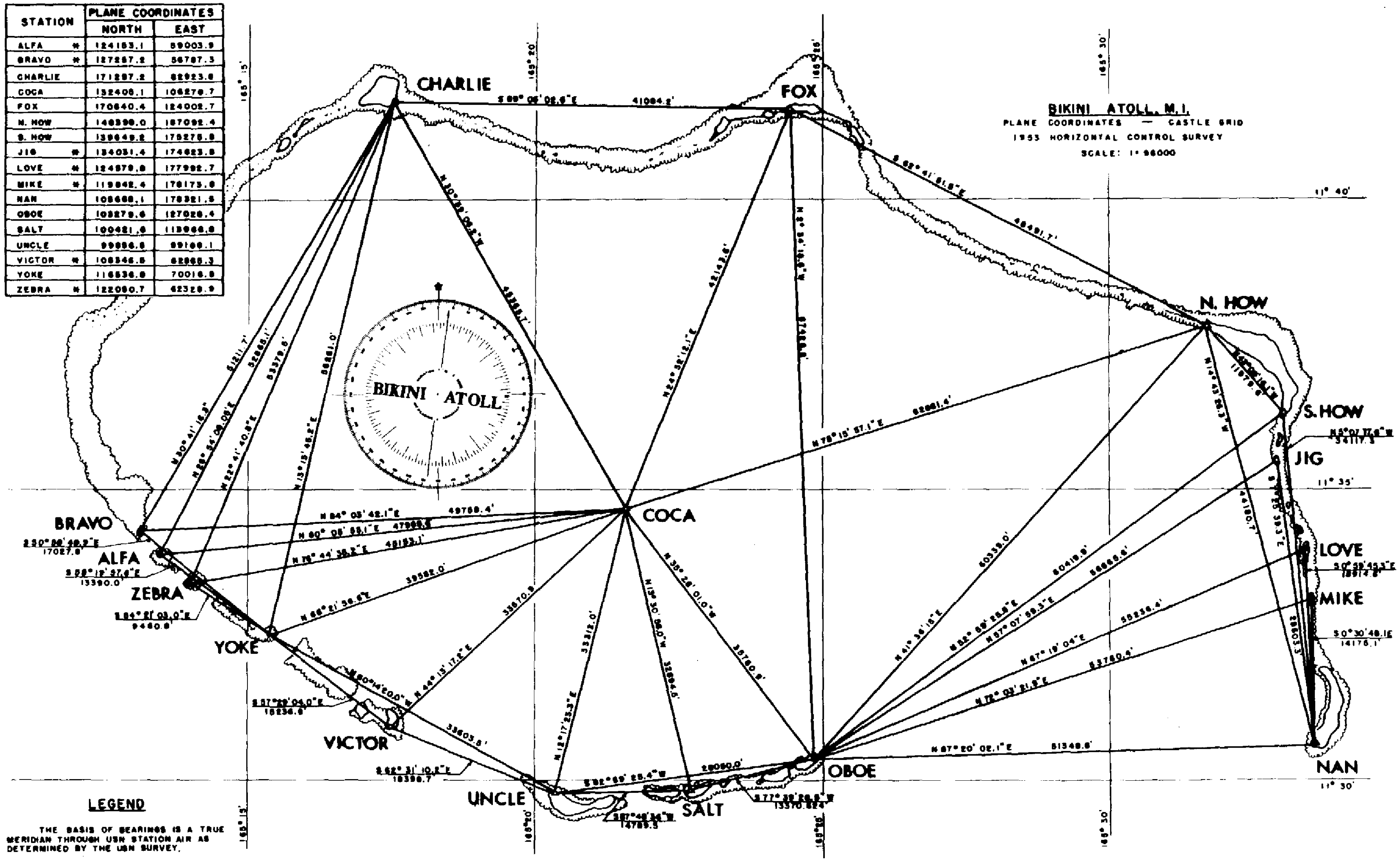


Figure 2-8. Orientation Traverses Dog to George

STATION	PLANE COORDINATES NORTH	EAST
ALFA *	124163.1	59003.9
BRAVO *	127287.2	56787.3
CHARLIE	171287.2	82923.8
COCA	132406.1	106270.7
FOX	170640.4	124002.7
N. HOW	146398.0	167092.4
S. HOW	139649.2	175278.8
JIG *	134051.4	174623.8
LOVE *	124879.8	177992.7
MIKE *	119842.4	178173.8
NAN	108668.1	178321.5
OBOE	103279.6	127028.4
SALT	100421.6	113966.8
UNCLE	99856.8	99160.1
VICTOR *	106346.5	82865.3
YOKE	116536.8	70016.8
ZEBRA *	122080.7	62320.9



LEGEND

THE BASIS OF BEARINGS IS A TRUE MERIDIAN THROUGH USN STATION AIR AS DETERMINED BY THE USN SURVEY.

THE ORIGIN OF PLANE COORDINATES N103672.0, E128879.0, WAS TAKEN AT STATION USN AIR.

* = THIRD ORDER STATION

Figure 2-9. Plane Coordinates - Bikini Atoll - CASTLE Grid

STATION	PLANE COORDINATES	
	NORTH	EAST
FOX	170,640.40	124,002.70
MON	167,499.29	131,458.20
FIRE	170,575.07	127,200.64
REEF	175,933.74	127,327.19
DOG	168,501.86	116,888.35
WP-1210	168,598.18	116,705.59
WP-1342	167,334.72	131,691.58
WP-30	161,698.83	116,800.27
WP-40	161,424.43	116,688.15

NO SCALE

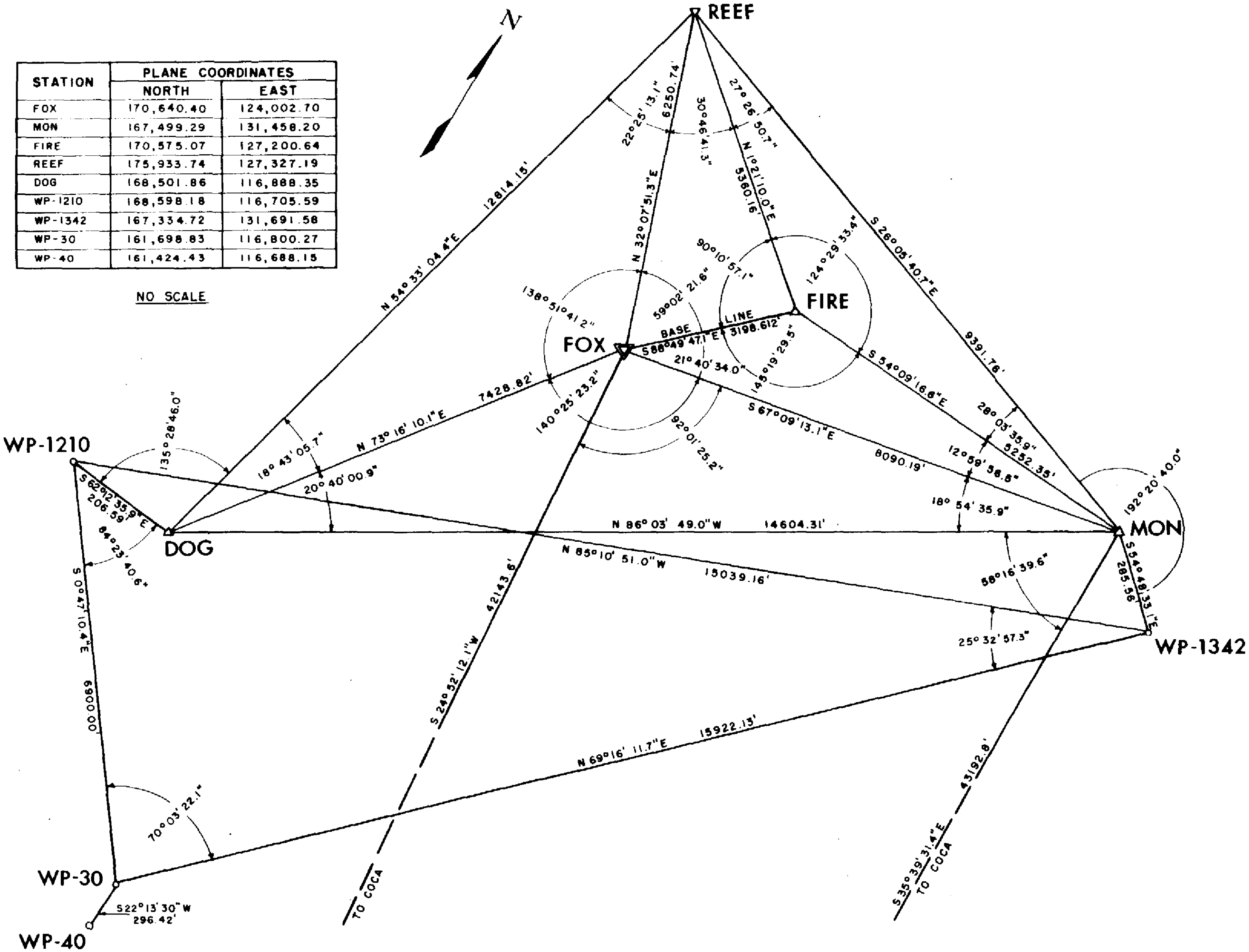
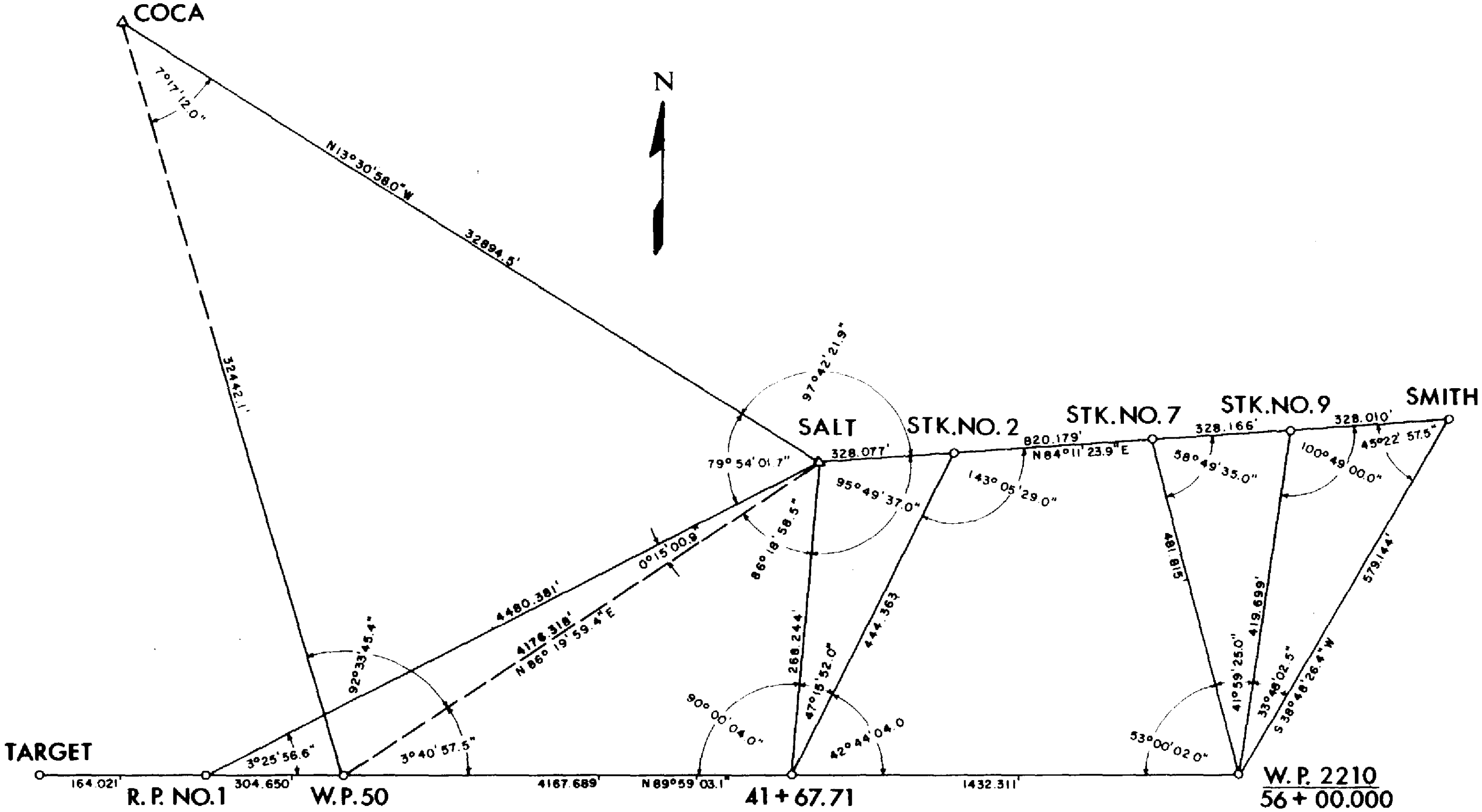


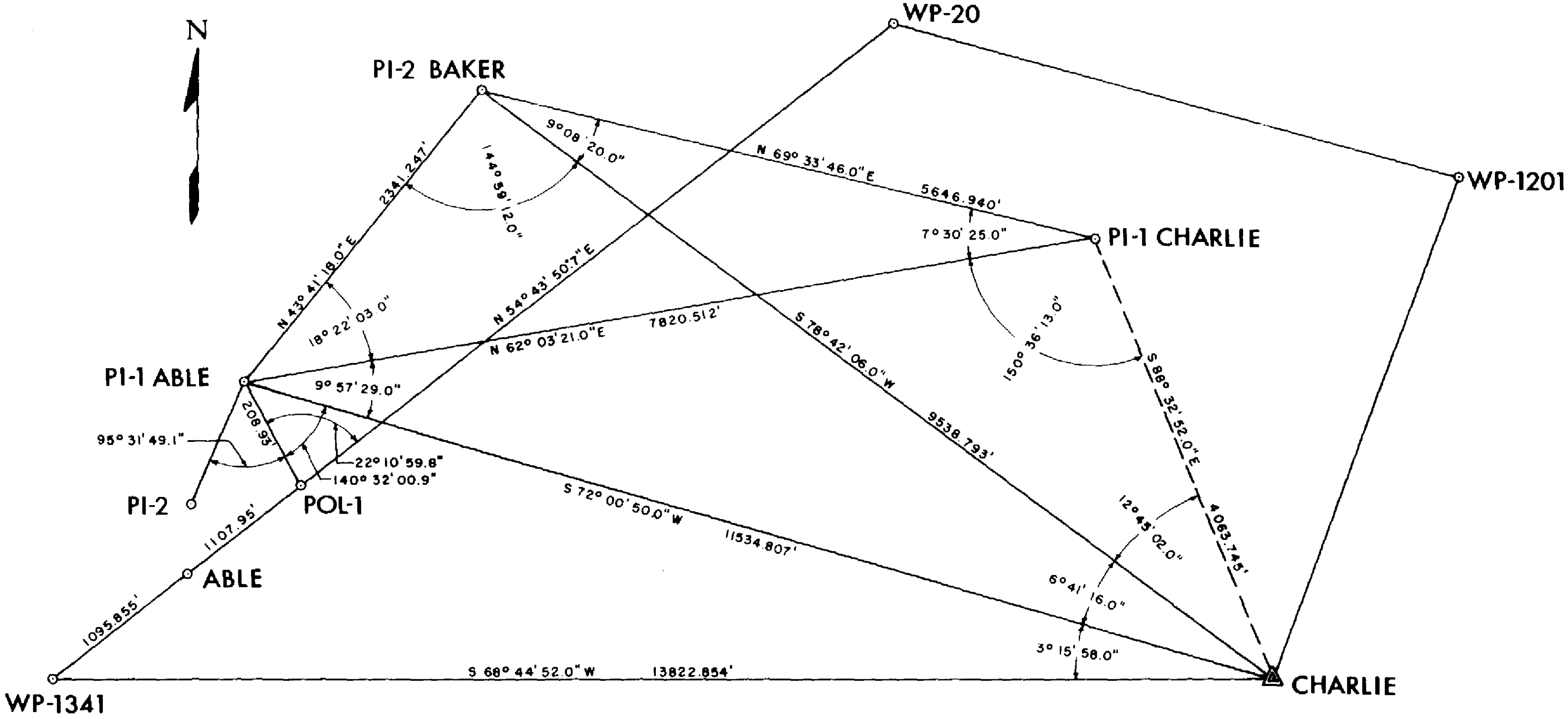
Figure 2-10. Location Stations 30, 40, 1210 and 1342



STATION	PLANE COORDINATES	
	NORTH	EAST
COCA	132,405.10	106,278.70
SALT	100,421.60	113,966.80
SMITH	100,604.26	116,761.96
W. P. 2210	100,152.96	115,399.01
41 + 67.71	100,153.36	113,966.70
W. P. 50	100,154.50	109,799.00

NO SCALE

Figure 2-11. Location Stations 50 and 1201



STATION	PLANE COORDINATES	
	NORTH	EAST
Δ CHARLIE	171,297.20	82,923.80
PI-1 CHARLIE	171,400.19	78,861.36
PI-2 BAKER	169,428.38	73,569.87
PI-1 ABLE	167,735.41	71,952.68
POL-1	167,559.29	71,840.28
ABLE	166,919.54	70,935.67

NO SCALE

Figure 2-12. Location Stations 20, 1201 and 1341

LOCATION BIKINI ATOLL, M. I.
DATUM U.S.N. 1946

SCIENTIFIC STATIONS

SECOND ORDER TRIANGULATION
SHEET 1 OF 1

STATION	LATITUDE LONGITUDE	AZIMUTH	BACK AZIMUTH	TO STATION	DISTANCE LOG. METERS	DISTANCE METERS	DISTANCE FEET
WP-20	N 11-41-26.895	264-13-36.2	84-13-50.0	CHARLIE	3.3161382	2070.80	6793.94
	E 165-16-24.754	321-43-47.7	141-44-48.9	COCA	4.1711207	14829.28	48652.4
WP-30	N 11-39-58.546	218-50-44.4	38-50-59.1	FOX	3.5440184	3499.60	11481.6
	E 165-23-13.741	248-24-16.1	68-24-46.0	USN-MON	3.6816798	4804.85	15763.9
WP-50	N 11-29-48.014	173-45-39.2	353-45-32.1	COCA	3.9951247	9888.37	32442.1
	E 165-22-03.388	266-19-24.6	86-19-33.0	SALT	3.1048079	1272.94	4176.318
WP-40	N 11-39-55.82	202-13-09.1	22-13-09.3	WP-30	1.9559234	90.35	296.42
	E 165-23-12.61						
WP-90	N 11-41-27.07	274-45-35.5	94-45-35.9	WP-20	1.8150395	65.32	214.30
	E 165-16-22.60						

Table 2-14. Bikini - Geographic Positions

STATION	LATITUDE LONGITUDE	AZIMUTH	BACK AZIMUTH	TO STATION	DISTANCE		
					LOG. METERS	METERS	FEET
ALFA (*)	N 11-33-45.872	206-51-50.4	26-52-38.9	CHARLIE	4.2071848	16113.31	52865.1
	E 165-13-32.361	260-03-37.8	80-05-13.2	COCA	4.1651630	14627.26	47989.6
		304-37-45.1	124-38-07.3	YOKE	3.6107909	4081.28	13390.0
BRAVO (*)	N 11-34-16.650	210-38-54.3	30-39-47.3	CHARLIE	4.1933851	15609.36	51211.7
	E 165-13-10.041	264-01-20.3	84-03-00.2	COCA	4.1808823	15166.39	49758.4
		308-58-48.3	128-59-15.0	YOKE	3.7151740	5190.08	17027.8
CHARLIE	N 11-41-33.672	270-53-27.9	90-54-51.7	FOX	4.0976907	12522.49	41084.2
	E 165-17-32.784	328-59-24.5	149-00-11.9	COCA	4.1407434	13827.49	45365.7
		13-14-16.1	193-13-50.0	YOKE	4.2342234	17148.39	56261.0
		22-40-11.7	202-39-30.0	ZEBRA	4.2113903	16270.10	53379.5
		26-52-38.9	206-51-50.4	ALFA	4.2071848	16113.31	52865.1
		30-39-47.3	210-38-54.3	BRAVO	4.1933851	15609.36	51211.7
COCA	N 11-35-07.935	324-31-17.1	144-31-58.9	OBOE	4.0374241	10899.94	35760.9
	E 165-21-27.917	346-28-20.1	166-28-35.6	SALT	4.0011390	10026.26	32894.5
		12-16-41.4	192-16-27.2	UNCLE	4.0066167	10153.52	33312.0
		66-21-14.7	246-20-01.6	YOKE	4.0815136	12064.62	39582.0
		149-00-11.9	328-59-24.5	CHARLIE	4.1407434	13827.49	45365.7
		204-51-30.2	24-52-06.2	FOX	4.1087473	12845.39	42143.6
		255-15-15.2	75-17-18.3	N. HOW	4.2825381	19166.29	62881.4
FOX	N 11-41-27.251	297-18-02.3	117-19-29.9	N. HOW	4.1696832	14780.30	48491.7
	E 165-24-26.220	357-25-35.2	177-25-41.3	OBOE	4.3128613	20552.34	67428.8
		24-52-06.2	204-51-30.2	COCA	4.1087473	12845.39	42143.6
		90-54-51.7	270-53-27.9	CHARLIE	4.0976907	12522.49	41084.2

* Third Order Stations.

Table 2-15. Bikini - Geographic Positions

STATION	LATITUDE LONGITUDE	AZIMUTH	BACK AZIMUTH	TO STATION	DISTANCE		
					LOG. METERS	METERS	FEET
N. HOW	N 11-37-46.528	316-56-04.7	136-56-21.4	S. HOW	3.5624582	3651.39	11979.6
	E 165-31-39.801	345-17-54.5	165-18-17.1	NAN	4.1292483	13466.30	44180.7
		41-37-36.3	221-36-15.5	OBOE	4.2646138	18391.36	60339.0
		75-17-18.3	255-15-15.2	COCA	4.2825381	19166.29	62881.4
		117-19-29.9	297-18-02.3	FOX	4.1696832	14780.30	48491.7
S. HOW	N 11-36-19.705	354-54-19.7	174-54-25.8	NAN	4.0169903	10398.97	34117.3
	E 165-33-02.103	53-01-03.2	232-59-26.0	OBOE	4.2651958	18416.02	60419.9
		136-56-21.4	316-56-04.7	N. HOW	3.5624582	3651.39	11979.6
JIG (*)	N 11-35-23.979	352-35-56.6	172-36-04.0	NAN	3.9404318	8718.30	28603.3
	E 165-32-55.516	57-09-35.3	237-07-59.5	OBOE	4.2373353	17271.71	56665.6
LOVE (*)	N 11-33-50.203	359-01-57.4	179-01-58.0	NAN	3.7608129	5765.18	18914.6
	E 165-33-29.362	67-20-46.8	247-19-04.3	OBOE	4.2262412	16836.09	55236.4
MIKE (*)	N 11-33-03.207	359-25-54.9	179-25-55.2	NAN	3.6355421	4320.58	14175.1
	E 165-33-31.160	72-05-05.0	252-03-22.2	OBOE	4.2144783	16386.20	53760.4
NAN	N 11-30-42.595	87-21-45.3	267-20-02.4	OBOE	4.1945443	15651.08	51348.6
	E 165-33-32.574	165-18-17.1	345-17-54.5	N. HOW	4.1292483	13466.30	44180.7
		172-36-04.0	352-35-56.6	JIG	3.9404318	8718.30	28603.3
		174-54-25.8	354-54-19.7	S. HOW	4.0169903	10398.97	34117.3
		179-01-58.0	359-01-57.4	LOVE	3.7608129	5765.18	18914.6
		179-25-55.2	359-25-54.9	MIKE	3.6355421	4320.58	14175.1

* Third Order Stations

Table 2-16. Bikini - Geographic Positions

LOCATION BIKINI ATOLL M. I.
DATUM U.S.N. 1946
SECOND ORDER TRIANGULATION
SHEET 3 OF 4

STATION	LATITUDE LONGITUDE	AZIMUTH	BACK AZIMUTH	TO STATION	DISTANCE LOG. METERS	METERS	FEET
OBOE	N 11-30-19.029	77-39-28.4	257-39-02.2	SALT	3.6101675	4075.3743	13370.624
	E 165-24-56.671	82-59-25.2	262-58-29.4	UNCLE	3.9319489	8549.66	28050.0
		144-31-58.9	324-31-17.1	COCA	4.0374241	10899.94	35760.9
		177-25-41.3	357-25-35.2	FOX	4.3128613	20552.34	67428.8
		221-36-15.5	41-37-36.3	N. HOW	4.2646138	18391.36	60339.0
		232-59-26.0	53-01-03.2	S. HOW	4.2651958	18416.02	60419.9
		237-07-59.5	57-09-35.3	JIG	4.2373353	17271.71	56665.6
		247-19-04.3	67-20-46.8	LOVE	4.2262412	16836.09	55236.4
		252-03-22.2	72-05-05.0	MIKE	4.2144783	16386.20	53760.4
		267-20-02.4	87-21-45.3	NAN	4.1945443	15651.08	51348.6
SALT	N 11-29-50.670	87-48-09.5	267-47-39.9	UNCLE	3.6539695	4507.85	14789.5
	E 165-22-45.305	166-28-35.6	346-28-20.1	COCA	4.0011390	10026.26	32894.5
		257-39-02.2	77-39-28.4	OBOE	3.6101675	4075.3743	13370.624
UNCLE	N 11-29-45.033	117-27-53.7	297-27-20.9	VICTOR	3.7488026	5607.93	18398.7
	E 165-20-16.670	119-44-43.7	299-43-45.1	YOKE	4.0104005	10242.37	33603.5
		192-16-27.2	12-16-41.4	COCA	4.0066167	10153.52	33312.0
		262-58-29.4	82-59-25.2	OBOE	3.9319489	8549.66	28050.0
		267-47-39.9	87-48-09.5	SALT	3.6539695	4507.85	14789.5
VICTOR (*)	N 11-31-09.198	122-29-26.9	302-29-01.0	YOKE	3.6669128	4644.22	15236.9
	E 165-17-32.469	224-11-48.2	44-12-35.3	COCA	4.0099788	10232.43	33570.9
		297-27-20.9	117-27-53.7	UNCLE	3.7488026	5607.93	18398.7

* Third Order Stations

Table 2-17. Bikini - Geographic Locations

STATION	LATITUDE LONGITUDE	AZIMUTH	BACK AZIMUTH	TO STATION	DISTANCE		
					LOG. METERS	METERS	FEET
YOKE	N 11-32-30.383	125-37-01.9	305-36-46.5	ZEBRA	3.4599448	2883.66	9460.8
	E 165-15-23.190	124-38-07.3	304-37-45.1	ALFA	3.6107909	4081.28	13390.0
		128-59-15.0	308-58-48.3	BRAVO	3.7151740	5190.08	17027.8
		193-13-50.0	13-14-16.1	CHARLIE	4.2342234	17148.39	56261.0
		246-20-01.6	66-21-14.7	COCA	4.0815136	12064.62	39582.0
		299-43-45.1	119-44-43.7	UNCLE	4.0104005	10242.37	33603.5
		302-29-01.0	122-29-26.9	VICTOR	3.6669128	4644.22	15236.9
ZEBRA (*)	N 11-33-25.036	202-39-30.0	22-40-11.7	CHARLIE	4.2113903	16270.10	53379.5
	E 165-14-05.823	256-42-24.7	76-43-53.3	COCA	4.1387033	13762.69	45153.1
		305-36-46.5	125-37-01.9	YOKE	3.4599448	2883.66	9460.8
USN-AIR	N 11-30-24.906	268-00-01.4	88-01-44.6	USN-ENYU	4.1956022	15689.25	51473.8
	E 165-24-55.168	345-50-39.4	165-50-39.7	OBOE	2.2700407	186.23	610.977
USN-ENYU	N 11-30-42.595	88-01-44.6	268-00-01.4	USN-AIR	4.1956022	15689.25	51473.8
	E 165-33-32.574	87-21-45.3	267-20-02.4	OBOE	4.1945443	15651.08	51348.6
	NOTE: USN-ENYU = STA. NAN						

* Third Order Stations

Table 2-18. Bikini - Geographic Locations

	STATIONS	BEARING	DISTANCE	LATITUDE	DEPARTURE	COORDINATES NORTH	COORDINATES EAST	
1	ALFA to *					124,153.2	59003.9	1
		N 35-31-51.8W	3814.2	N 3104.0	W 2216.6			
2	BRAVO *					127,257.2	56787.3	2
		N 26-54-08.0E	52865.1	N 47144.0	E 23919.9			
3	CHARLIE					171,297.2	82923.8	3
		N 80-05-55.1E	47989.6	N 8251.9	E 47274.8			
4	COCA					132,405.1	106278.7	4
		S 55-19-57.6E	13390.0	S 7616.4	E 11012.9			
5	YOKE					116,536.8	70016.8	5
		S 57-41-36.9E	3934.0	S 2102.5	E 3325.0			
6	ZEBRA *					122,050.7	62328.9	6
7								7
8	BRAVO to *					127,257.2	56787.3	8
		N 30-41-16.3E	51211.7	N 44040.0	E 26136.4			
9	CHARLIE					171,297.2	82923.8	9
		N 84-03-42.1E	49758.4	N 5147.9	E 49491.4			
10	COCA					132,405.1	106278.7	10
		S 50-58-49.9E	17027.8	S 10720.4	E 13229.4			
11	YOKE					116,536.8	70016.8	11
		S 35-31-51.8E	3814.2	S 3104.0	E 2216.6			
12	ALFA *					124,153.2	59003.9	12
13								13
14	CHARLIE to					171,297.2	82923.8	14
		S 89-05-02.6E	41084.2	S 656.8	E 41078.9			
15	FOX					170,640.4	124002.7	15
		S 30-59-06.2E	45365.7	S 38892.1	E 23354.9			
16	COCA					132,405.1	106278.7	16
		S 13-15-45.2W	56261.0	S 54760.4	W 12907.0			
17	YOKE					116,536.8	70016.8	17
		S 22-41-40.8W	53379.5	S 49246.5	W 20594.9			
18	ZEBRA *					122,050.7	62328.9	18
		S 26-54-08.0W	52865.1	S 47144.0	W 23919.9			
19	ALFA *					124,153.2	59003.9	19
		S 30-41-16.3W	51211.7	S 44040.0	W 26136.4			
20	BRAVO *					127,257.2	56787.3	20
21								21
22	COCA to					132,405.1	106278.7	22
		S-35-28-01.0E	35760.9	S 29125.5	E 20749.7			
23	OBOE					103,279.6	127028.4	23
		S 13-30-58.0E	32894.5	S 31983.4	E 7688.1			
24	SALT					100,421.6	113966.8	24
		S 12-17-23.3W	33312.0	S 32548.6	W 7090.7			
25	UNCLE					99,856.5	99188.1	25
		S 66-21-56.6W	39582.0	S 15868.3	W 36262.0			
26	YOKE					116,536.8	70016.8	26

* Third Order Stations

Table 2-19. Bikini Plane Coordinates

	STATIONS	BEARING	DISTANCE	LATITUDE	DEPARTURE	COORDINATES NORTH	COORDINATES EAST	
1	COCA to					132,405.1	106,278.7	1
2	CHARLIE	N 30-59-06.2W	45365.7	N 38892.1	W 23354.9	171,297.2	82,923.8	2
3	FOX	N 24-52-12.1E	42143.6	N 38235.4	E 17724.0	170,640.4	124,002.7	3
4	N. HOW	N 75-15-57.1E	62881.4	N 15992.9	E 60813.6	148,398.0	167,092.4	4
5								5
6	FOX to					170,640.5	124,002.7	6
7	N. HOW	S 62-41-51.5E	48491.7	S 22242.5	E 43089.7	148,398.0	167,092.4	7
8	OBOE	S 2-34-18.8E	67428.8	S 67360.9	E 3025.7	103,279.6	127,028.4	8
9	COCA	S 24-52-12.1W	42143.6	S 38235.4	W 17724.0	132,405.1	106,278.7	9
10	CHARLIE	N 89-05-02.6W	41084.2	N 656.8	W 41078.9	171,297.2	82,923.8	10
11								11
12	N. HOW to					148,398.0	167,092.4	12
13	S. HOW	S 43-05-16.1E	11979.6	S 8748.8	E 8183.5	139,649.2	175,275.8	13
14	NAN	S 14-43-26.3E	44180.7	S 42729.9	E 11229.1	105,668.1	178,321.5	14
15	OBOE	S 41-36-15.3W	60339.0	S 45118.4	W 40064.0	103,279.6	127,028.4	15
16	COCA	S 75-15-57.1W	62881.4	S 15992.9	W 60813.6	132,405.1	106,278.7	16
17	FOX	N 62-41-51.5W	48491.7	N 22242.5	W 43089.7	170,640.4	124,002.7	17
18								18
19	S. HOW to					139,649.2	175,275.8	19
20	NAN	S 5-07-17.6E	34117.3	S 33981.1	E 3045.6	105,668.1	178,321.5	20
21	OBOE	S 52-59-25.8W	60419.9	S 36369.6	W 48247.4	103,279.6	127,028.4	21
22	N. HOW	N 43-05-16.1W	11979.6	N 8748.8	W 8183.5	148,398.0	167,092.4	22
23								23
24	JIG to *					134,031.4	174,623.8	24
25	NAN	S 7-25-39.3E	28603.3	S 28363.3	E 3697.7	105,668.1	178,321.5	25
26	OBOE	S 57-07-59.3W	56665.6	S 30751.8	W 47595.4	103,279.6	127,028.4	26

* Third Order Stations

Table 2-20. Bikini Plane Coordinates

	STATIONS	BEARING	DISTANCE	LATITUDE	DEPARTURE	COORDINATES NORTH	COORDINATES EAST	
1	LOVE to *					124,579.8	177,992.7	1
2	NAN	S 0-59-45.3E	18914.605	S 18911.7	E 328.8	105,668.1	178,321.5	2
3	OBOE	S 67-19-04.0W	55236.4	S 21300.2	W 50964.3	103,279.6	127,028.4	3
4								4
5	MIKE to *					119,842.4	178,173.8	5
6	NAN	S 0-35-48.1E	14175.1	S 14174.3	E 147.7	105,668.1	178,321.5	6
7	OBOE	S 72-03-21.9W	53760.4	S 16562.8	W 51145.4	103,279.6	127,028.4	7
8								8
9	NAN to					105,668.1	178,321.5	9
10	OBOE	S 87-20-02.1W	51348.6	S 2388.5	W 51293.1	103,279.6	127,028.4	10
11	N. HOW	N 14-43-26.3W	44180.7	N 42729.9	W 11229.1	148,398.0	167,092.4	11
12	JIG *	N 7-25-39.3W	28603.3	N 28363.3	W 3697.7	134,031.4	174,623.8	12
13	S. HOW	N 5-07-17.6W	34117.3	N 33981.1	W 3045.6	139,649.2	175,275.8	13
14	LOVE *	N 0-59-45.3W	18914.6	N 18911.7	W 328.8	124,579.8	177,992.7	14
15	MIKE *	N 0-35-48.1W	14175.1	N 14174.3	W 147.7	119,842.4	178,173.8	15
16								16
17	OBOE to					103,279.6	127,028.4	17
18	SALT	S 77-39-28.5W	13370.6	S 2857.9	W 13061.6	100,421.6	113,966.8	18
19	UNCLE	S 82-59-25.4W	28050.0	S 3423.1	W 27840.3	99,856.5	99,188.1	19
20	COCA	N 35-28-01.0W	35760.9	N 29125.5	W 20749.7	132,405.1	106,278.7	20
21	FOX	N 2-34-18.8W	67428.8	N 67360.9	W 3025.7	170,640.4	124,002.7	21
22	N. HOW	N 41-36-15.3E	60339.0	N 45118.4	E 40064.0	148,398.0	167,092.4	22
23	S. HOW	N 52-59-25.8E	60419.9	N 36369.6	E 48247.4	139,649.2	175,275.9	23
24	JIG *	N 57-07-59.3E	56665.6	N 30751.8	E 47595.4	134,031.4	174,623.8	24
25	LOVE *	N 67-19-04.0E	55236.4	N 21300.2	E 50964.3	124,579.8	177,992.7	25
26	MIKE *	N 72-03-21.9E	53760.4	N 16562.8	E 51145.4	119,842.4	178,173.8	26
	NAN	N 87-20-02.1E	51348.6	N 2388.5	E 51293.1	105,668.1	178,321.5	

* Third Order Stations

Table 2-21. Bikini Plane Coordinates

LOCATION BIKINI ATOLL M. I.

PROJECTION PLANE GRID

CASTLE GRID

SHEET 4 OF 5

	STATIONS	BEARING	DISTANCE	LATITUDE	DEPARTURE	COORDINATES NORTH	COORDINATES EAST	
1	SALT to					100,421.6	113,966.8	1
2	UNCLE	S 87-48-36.0W	14789.5	S 565.2	W 14778.7	99,856.5	99,188.1	2
3	COCA	N 13-30-58.0W	32894.5	N 31983.4	W 7688.1	132,405.1	106,278.7	3
4	OBOE	N 77-39-28.5E	13370.6	N 2857.9	E 13061.6	103,279.6	127,028.4	4
5								5
6	UNCLE to					99,856.5	99,188.1	6
7	VICTOR *	N 62-31-10.2W	18398.7	N 8490.0	W 16322.8	108,346.5	82,865.3	7
8	YOKE	N 60-14-20.0W	33603.5	N 16680.3	W 29171.3	116,536.8	70,016.8	8
9	COCA	N 12-17-23.3E	33312.0	N 32548.6	E 7090.7	132,405.1	106,278.7	9
10	OBOE	N 82-59-25.4E	28050.0	N 3423.1	E 27840.3	103,279.6	127,028.4	10
11	SALT	N 87-48-36.0E	14789.5	N 565.2	E 14778.7	100,421.6	113,966.8	11
12								12
13	VICTOR to*					108,346.5	82,865.3	13
14	YOKE	N 57-29-04.0W	15236.9	N 8190.3	W 12848.5	116,536.8	70,016.8	14
15	COCA	N 44-13-17.2E	33570.9	N 24058.6	E 23413.4	132,405.1	106,278.7	15
16	UNCLE	S 62-31-10.2E	18398.7	S 8490.0	E 16322.8	99,856.5	99,188.1	16
17								17
18	YOKE to					116,536.8	70,016.8	18
19	ZEBRA *	N 54-21-03.0W	9460.8	N 5513.9	W 7687.8	122,050.7	62,328.9	19
20	ALFA *	N 55-19-57.6W	13390.0	N 7616.4	W 11012.9	124,153.2	59,003.9	20
21	BRAVO *	N 50-58-49.9W	17027.8	N 10720.4	W 13229.4	127,257.2	56,787.3	21
22	CHARLIE	N 13-15-45.2E	56261.0	N 54760.4	E 12907.0	171,297.2	82,923.8	22
23	COCA	N 66-21-56.6E	39582.0	N 15868.3	E 36262.0	132,405.1	106,278.7	23
24	UNCLE	S 60-14-20.0E	33603.5	S 16680.3	E 29171.3	99,856.5	99,188.1	24
25	VICTOR *	S 57-29-04.0E	15236.9	S 8190.3	E 12848.5	108,346.5	82,865.3	25
26								26

* Third Order Stations.

Table 2-22. Bikini Plane Coordinates

LOCATION BIKINI ATOLL M. I.
PROJECTION PLANE GRID

CASTLE GRID
SHEET 5 OF 5

	STATIONS	BEARING	DISTANCE	LATITUDE	DEPARTURE	COORDINATES NORTH	COORDINATES EAST	
1	ZEBRA to *					122,050.7	62,328.9	1
		N 22-41-40.8E	53379.5	N 49246.5	E 20594.9			
2	CHARLIE					171,297.2	82,923.8	2
		N 76-44-35.2E	45153.1	N 10354.4	E 43949.8			
3	COCA					132,405.1	106,278.8	3
		S 54-21-03.0E	9460.8	S 5513.9	E 7687.8			
4	YOKE					116,536.8	70,016.8	4
5								5
6								6
7								7
8								8
9								9
10								10
11								11
12								12
13								13
14								14
15								15
16								16
17								17
18								18
19								19
20								20
21								21
22								22
23								23
24								24
25								25
26								26

* Third Order Stations

Table 2-23. Bikini Plane Coordinates

HORIZONTAL CONTROL

PRELIMINARY TRAVERSE. Preliminary traverses, of third order accuracy, were established for mapping purposes. These were generally on the perimeter of an island and were not referenced, since it was not intended to use them later for construction layout. Due to the work load of the department it was not possible to establish more accurate controls in some of the areas before the start of construction operations. Where the accuracy of these traverses was considered consistent with accuracy requirements, they were utilized for construction layout.

PRIMARY TRIANGULATION. The basic horizontal control for all surveys was a triangulation network established to second order specifications and procedure of the U. S. Coast and Geodetic Survey. This survey is outlined elsewhere in this report and consisted of a network of triangles expanding from a measured base line and from which the interrelations of all areas and project features could be determined.

SECONDARY TRIANGULATION. Requirements for determination of the precise interrelation of structures in some areas resulted in establishing local triangulation nets by breakdown from the primary network. In the Able-Charlie and Dog-George areas, local nets were established which expanded from base lines, whose lengths were determined by first order traversing and which were related to and oriented from the primary control network.

PERMANENT LOCAL CONTROL. In addition to a station of the primary network on an island, additional permanent control was established where practical. On Fred and Elmer, at Eniwetok Atoll, traverses were established and referenced to monuments as controls for all surveys in these areas. These traverses are of approximately second order traverse accuracy. On smaller islands it was the intention to maintain at least two points whose interrelation and relation to the primary network were known. In some locations these points were destroyed during test operations and were replaced before subsequent operations.

PERMANENCY OF PRIMARY CONTROL MARKERS. At each Atoll, practical methods were used to assure the permanency of the primary network. In addition to a concrete marker at each station, the general procedure was to establish three reference markers and determine their relation to the primary marker. From any two of the reference markers it is possible to re-establish the primary marker.

In the blast areas, stations and reference markers were destroyed and could be replaced only by expansion from the primary control stations existing at other locations. At each Atoll a reconnaissance will be made and recommendations submitted covering the additional surveys required to maintain an adequate primary control network.

VERTICAL CONTROL. No records were available of vertical control established at either of the Atolls by previous surveys. There had been no scientific requirement for an over-all vertical control network, and such a network would involve extensive observations over a considerable period of time. A preliminary datum was established independently on each of the project islands as surveys were made and the accuracy was considered consistant with project requirements. This datum may be described as "A datum approximating mean low water springs was arrived at by applying corrections from the USC & GS publications 'Tide Tables of the Pacific Ocean' to a series of tidal observations. This is a temporary datum but should be significant to less than a foot."

The procedure was to erect a tide staff or other means of measuring the height of water at each island and take periodical observations as surveys were made in the areas. After applying corrections, a mean of these corrected observations was adopted as the temporary datum. This datum was transferred to permanent monuments in the vicinity and became the origin of all vertical control for the area.

Subsequent to establishing the preliminary datum, automatic tide gages were operated at three locations. At site Fred, at Eniwetok Atoll, a differential of 0.14 foot was determined between the preliminary and the automatic gage datum which was of no consequence in the tidal relations to project structures. The adjusted results of the observations at Bikini Atoll are not available at this time. A comparison of the unadjusted data indicates a small diffential at site Tare with approximately one foot differential at site Charlie. This was believed to be accounted for by the difficulty of finding a location for the preliminary observations which was free from effects of local currents causing abnormal tide level.

CONSTRUCTION LAYOUT

GENERAL. The layout for construction was the largest survey activity. This included preliminary staking for clearing and rough grading, followed by accurate layout of the particular item. Due to the isolation of many of these items and the time required for transportation to and from the locations, the man-hours required for construction surveying were high. Where justified by the work load, survey parties were assigned to an area during the construction period. Where this was not practical, a party was made available to go to an area on short notice in order that there would be no delay to construction operations.

Figure 2-13. Survey Layout of Scientific Station

permissible latitude in locating a station, and the required accuracy in determining its relation to the primary controls. The latitude in locating a station was specified by the User. The relation of the majority of the stations to a specified primary station was determined within a linear tolerance of 1:5,000. Where greater accuracy was desired for outlying stations the linear tolerance was stated to be within 1:10,000, the minimum strength of the primary network. However, the actual accuracy of location can be considered to be greater than the minimum value. Figure 2-13 notes typical example of the layout of a Scientific Station.

Procedures were established to assure that the accuracy of layout was within specified tolerances. The working point of a station was established by a measured angle and distance from a local control point. This working point was then occupied and check angles observed

In addition to the scientific programs, considerable survey time was expended at Eniwetok Atoll on the long range improvement program at sites Fred and Elmer. This effort included "as-built" surveys of existing construction to facilitate design of new improvements and the layout for construction of these improvements.

SCIENTIFIC STRUCTURES. The large number and variety of Scientific Stations subject to changes in design and location by Users were major construction layout items. These varied from location of moorings in the lagoon to layout of large concrete structures requiring the services of a survey party at intervals throughout construction. The laying out of the three UCRL pipe arrays were unusual surveys due to the large number of individual items to be laid out and then checked during construction.

ASSISTANCE TO INSPECTION. In-place checks were performed including the alignment of concrete forms, interior walls, and location of equipment. Settlement checks were made on major structures, and final cross sections were surveyed to bring causeways and earth fills over structures to design grade. Close relations were maintained with the Inspection Department to assure scheduling which would meet the daily construction requirements.

LAYOUT AND LOCATION OF SCIENTIFIC STRUCTURES.

ACCURACY OF LAYOUT. The layout of these structures was controlled by two factors: the

Figure 2-14. Precise Measurement Survey Party

to one or more additional control points. Figure 2-14 shows a precise measurement party at work and procedure used in holding on rear mark. The orientation of the station was checked, where possible, by direct observation to the primary station. Where this was not possible the orientation was checked by laying off computed angles from two or more local control points.

LAGOON STATIONS. Scientific Stations were moored in the Bikini Lagoon and in the Eniwetok Lagoon. Due to the mooring scope of these stations, a high degree of accuracy in location was not possible. A procedure was established which was satisfactory to the User and consisted of determining the location by the intersection of observed angles from existing primary control stations. Periodic inspection trips were made prior to tests to determine that these stations were in place and a number of replacement stations were located.

Figure 2-15. Measuring Chaining Bucks

LOCATION OF STRUCTURES. The local controls in the various areas were satisfactory for layout of the majority of the Scientific Stations following the procedure outlined above. Figure 2-15 shows a precise measurement party at work and the equipment they used to measure between two chaining bucks.

PIPE ARRAYS. The alignment of Stations 1203, 2220 and 2230 was an unusual survey assignment requiring the design of special equipment and establishing precise survey procedures to assure alignment within specified tolerances.

Station 1203 consisted of 12 pipe lines 7,500 feet in length at varying grades and offsets. The linear relation between the working points at the extremities of the array was required to be within a tolerance of 1:25,000. The alignment of the centerline of each pipe was specified to be within a tolerance of plus or minus one inch from a true line of sight between working points. The pipes were supported on hangers providing for horizontal and vertical adjustments at approximately 20-foot intervals totalling approximately 9,000 adjustment points.

The relation between working points at the extremities of the lines was determined by first order traverse methods. Precise differential levels were run over the line with bench marks established at approximately 450-foot intervals. A horizontal line of sight was established by precise methods operating at night to minimize the effects of refraction. These line points were set on observing towers at intervals along the line.

Vertical adjustments were accomplished by transferring elevations from the bench marks

Figure 2-16. Vertical Alignment of Pipe Arrays

to the individual supports and adjusting each pipe to a predetermined grade to which a correction for curvature of the earth had been applied. Figure 2-16 notes personnel and equipment used for the vertical alignment.

Horizontal alignment was accomplished by transferring the horizontal line of sight to the individual supports and applying the adjustments by horizontal measurement from the established centerline of the array. Figure 2-17 shows a precise level party using Zeiss level and Invar rods.

Figure 2-17. Precise Horizontal Alignment

The alignment of the pipes was checked by the User by two methods: one was a 200 power Cassegrain telescope and light probes, and the other a gamma ray source. Survey personnel worked with the Users in making these checks, and it was determined that it was practical to meet the alignment specifications by the survey procedure established for this purpose. In future projects of this type, the alignment procedure could be simplified by combining the use of the telescope with the conventional survey methods. Figure 2-18 notes survey personnel using a target light assembly for the alignment of pipes.

Station 2220 consisted of two pipes 5,600 feet long, and Station 2230 of two pipe lines 2,843 feet long. The alignment was accomplished by modification of the procedure used for Station 1203.

BARGE POSITIONING AND LOCATION. Procedures and horizontal controls were established previous to the tests to moor successively four test barges at a location in the Bikini Lagoon off the Dog-George area. Stations 30 and 40 occupied this location but the location of Station 90 was changed to the Charlie crater and Station 10 to the Flora crater at Eniwetok Atoll.

The procedure to position Station 30 consisted of mooring the barge at the intersection of predetermined theodolite angles from two reef stations whose precise interrelation was known. The positioning of four anchors was accomplished first by this method, the anchor cables, were connected to the barge and the barge was brought into position with winches. Then the locations and the movement of the working point around a fixed point was checked by repetition of observations from the reef stations. Radio communication was used to assure simultaneous observation of angles, and these observations were repeated at intervals and on successive days. The results of the observation proved that it was possible to meet the requirements of mooring and holding the working point of a barge within a two-foot radius circle. Thirty positions were observed on the working point of this barge on 11 April 1954 and 30 on 19 April. Coordinates were computed and plotted for each position and indicated that the working point was being held within a radius of one and a half feet of the assigned coordinates.

The mooring of Station 90 in the Charlie crater and of Station 40 in the vicinity of Station 30 location was accomplished under unusually difficult operational conditions. It was not possible to obtain accurate position or movement checks on these stations. The positions based on limited observations to existing Scien-

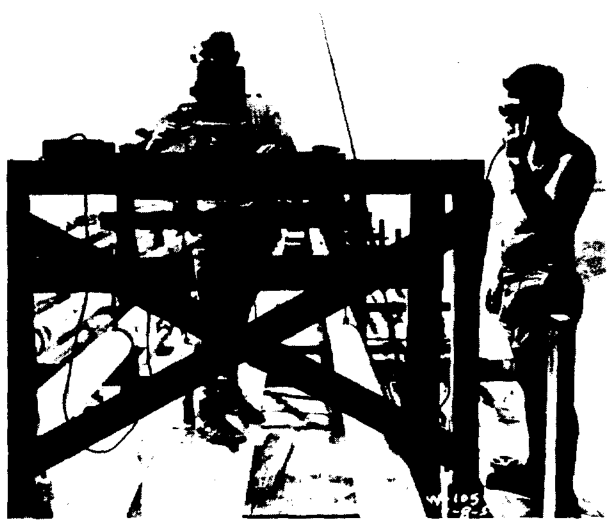


Figure 2-18. Target Light Assembly

tific Stations and ranges established for the post-blast survey of the Station 20 were accepted by the Scientific Group.

Station 10 was moved into the Flora crater, and its position and movement checked by the same procedures used for Station 30. Due to the late scheduling for moving this station to the Flora crater, it was not possible to re-establish precise control in the area by expansion from the primary network. However, satisfactory local control established during OPERATION IVY was recovered and assured the positioning of the barge to required tolerances.

SECTION 1B
TESTS AND INSPECTION

GENERAL

Operating as a part of the Engineering Division, the Test and Inspection Department, under the supervision of a principal engineer, was divided into two distinct sections - Field Inspection and Materials Testing. The primary function of the Field Inspection Section was to assure that all work performed and all materials used complied with the approved plans and specifications. The primary function of the Materials Testing Section was to undertake physical tests on construction materials and to assure physical compliance with specifications.

MATERIAL TESTING SECTION. The Material Testing Laboratory on Elmer was used as headquarters for the Test Section with a branch base for the Bikini Atoll located on Tare. The bulk of the work consisted in obtaining samples and testing construction materials such as cement, aggregates, concrete mixes and as-

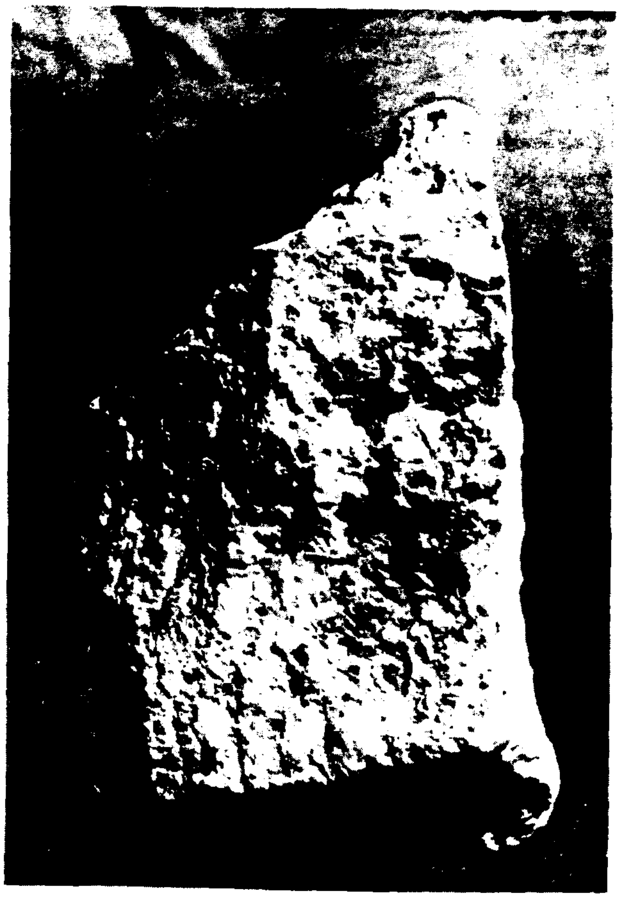


Figure 2-19. Coral Rock from Site Nan.

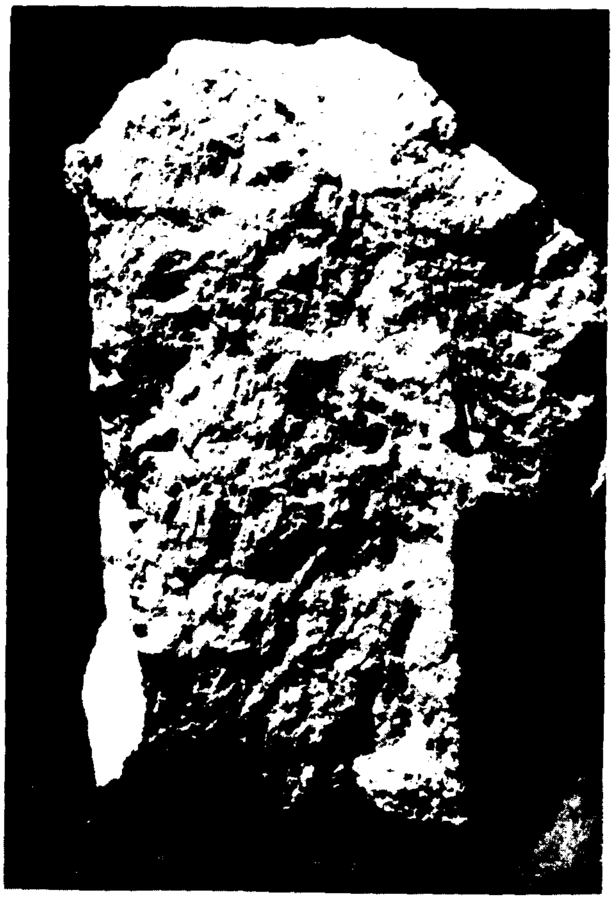


Figure 2-20. Coral Rock from Site Charlie

phalts. The major testing equipment was installed in the Elmer Laboratory although small branch laboratories were established on various islands on both atolls as required. Site Tare had equipment for making determinations of coral aggregate sieve analyses and moisture content; site Fred had a small laboratory for testing asphalt.

Aggregates for the concrete mixes were comprised of crushed coral rock with the addition of fine coral beach sand. Past experience in both OPERATION GREENHOUSE and OPERATION IVY showed coral deposits had wide variations in their specific gravities and in their percentages of absorption. The testing and control of these two factors are most important in the economical production of 2500 to 3500 psi concrete.

For OPERATION CASTLE, it was estimated in April 1953 that about 20,000 cubic yards of coral aggregate would be required for Bikini Atoll, and it was planned to stockpile the aggregate in about four or five separate areas in that atoll. This included an estimated yardage of 14,000 for the Scientific Program, plus yardage for camp construction and miscellaneous work and wastage. On 25 April 1953, explorations of the Bikini Atoll were started to determine the locations, characteristics and amounts of coral aggregate available. Samples were obtained and tests on these samples were completed on 3 June 1953. Excellent grades of aggregates were found on exposed reefs in the top three to eight feet at sites Charlie, Easy, Nan, and Oboe and these sites were selected as areas for stockpiles. Figure 2-19 shows the type of coral rock selected and used at Nan. The apparent specific gravity of this rock was 2.652 and the absorption was 1.00%. The heavier the rock, the denser the concrete. Absorption critically affects the ultimate strength of the concrete and should be kept to a minimum. If the absorption is excessive, the strength will be reduced as much as 50%. As far as is known, including U. S. Navy and the U. S. Department of Interior sources, the rock on Nan represents the highest in specific gravity and the lowest percentage of absorption of coral rock tested to date. Figure 2-20 shows the type of coral rock selected and used at Charlie. This rock was entirely different in appearance, structure and formation from the rock used on Nan. The apparent specific gravity for this rock was 2.63 and the absorption was 1.17%. As a yardstick for comparison, good structural coral rock will average an apparent specific gravity of 2.33 and an absorption percentage of 6.66.

The variations in the physical properties of coral rock, as noted above, required individual tests, computations and design mixes for each selected site. For computing and checking these design mixes, 630 test cylinders were cast and tested to destruction. Three and seven-day old cylinders were tested for comparative purposes and Figure 2-21 shows a seven-day break for aggregate procured at site Oboe. The length of the break is typical of coral rock. With a cement content of 6.5, 3430 psi was obtained in seven days. The lack of shear in the rock is likewise typical of seven-day tests. With the evaluation of these preliminary tests, final mixes were designed and tested. Figure 2-22 is a typical 28-day test. This cylinder, with a cement content of 6.5, broke at 4527 psi; 95% of the rock had been sheared. With such excellent coral rock and improved test results, it was possible to reduce the cement factor from 7.0 (used in OPERATION IVY) to an average of 5.8.

Figure 2-21. Seven Day Concrete Test Cylinder

In conjunction with the above tests, additional tests and surveys were made on coral concretes in regard to: (1) effect of temperature on curing rate; (2) effect of use of salt water in mixes; (3) use of admixtures; (4) methods of processing, including membranes; (5) study of variations of water content; (6) study of shear patterns.

Placement of concrete was required on 23 different island sites in the two atolls. Seven stockpiles and seven central concrete batch plants were established. Figure 2-23 shows the start of a typical stockpile. The fine aggregate pile is in the right foreground; the coarse aggregate is in the background.

With the placement of concrete, compressive strength cylinders were made and shipped to the laboratory at Elmer. A total of 800 cylinders were tested for quality. This amounted to one control cylinder tested for every 32 cubic yards of concrete poured during the Operation. A breakdown of the results obtained from testing these 800 quality-control cylinders from all classes of concrete is tabulated as follows:

Class of Concrete	Averages at 28 days Eniwetok sites	Bikini sites
2000 psi required	2453 psi	2546 psi
2500 psi required	2808 psi	3563 psi
3000 psi required	3943 psi	3612 psi
3300 psi required	3690 psi	3866 psi

The laboratory provided a variety of testing services other than mix design and quality control on concrete and concrete aggregates. An extensive series of soil plate bearing tests were

Figure 2-22. Twenty-eight Day Concrete Test Cylinder

Figure 2-23. Crusher Plant at Site Charlie

Figure 2-24. Broken Limonite Test Cylinder

conducted to provide design information for the improvements to the airstrip at site Fred and the Peter-Oboe airstrip.

Paint durability tests were conducted under the supervision of the laboratory; materials such as gypsum and plasticized sealers were tested for effectiveness; the breaking strength of cables and the working load of steel springs in tension and compression were determined. Services such as in-place soil density tests were provided for various User groups. The laboratory provided information for the design section in regard to effect of shear values on creosoted timbers. Materials for the construction of waste lines were tested for the distillation department for resistance to acids.

A careful check was maintained by the testing laboratory on the condition, storage and consumption of cement. When a new shipment of cement was received at Jobsite, samples were taken and tested in accordance with Spec. ASTM C-15-49. These tests consisted of fineness, soundness, loss of ignition, time of set and mortar strength tests.

Limonite (which is heavy weight shielding concrete) amounting to slightly less than 500 cubic yards was again placed during the current Operation. With the experience gained during the GREENHOUSE project and a further program of tests and mix designs for CASTLE, no particular difficulties arose. Limonite concrete pours were somewhat slower than coral concrete pours because the weight of a batch of this type of concrete necessarily reduced the capacity of the concrete mixers. Although more cement per yard was utilized in these mixes than in coral concrete mixes, no adverse thermal cracking was noted. Figure 2-24 shows a broken limonite cylinder. This cylinder broke at over 3500 psi and yet it will be noted how little, if any, bond exists between the scrap steel and limonite ore grout of which the heavy shielding concrete is composed. A limonite concrete mix was designed to produce a unit weight of 312 pounds per cubic foot for a small "cushion" without increasing mixing and placing difficulties. Compressive strengths in excess of 3000 psi were realized from these dense mixes but the amount of mixing water had to be sharply restricted to produce the required unit weights. Compressive strengths and unit weights obtained on the limonite concrete pours were good. The results of all the limonite concrete test cylinders show that an average compressive strength of 3259 psi was obtained at ages of 28 days. The in-place unit weights of limonite concrete structures were checked by carefully calculating the capacity of the forms and comparing the volume with the number and weights of all batches of concrete going into a particular pour. Very close or exact agreements were obtained between the unit weight of the mix design and the calculated in-place weight. Figure 2-25 shows a foundation for a Scientific Station. At the right has been

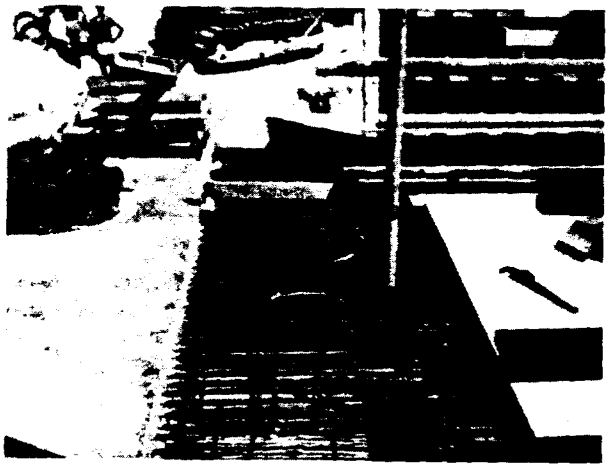


Figure 2-25. Limonite Blast Wall for Station 1342

poured a regular coral concrete pour. The reinforcement shown is for limonite concrete and this reinforcement must be continuous. In order to remove the forms for the regular concrete, an opening was burned out as shown in the center. With the forms removed, the reinforcing bars were replaced over the opening and welded in place.

FIELD INSPECTION. The Field Inspection Section inspected all phases of construction work from the first clearance and grading until final completion and acceptance. The preliminary work consisted of studying plans and specifications, bills of materials and any special conditions. Materials were then checked for conformance with specifications and adequacy of amounts on hand and available. The procedure of work, manpower and equipment to be used was usually decided in conference with the work superintendents involved. With the commencement of work, inspection was continuous. Excavations and foundations were inspected for location, dimensions and orientation; forms were checked for adequacy; reinforcing rods were checked for size, bends, spacing, ties and rigidity of support; embedded fixtures were checked for location and size. The placement of concrete was inspected to insure a well-compacted, and well-bonded and smooth, dense concrete. Inspection after placement, removal of forms and backfilling was likewise continuous. With the structure formed, inspection on electrical, sanitary, mechanical, piping and similar work followed.

As to deviations, the very existence and surveillance of active inspection was a deterrent to careless workmanship, particularly since it was backed by top management and respected by supervision. Its chief function thus became a reporting agency to the superintendent, who rectified unsatisfactory conditions directly and promptly. Authority of the inspection service to correct deviations from plans and specifications was not, however, limited to this level. If conditions were not rectified, the Resident Inspector would notify the Chief Inspector who would refer the matter to the Resident Engineer. The Resident Engineer would then investigate and recommend action to be taken by the project Manager. His discretion was used to expedite construction and insure integrity of the work not only by enforcement of remedial measures, but also by adjusting to material shortages and functional changes by effective and controlled substitution.

Safety inspection was assigned as an additional duty to all Field Inspectors. The Safety Engineer gave all inspectors a series of safety lectures defining the required safety standards, operating practices and working conditions. He also issued to them various types of safety manuals, especially in regard to safety practices in construction, vehicles and job hazards. Jobsite procedure provided that inspectors could hold up work on a project if unsafe practices were involved, until the unsafe conditions were rectified.

With work being undertaken at so many sites and locations, and in order to have uniform standards, detailed procedures were set up in regard to:

1. Approval of construction changes.
2. A weekly construction progress report noted the percentage of completion of all outstanding work orders and completion dates for same.
3. Weekly inspection narrative report, a condensed summary of pertinent inspection items noting the difficulties, delays and other factors affecting the progress of the work.
4. Inspectors' "as-built" corrections, the procedure to be followed in maintaining prints in an up-to-date condition and marking all variations.
5. Concrete design mix, specifying to Construction the amounts of the various

ingredients to be used for particular purposes.

6. Concrete placement approval, informing Construction that Inspection had checked all items and approved the work as ready for placement of concrete. This permitted reasonable control to avoid any unauthorized or unscheduled pours which are prone to occur where widely scattered operations are involved.
7. Inspection punch list, used by inspectors to note items of work yet to be accomplished or corrections required.
8. Completion report, the final notice by Inspection that all work was completed and met requirements.
9. Inspectors' check-off list, similar to the check-off list as used by the U. S. Army Engineers for inspection. This check-off list represented the minimum requirements of the inspection standards.
10. In addition, a daily log or diary was maintained by each inspector and by the Material Testing Laboratory.

Mechanical and electrical features for Scientific Stations were tested for operation to the satisfaction of the User.

SECTION 2
CONSTRUCTION

Preliminary consideration of construction for OPERATION CASTLE was inaugurated in June 1952 when a request was received from the Field Manager for a reconnaissance and report for facilities on Bikini Atoll. This request resulted in a careful study of construction equipment and other long delivery items for the purpose of evaluating the capability of carrying on construction work at two widely separated sites, Eniwetok and Bikini. Since reinforced concrete construction was to be one of the major items, the requirements for large scale aggregate production equipment were finalized and orders placed for the delivery of two crushing and screening plants.

In September 1952 a directive was received to proceed with the establishment of a beachhead camp on site Tare at Bikini and the construction of a 250-man temporary camp capable of being expanded to a 1000-man camp, a 4500-foot by 150-foot airstrip with connecting causeways, and beaching facilities for LSTs and smaller marine craft. Since this requirement occurred as the construction phase of IVY was drawing to a close, it was possible to staff the initial Bikini effort with manpower and equipment as it became surplus to the needs of the work at Elmer, on Eniwetok Atoll.

In November 1952 a directive was received from the Field Manager to establish a temporary 200-man camp at Ursula and to proceed with the filling of the Ruby Crater to create usable land. Figure 2-26 shows the radioactive crater partially filled on Ruby. This picture was taken on 25 March 1953 and work was underway to lower the radiation level. This work was complicated by the fact that the average radiation level in this area was 50 to 95 mr per hour in December, necessitating close Rad-Safe control over men working in this area. Some experimental work was done toward decontaminating the areas and it was found that the most satisfactory results were obtained by removal of vegetation and up to 12 inches of the top soil in areas affected. Attempts to decontaminate concrete slabs in the camp by flushing with salt water were not too satisfactory in that most of the readily removable or soluble irradiated particles had been already washed off by normal rains. The early stages of construction were carried on by forces based at Elmer and flown into Ursula each morning by plane. Later the forces were based on an LCU equipped as a house boat. By May 1953 the radiation level had been lowered by decontamination and decay to a point that allowed the forces to live ashore in a camp indefinitely, within allowable dosage.

These two requirements for camps provided the pattern for planning bases of operation for CASTLE. The entire scope of the Scientific Program was not known at this time; however, enough information was available in January 1953 for preliminary planning of requirements for manpower, construction materials, air and surface transportation, communications, shipping, and construction equipment. Advance material estimates were prepared and orders placed for common usage construction materials and additional equipment.

In April 1953 the scope of Scientific Structure construction for CASTLE was well delineated for both atolls, and final scheduling of the work, location of the concrete batching plants, establishment of material stockpiles, allocation

Figure 2-26. Radioactive Crater - Site Ruby

Figure 2-27. Aerial View of Sites Dog and Easy

of construction equipment and manpower could be projected.

On Bikini Atoll, the construction program ultimately far exceeded the preliminary planning. Additional tests were scheduled, including three barge tests which required several additional major reinforced concrete structures. On Eniwetok Atoll, a Barge Slip and Assembly Area at Elmer and the scientific work required in the Ruby-Sally area likewise exceeded the preliminary planning. Additional work also included a large scale paving project for the additional airstrip requirements and Air Force Buildings on Fred.

This additional work required a further review of construction equipment requirements. The asphalt paving equipment was in very poor condition. It had been acquired as used equipment in 1949 and had been subjected to a great deal of use in previous Operations and required replacement. New equipment of the traveling type was purchased which was more adaptable

Figure 2-28. Aerial View of Site Able

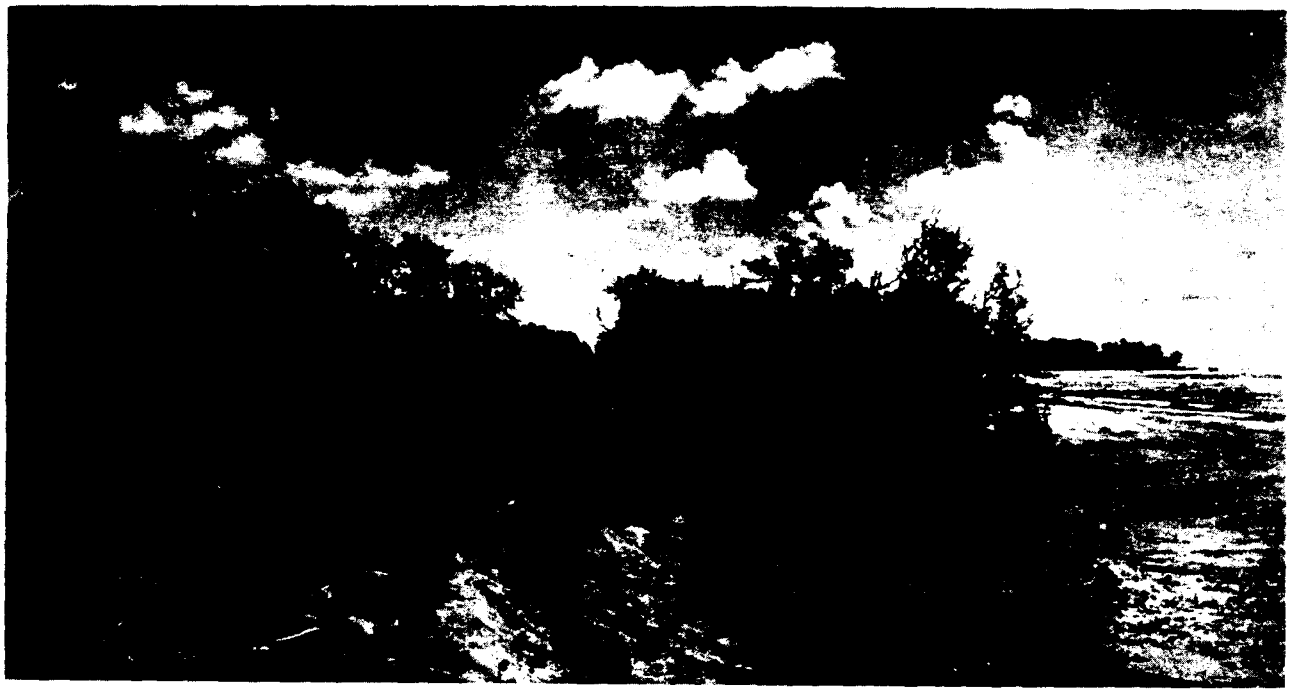


Figure 2-29. Typical Island Undergrowth

to the various types of work at the PPG. A much lower capital investment was likewise involved. Because of the distribution of this work the decision was made to establish temporary camps with marine landings, helicopter pads, shops and warehouse facilities at Charlie, Fox, Nan and Tare. It was also necessary to provide an entrance channel to Able and to connect the Dog-George group with a causeway. Figure 2-27 is an aerial view of sites Dog and Easy and notes conditions there on 11 June 1953. Figure 2-28 is an aerial view of Able prior to operations on 11 June 1953. Figure 2-29 shows typical island undergrowth that was encountered in all beach landings. This photograph shows the original campsite selected for site Charlie as it was on 6 April. Figure 2-30 shows this undergrowth cleared and a typical beachhead camp established by 11 June.

Figure 2-30. Beachhead Camp - Charlie

Coral aggregate quarries were located at each of the camp sites and production of aggregate was started early in April. To obtain coral rock, the ocean reefs were drilled for four feet and then blasted. Figure 2-31 shows the equipment used for drilling the reefs at Elmer. The rock was then crushed to sizes desired and stockpiled. Figure 2-32 notes the production of aggregate at site Easy. Two crushing plants were available at Bikini Atoll for producing aggregate at four locations and one plant was available at Eniwetok Atoll for production at three locations. Having the equipment available for an early start on this work aided in meeting scheduled construction dates. Figure 2-33 pictures the batch plant at site Oboe.

The Operation presented a very tight construction schedule which was further complicated by the simultaneous release of the major items of Scientific Structures. This placed a high production requirement on the bending and placing of reinforcing steel, preparation of forms and pouring of concrete.

Due to the complexity of the work at Bikini it was necessary to set up an organization at the Tare camp similar to the base organization at Elmer. In this way the full support of the various departments at Elmer could be utilized in operating the base at a remote site. The other temporary camps were placed under the direction of an Assistant Superintendant.

Figure 2-31. Drilling Reef for Coral Rock

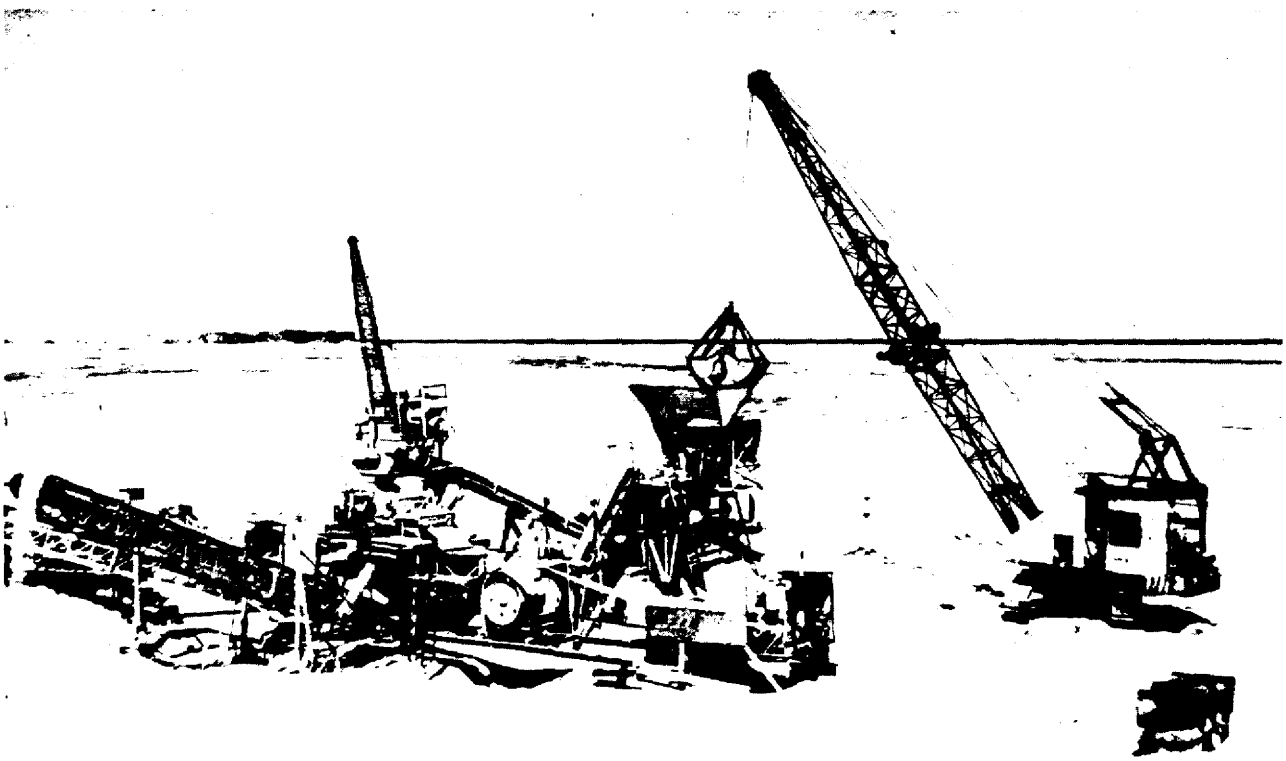


Figure 2-32. Crusher and Hopper Plant - Site Easy

Figure 2-33. Batch Plant - Site Oboe

Figure 2-34. Temporary 50-Man Camp - Site Nan

Figure 2-34 shows a temporary 50-man camp located on site Nan as of 14 September.

One of the most difficult problems experienced was that of scheduling the use of construction equipment since sufficient equipment was not available to outfit adequately the construction crews at each camp. This was especially true of concrete placing equipment, cranes, trucks and earth moving equipment. The problem was overcome by carefully planning the equipment usage for each phase of the construction of each structure with the idea of fully utilizing all equipment. This involved considerable movement of the equipment between camps at each atoll in order to have it available when required. It also required rigid scheduling of the various crafts in order that the placement of reinforcing steel, electrical, mechanical and other related items would fit the plan for equipment usage.

Considerable movement of construction personnel between camps was also required in order to utilize fully the restricted manpower available in several of the various crafts. Careful planning of these movements was necessary to maintain the construction and equipment usage schedule, but the actual shifting of personnel between camps created no problem.

Delivery of materials to construction areas spread over two atolls required very careful planning. The main receiving and warehousing facilities were maintained at Elmer on Eniwetok, and all surface and air freight was shipped to that point except for some easily identified items which were off-loaded at Tare, on Bikini. From this central point at Elmer materials were transshipped to warehouses at Ursula and Fred by LCMs and LSUs and to Tare by LST. From Tare, materials were again transshipped to warehouses at Charlie, Fox and Nan by LCMs or LSUs. This movement of material from its original point of receipt to its final location was always critical due to the tight construction schedule.

The entire construction program was projected on an Estimated Operations Schedule which programmed each item of work from design through procurement to the completed structure ready for occupancy. This schedule was prepared in the Home Office based on the known requirments; the Chief Project Engineer established completion dates for design and drawings which would give the Procurement Department the necessary information for scheduling the purchase and delivery of materials and equipment. With this information the Project Manager and Chief of Operations planned the actual construction. The schedule was reviewed monthly by all concerned so that corrective measures could be taken as required to insure completion of the drawings and delivery of materials as planned.

The major difficulty Construction experienced was the late receipt of approved working drawings for the Scientific Stations. This in turn was due to the late receipt of design criteria. The dates in February, March and April of 1953 scheduled and set for the development and submission of criteria by the Scientific Using Agencies were not met.

Construction schedules were essentially met however, even though an additional test barge and a major recorder structure were added to the program in September. The completion of the work gave the User a chance to schedule his equipment installations with a minimum of interference from the constructing forces.

The authorized work week on both atolls was 54 hours. Any overtime work in excess of 54 hours required prior approval and authorization. Overtime work in excess of 54 hours was required at intermittent intervals for unloading ships (off-shore), for marine craft operators, for handling supplies ashore, for camp operation, for special services, and, to a very limited extent, for actual construction work on the Scientific Program. The entire overtime pay in excess of 54 hours averaged less than one percent of the total payroll. The actual construction overtime was therefore negligible.

The construction progress of Expendable Construction, based on the Estimated Operations Schedule as noted above, is shown by Charts 2-1 and 2-2. It will be noted that in general the contract items were substantially completed by their scheduled dates. The summary in Chart 2-2 notes that schedules were met by February 1954 and then maintained for the balance of the Operation.

This condition is likewise reflected in the progress curve for the over-all program as shown in Chart 2-3. The estimated schedule in May 1953 was predicated on the receipt of design criteria and working plans. With the increase in the scientific work load and having received the majority of the criteria, the estimated schedule was revaluated on 15 November 1953. The break noted in the curve for April 1954 resulted from additional work authorized in March 1954 for such items as A-67-C and A-74-C. As Chart 2-3 is based on percentage of completion, the additional scope of work is reflected in the percentages of estimated and actual completion.

The over-all costs were appreciably less than was estimated. This is shown in Chart 2-4 where the actual commitments are less than the estimated commitments. It will be noted that the actual commitments exceeded the estimated commitments from 1 June 1953 to 15 November. This was due to the fact that the estimated commitments were based on the preliminary planning. As additional tests and structures were authorized and the scope of work was expanded, increased costs were reflected in actual commitments. In November, with the work load stabilized, the estimated commitments were revaluated for the balance of the Operation.

It was not necessary to slow down or to accelerate construction work. It will be noted in Chart 2-3 that a constant rate of progress was maintained from 15 September 1953 until 1 February 1954. Surplus manpower, when it occurred, was utilized in the permanent construction program, Projects 3028 and 4015. The rate of progress, to some extent, may likewise be determined by the yardage of concrete poured. As shown in Charts 2-5 and 2-6, a constant rate of pouring was maintained from 1 September to 1 December. The increase noted for April and May at Eniwetok was due to additional authorized items of work, as example, Item A-74-C, Sea-Wall at Fred.

SECTION 3
PERMANENT CONSTRUCTION

Permanent construction is listed under Budget Projects 3028 and 4015. The cut-off date for reporting permanent construction is dependant upon the date the project is completed and does not necessarily coincide with the completion date of the scientific construction. At the commencement of OPERATION CASTLE (1 January 1953), Project 3028 was 79.08% completed. At the cut-off date for OPERATION CASTLE (15 May 1954), Project 4015 was 86.74% completed. These budget projects are reported upon the completion of each budget project and include final cost data.

A large percentage of this permanent construction was required due to increases in operational population at both Elmer and Fred. Additional barracks, mess hall additions, laundry additions, additional sewers, water facilities, electrical facilities, communications facilities, were included. Additional warehouses, shop additions, and fifty-three miscellaneous permanent construction items were likewise required. The majority of this work was accomplished concurrently with the test program.

SECTION 4
EXPENDABLE CONSTRUCTION

FOREWARD

This section comprises all expendable construction and is reported in numerical sequence of the contract item number, with the following exceptions:

Contract Item Number	Description	Reported in
A-26	Causeways	Chap. 2, Sec. 6
A-27	Scientific Structures	Chap. 2, Sec. 5
A-29	Interisland Cables	Chap. 2, Sec. 7

CONTRACT ITEM NUMBERS A-1 THRU A-24 - TARE CAMP

GENERAL. The Tare Camp was started in October 1952. A temporary beachhead was established and facilities were laid out for a 250-man camp. This included a pier and an LST landing ramp. Figure 2-35 notes the progress in construction by February 1953. The original beachhead camp is shown on the extreme right. Figure 2-36 shows the pier under construction in February. Tentative approval was obtained in January 1953 to use the Tare Camp as a base for the Bikini Operations with smaller outlying construction camps at other sites on the atoll as required. At that time it was estimated that facilities for 1000 men would be required at site Tare. On 18 February authorization was received for the layout of this 1000-man camp, and design work, including supporting facilities, was started by Field Engineering. On 16 March construction was authorized. On 27 March, authority was granted to requistion standard basic materials in order to expand the camp to 1500 men. Figure 2-37 notes construction progress as of 7 April. Figure 2-38 shows the enlarged Mess Hall as 91% completed on 10 June and Figure 2-39 shows the camp area and construction progress by 11 June. Figure 2-40 shows the exterior of the completed Chapel. Plans for an ultimate potential expansion to 1500 men were prepared in June in case the operation might require that population. This

		1953												1954						
ITEM	DESCRIPTION	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	REMARKS
A-1 THRU A-24-C	TARE CAMP - (1,000-MAN)	47.28	54.41	61.56	77.44	83.97	89.57	90.57	91.57	92.10	92.19	99.22	100.00							
		47.49	54.41	61.55	75.77	83.79	88.65	92.10	95.07	98.48	98.70	99.22	99.80	100.00						
A-1 THRU A-24-C	TARE CAMP ADDITIONS							25.00	30.00	35.00	40.00	47.36	91.42	100.00						
								25.00	50.00	76.00	50.34	47.96	54.11	97.97	98.33	100.00				
A-25-C	AIRSTRIP - OBOE-PETER	60.00	65.00	74.00	75.00	88.89	90.00	100.00												
		60.04	68.46	73.82	76.47	88.00	89.68	90.00	90.00	99.00	100.00									
A-26-C	CAUSEWAYS							28.13	56.26	60.00	65.00	98.71	99.00	99.50	100.00					SITES CHARLIE & TARE
								53.00	84.00	98.00	98.43	98.71	98.71	98.71	100.00					
A-27-C	SCIENTIFIC STATIONS						0.75	6.91	16.06	32.53	45.00	53.84	79.61	95.60	99.89	100.00				
							0.50	0.83	3.13	12.73	23.85	53.84	69.33	93.78	99.91	99.91	99.99	100.00		
A-28-C	CONSTRUCTION EQUIPMENT																			PROCUREMENT ONLY
A-29-C	SUBMARINE CABLE							8.34	16.00	25.00	35.00	45.88	75.00	95.95	98.94	100.00				
								0.00	0.00	2.00	46.01	45.88	69.49	88.50	97.31	98.28	100.00			
A-31-C	URSULA CAMP	27.11	57.95	67.93	82.13	93.37	95.00	98.00	99.88	99.88	99.88	99.88	100.00							
		10.79	58.83	67.30	84.94	84.94	92.00	98.69	99.88	99.88	99.88	99.88	99.88	99.88	100.00					
A-32-C	CRATER FILL - RUBY		16.67	50.00	83.33	100.00														
				10.00	99.00	100.00														
A-33-C	MISC. CONSTRUCTION - ALL SITES	5.55	11.10	16.65	22.20	27.75	33.30	38.55	44.40	97.36	97.36	99.58	100.00							ALL WORK AUTH. PRIOR TO 1 JULY 1953
		5.55	11.10	16.65	22.20	27.75	33.30	38.55	44.40	97.36	97.36	99.58	99.58	100.00						
A-34-C	SPECIAL ENGINEERING REPORTS																			ENGINEERING ONLY
A-35-C	AIRPORT FACILITIES - PETER				33.33	66.67	90.00	99.00	99.00	99.00	99.00	99.54	100.00							
					4.47	65.06	95.80	99.00	99.00	99.00	99.00	99.54	99.94	100.00						
A-36-C	CHARLIE CAMP				9.31	30.50	48.71	76.83	89.60	99.00	99.00	99.00	100.00							
					12.00	25.39	60.89	85.01	96.37	99.00	99.00	99.00	99.00	99.67	100.00					
A-38-C	FURNITURE & FIXTURES - ALL SITES																			PROCUREMENT ONLY
A-39-C	TEST SUPPORT FACILITIES - ELMER							11.11	22.22	33.33	44.45	78.10	80.00	90.00	95.00	100.00				
								11.11	22.22	33.33	35.21	78.10	30.51	99.00	99.70	100.00				
A-39.3	DISTILLATION UNITS - ELMER																			PROCUREMENT ONLY

LEGEND
CONSTRUCTION SCHEDULE ESTIMATED PERCENT
CONSTRUCTION IN PLACE PERCENT COMPLETED

Chart 2-1. Construction Progress - Estimated and Actual
Contract Items A-1-C through A-39.3-C

		1953												1954						
ITEM	DESCRIPTION	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	REMARKS
A-40-C	TEST SUPPORT FACILITIES - FRED							6.00	12.00	18.00	24.35	35.21	85.67	90.67	95.89	100.00				AWAITS MINOR ELECT. INSTALLATIONS
								6.00	12.00	18.00	24.35	35.21	99.16	86.06	88.78	91.17	93.50	99.68	99.87	
A-40.1-C	AIRSTRIP IMPROVEMENTS - FRED						2.00	3.00	4.00	5.00	35.00	60.00	100.00							
							2.00	3.00	5.00	5.50	50.00	50.00	88.00	96.00	100.00					
A-40.2-C	ADDED DISTILLATION PLANT - FRED								8.00	20.00	25.00	30.00	75.00	93.00	100.00					
									7.00	14.00	25.00	30.00	45.00	100.00						
A-44-C	INCIDENTAL CONSTRUCTION - ALL SITES									2.00	16.00	35.00	60.00	85.00	100.00					
										2.00	16.00	35.00	60.00	85.00	100.00					
A-57-C	NAN CAMP						16.67	20.00	30.00	6.00	40.00	50.03	100.00							
							15.00	35.00	35.00	6.00	38.12	50.03	55.32	91.80	100.00					
A-63-C	FOX CAMP						2.00	5.00	40.00	80.00	96.00	99.91	100.00							
							2.00	5.31	38.33	76.00	96.56	99.91	99.91	100.00						
A-64-C	P.O.L. FACILITIES - SUGAR							10.00	20.00	50.00	86.00	93.00	100.00							
								10.00	20.00	56.00	86.00	93.00	93.00	98.00	100.00					
A-65-C	EQUIP. (NOT IN CONST. PROJECTS)																			PROCUREMENT ONLY
A-67-C	MISC. CONSTRUCTION (EXPENDABLE)							2.00	5.00	10.00	16.00	25.00	35.00	50.00	65.00	75.00	85.00	95.00	100.00	ALL WORK AUTHORIZED AFTER 1 JULY 1953
								2.00	5.00	10.00	16.00	25.00	35.00	50.00	65.00	75.00	85.00	95.00	100.00	
A-68-C	J.T.F.-SEVEN CONSTRUCTION - FRED										40.00	64.73	100.00							
											18.15	64.73	81.38	81.38	98.34	99.96	99.96	100.00		
A-69-C	CRYOGENICS FACILITIES																			ENGINEERING ONLY
A-69.1-C	SLAB-CAB MOCK-UP - U.C.R.L.																			ENGINEERING ONLY
A-70-C	RADIO COMMUNICATIONS - ALL SITES										1.00	1.23	100.00							
											1.00	1.23	53.31	74.78	100.00					
A-72-C	SUBMARINE CABLE TO BUOYS - ALL SITES													46.40	100.00					
														46.40	100.00					
A-74-C	SEA WALL - FRED															31.00	75.00	100.00		
																31.00	67.00	91.00		
	SUMMARY OF EXPENDABLE CONST.	7.78	9.44	11.19	14.01	16.54	19.22	29.03	39.63	53.23	60.00	64.71	84.69	95.38	98.97	99.54	99.72	99.91	100.00	
		7.59	9.38	10.66	14.10	16.20	19.31	24.15	29.72	34.21	45.42	64.71	77.25	93.88	98.93	99.22	98.72	98.48	99.89	

LEGEND

CONSTRUCTION SCHEDULE ESTIMATED PERCENT

CONSTRUCTION IN PLACE PERCENT COMPLETED

Chart 2-2. Construction Progress - Estimated and Actual
Contract Items A-40-C through A-74-C

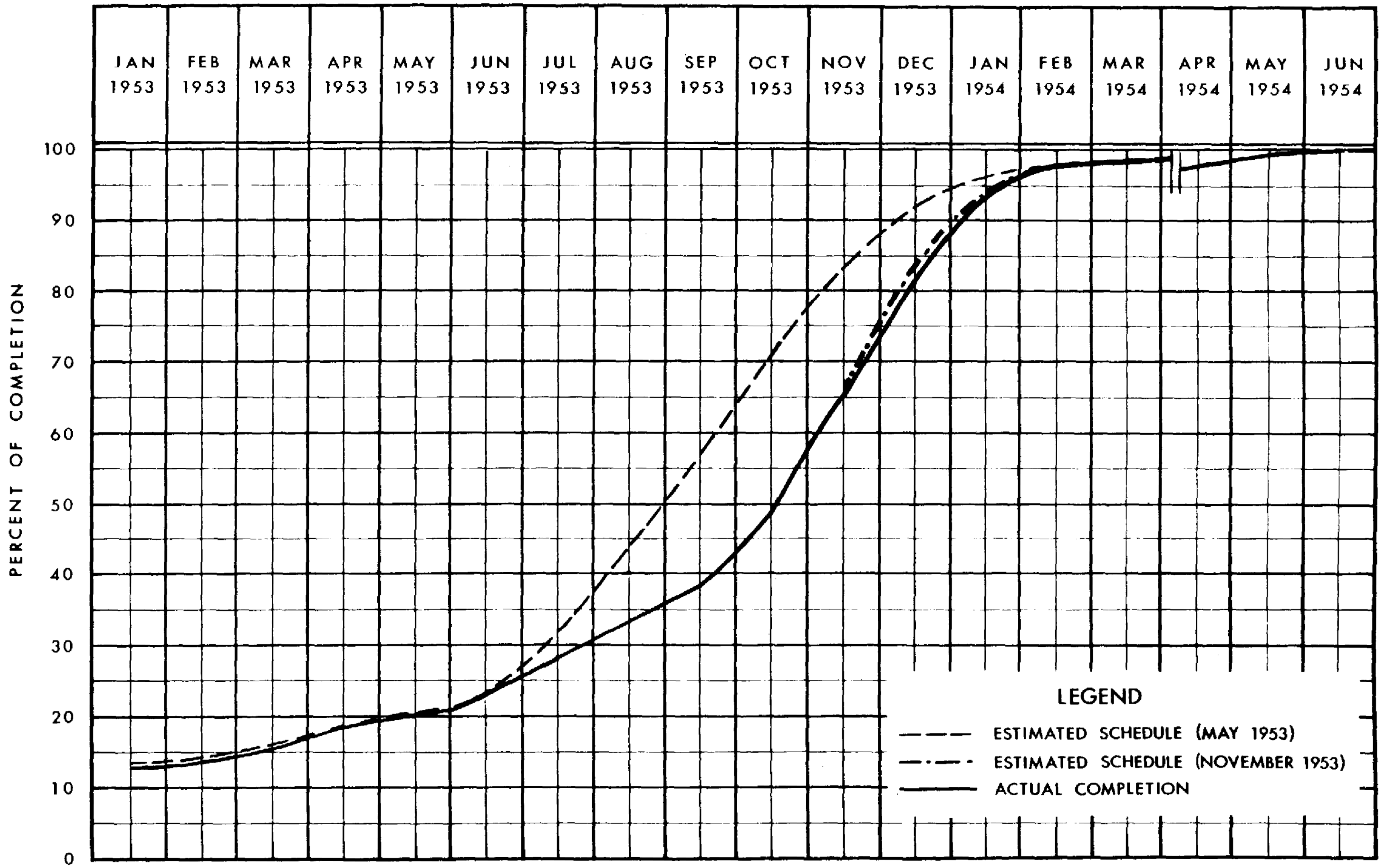


Chart 2-3. Construction Progress Curve - Over-all Program

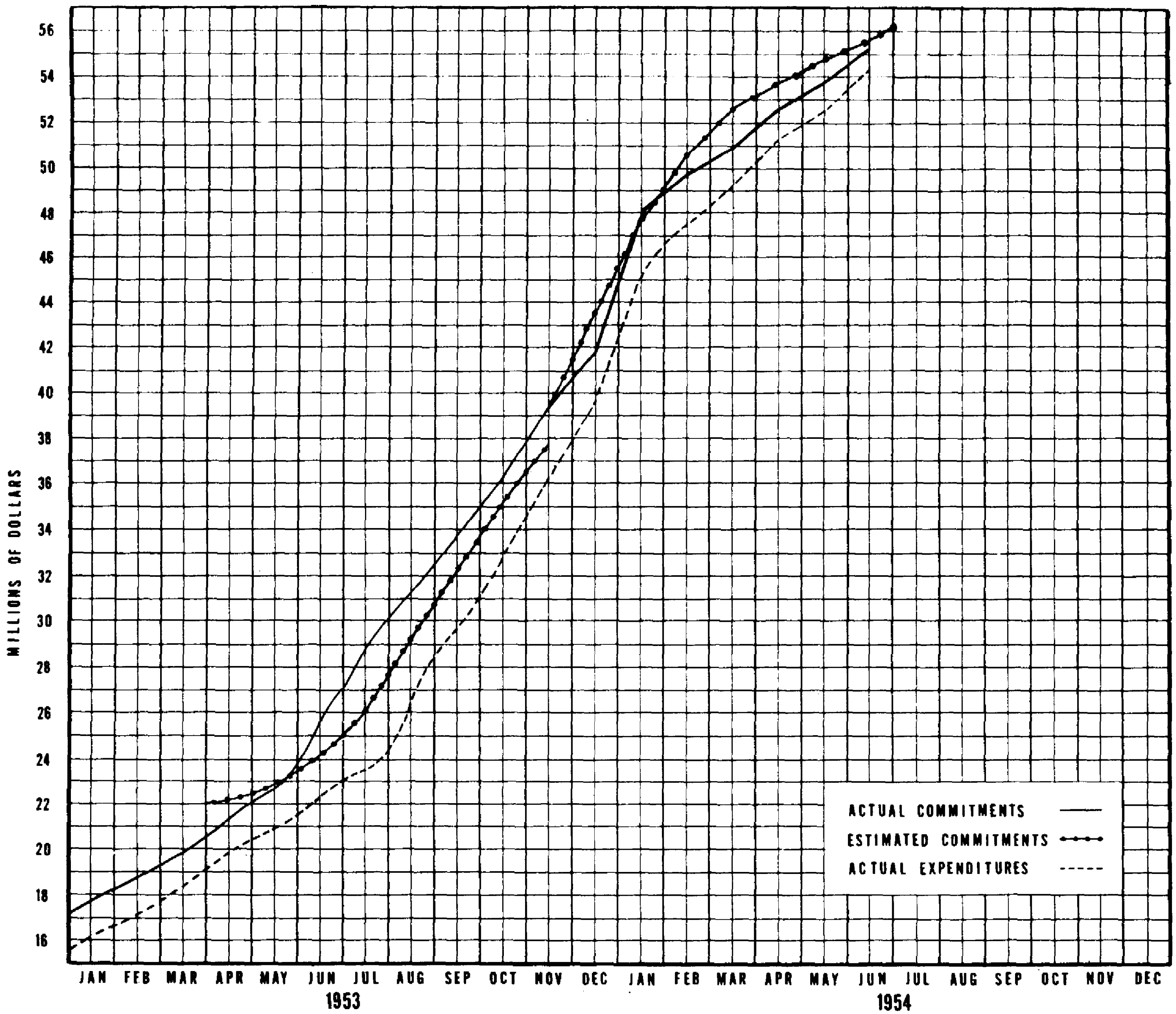


Chart 2-4. Expenditures and Commitments

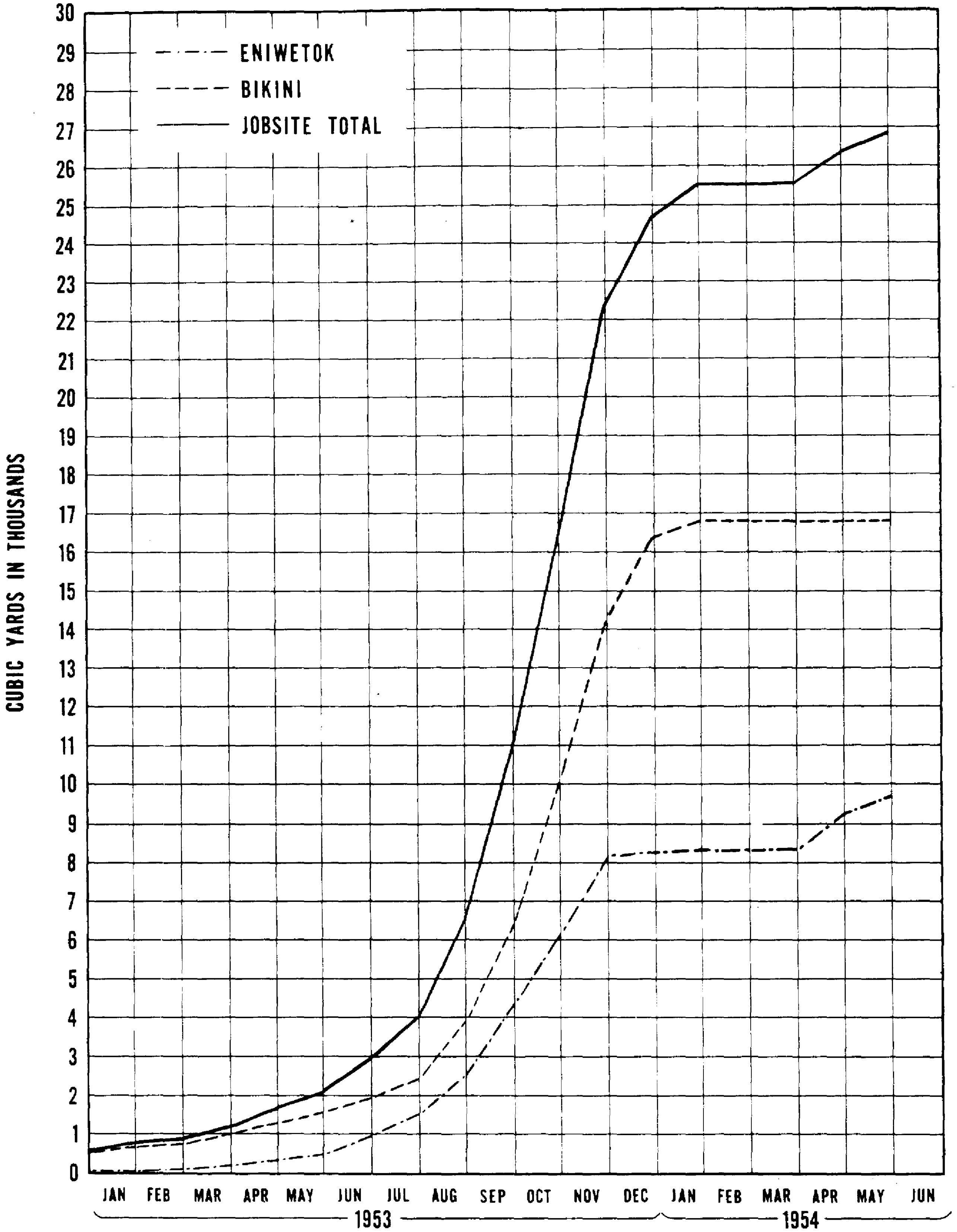


Chart 2-5. Accumulated Monthly Totals Concrete Poured

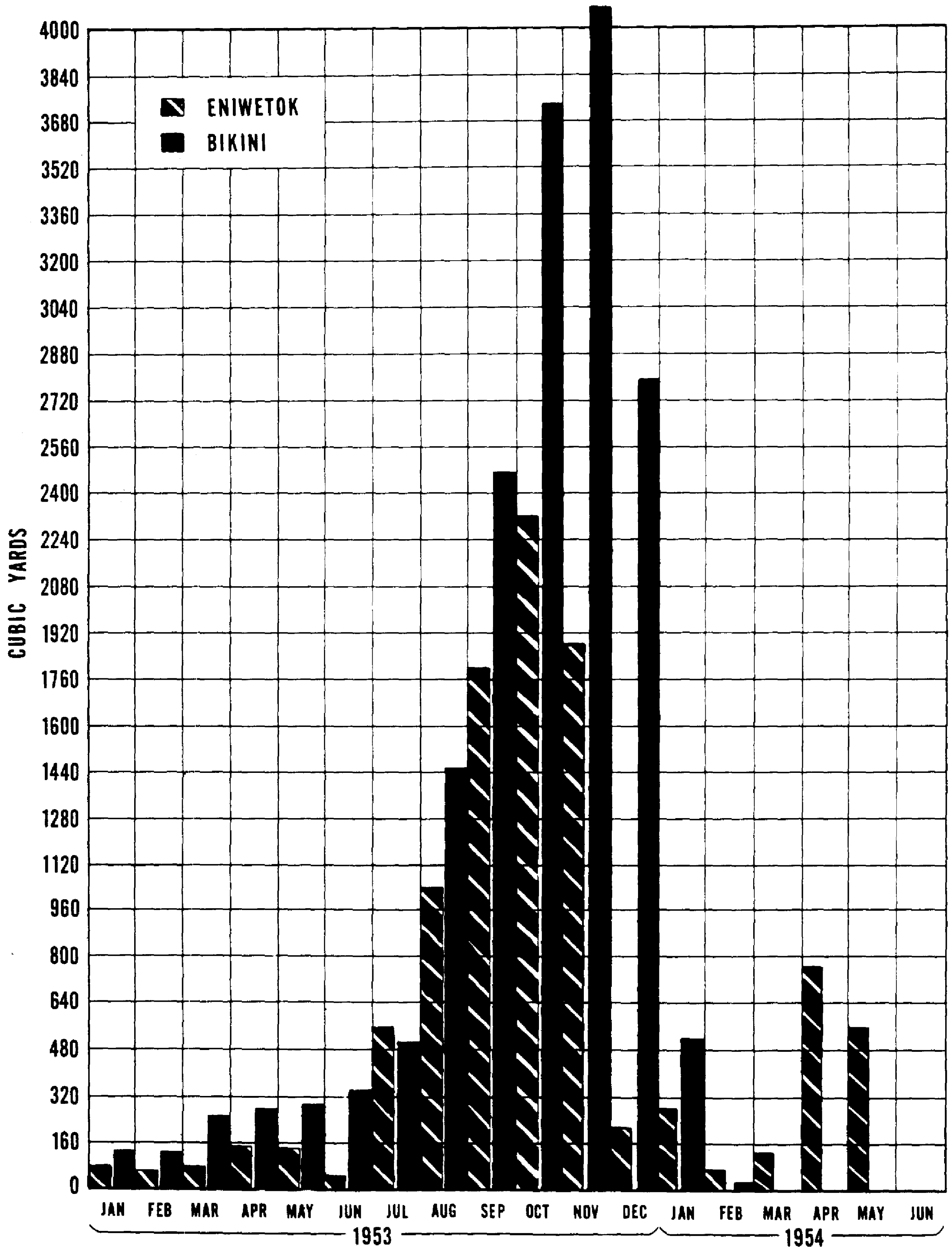


Chart 2-6. Monthly Totals Concrete Poured - Both Atolls

Figure 2-35. Tare Camp - February 1953

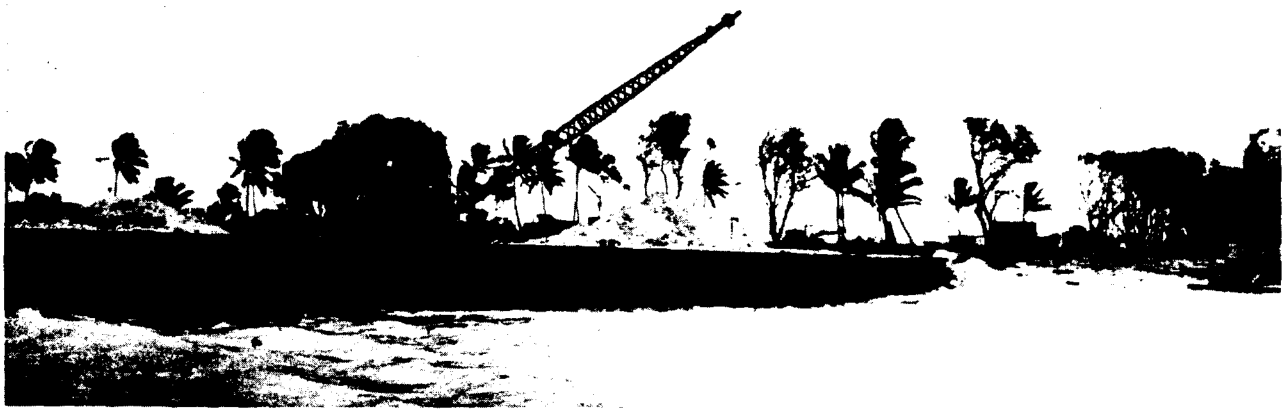


Figure 2-36. Tare Pier Under Construction

Figure 2-37. Progress Photograph 7 April 1953

Figure 2-38. Tare Mess Hall

Figure 2-39. Progress Photograph 11 June 1953

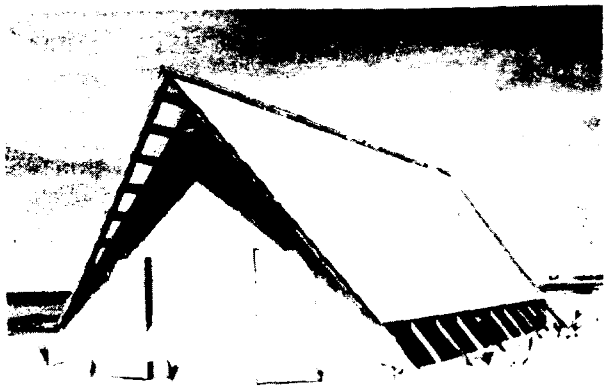


Figure 2-40. Chapel - Site Tare

work was not undertaken as the population of the Tare camp never reached 1000 men.

ENGINEERING. The design requirments were basically the same as other temporary expendable camps, using wood-frame construction with plywood covering on concrete slabs, prefab wood trusses, corrugated aluminum roofs, and shutter windows. Painting was used only on the interiors of the infirmary and mess hall, also on back boards and shelves in latrines. Typical details and layouts, using a standard width and a module of four-foot increments were developed for such buildings as warehouses, latrines, shops, mess hall, etc., making for quick and economical erection. The Field Engineering Division prepared the camp layout studies and processed the construction plans, developing typical designs used in construction of the various facilities. The Tare camp was used as the headquarters camp for Bikini Atoll and for the construction of Scientific Stations located on sites Tare, Sugar, Roger, Peter and Oboe, and for the Peter-Oboe Airstrip. Figure 1-5 is a plan view of the camp.

CONSTRUCTION. Construction started on this camp immediately upon authorization and the work progressed continuously from the beachhead camp on through the expansion, with no major construction problems, to final completion on 31 December 1953. Figure 2-41 is an aerial photograph of the completed camp.

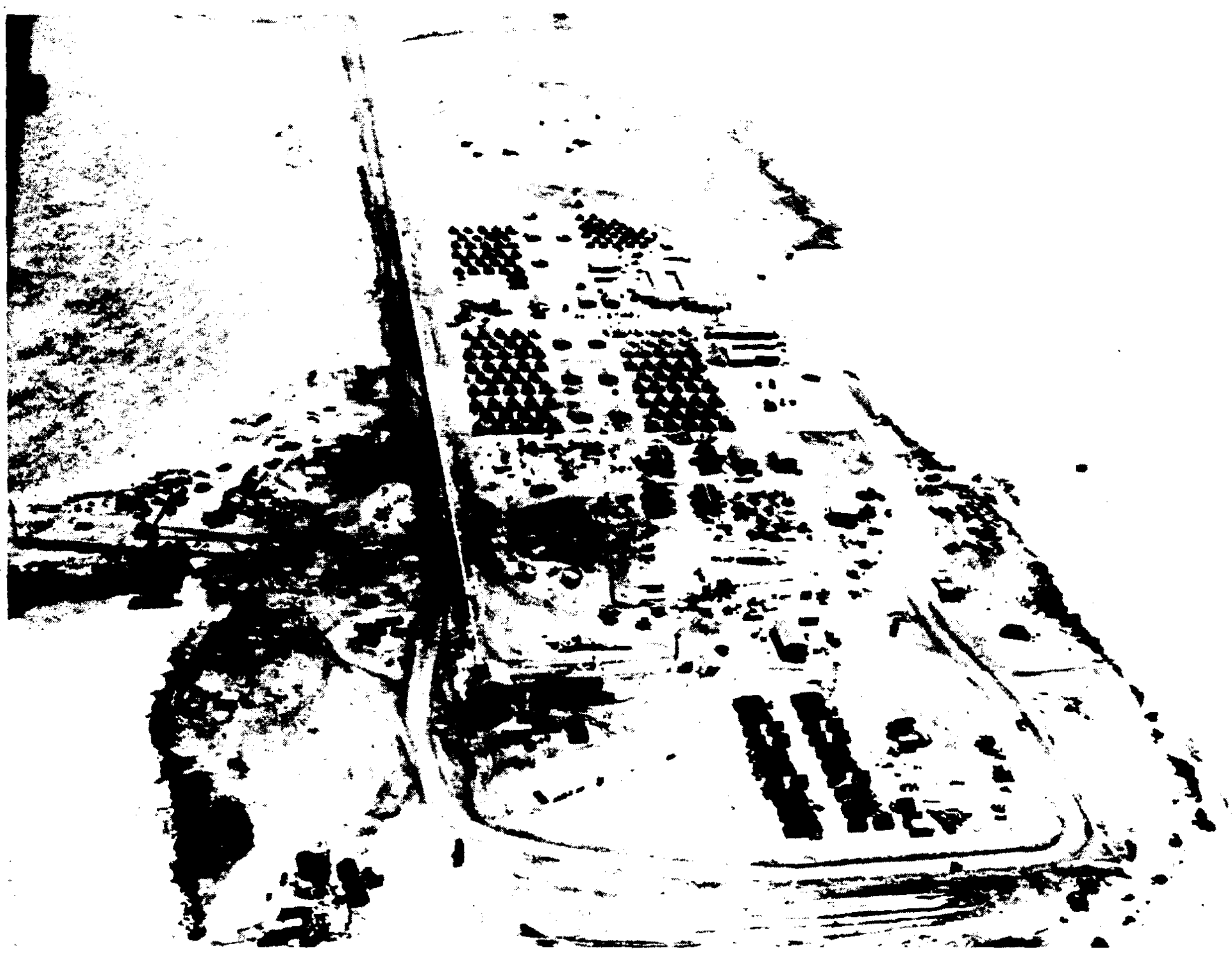


Figure 2-41. Aerial - Tare Camp Completed

As this crater area was required for OPERATION CASTLE, it was necessary to fill it, primarily for topographic rather than contamination reasons.

ENGINEERING. Field Engineering prepared two field sketches.

CONSTRUCTION. The Ruby Crater Fill was started on 15 February 1953 and completed on 13 May 1953. Figure 2-26 in Section 2 shows this crater as of 25 March.

CONTRACT ITEM NUMBER A-33
MISCELLANEOUS CONSTRUCTION
SITES VARIOUS

GENERAL. This contract item number covers 61 Miscellaneous Construction jobs on the sites of Eniwetok and Bikini Atolls that were necessary for the support of the Operation. Some of the larger jobs consisted of AVR facilities at site Tare, Blast Damage Repair at sites Elmer and Fred, Landing Pier at site Yvonne, Typhoon Hester Clean-up on sites Elmer and Tare, additional camp facilities, contaminated storage area and storage and dock area grading at Elmer, and minor rehabilitation to various facilities. This construction was necessary for maintenance and rehabilitation of existing facilities to be used for support of the Operation.

ENGINEERING. Field Engineering processed approximately 45 field sketches for the execution of this work.

CONSTRUCTION. Work was continuous.

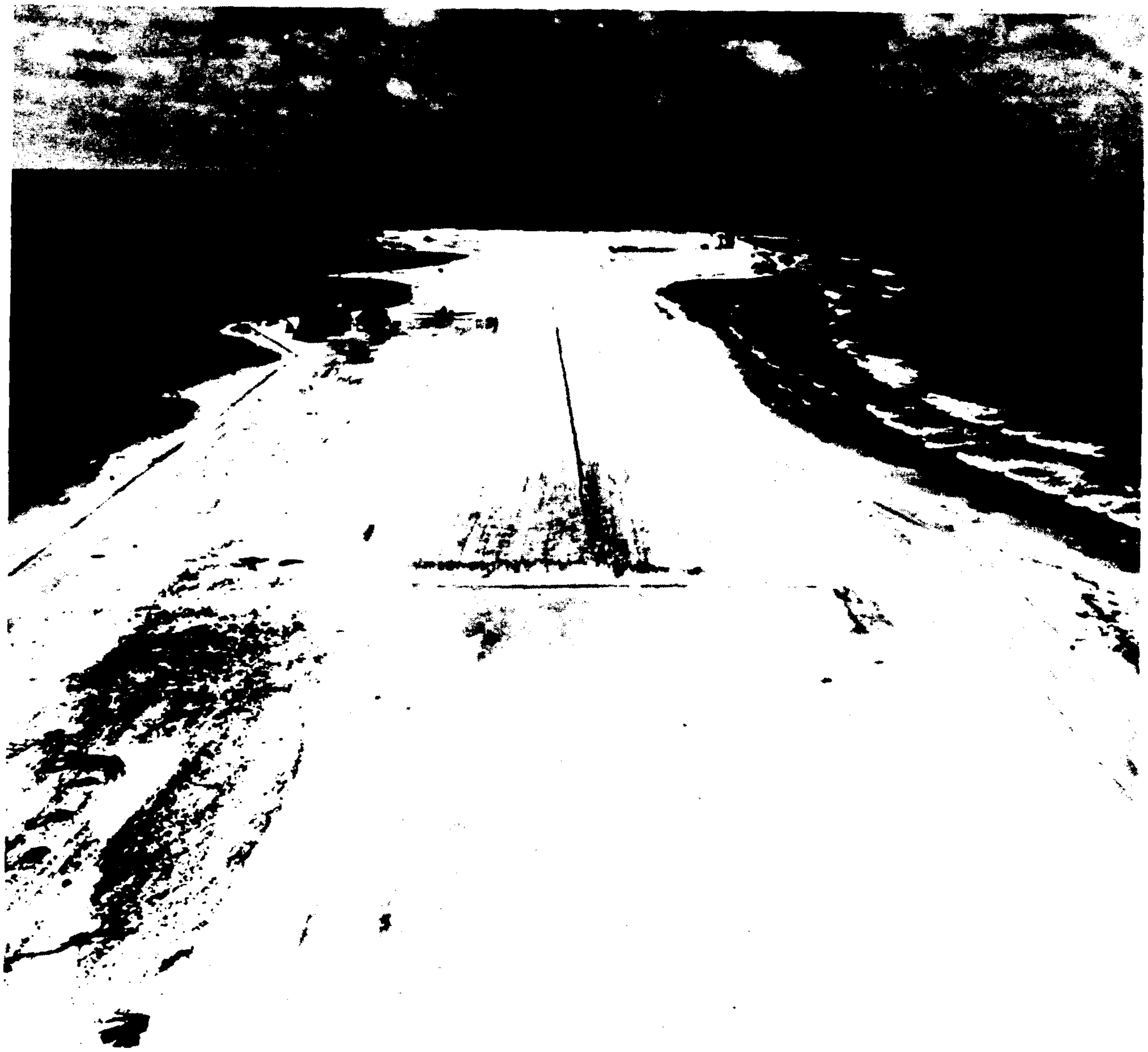


Figure 2-44. Peter-Oboe Airstrip Completed

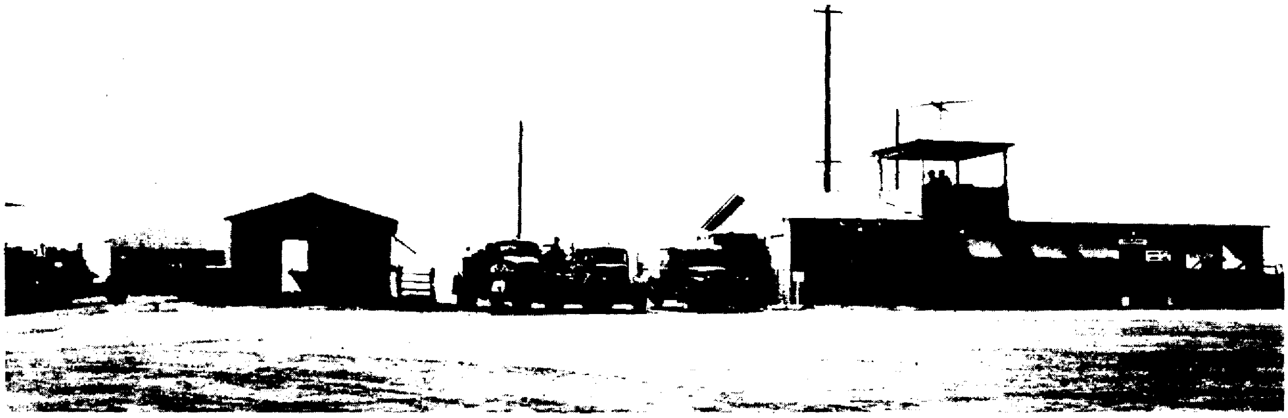


Figure 2-45. Peter-Oboe Airport Facilities

CONTRACT ITEM NUMBERS A-35 THRU A-35.6 - AIRPORT FACILITIES - SITE PETER-OBOE

GENERAL. The facilities constructed under this item consisted of the Air Operations Building, Fire and Crash Building, Hangar Building, Power House, 8-Man Ready Tent, Outside Latrine and appurtenant facilities. These facilities were necessary, in conjunction with the Airstrip (Item A-25), to provide an air terminal as a basis of operation for regular scheduled flights between Eniwetok and Bikini Atolls. Figure 2-45 notes these facilities, consisting of a power house, fire crash building and an air operations building nearing completion on 11 June 1953. Figure 2-46 shows the Helicopter Hangar completed

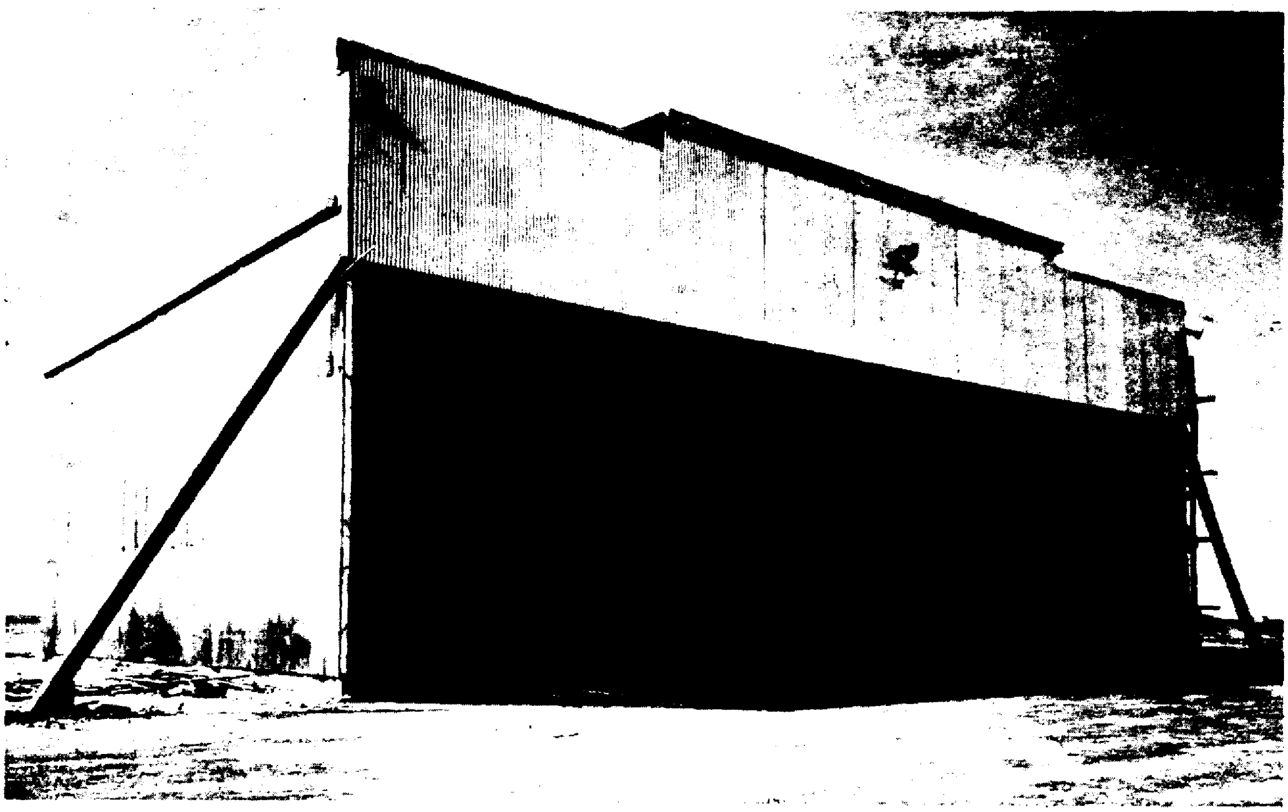


Figure 2-46. Helicopter Hangar - Site Peter

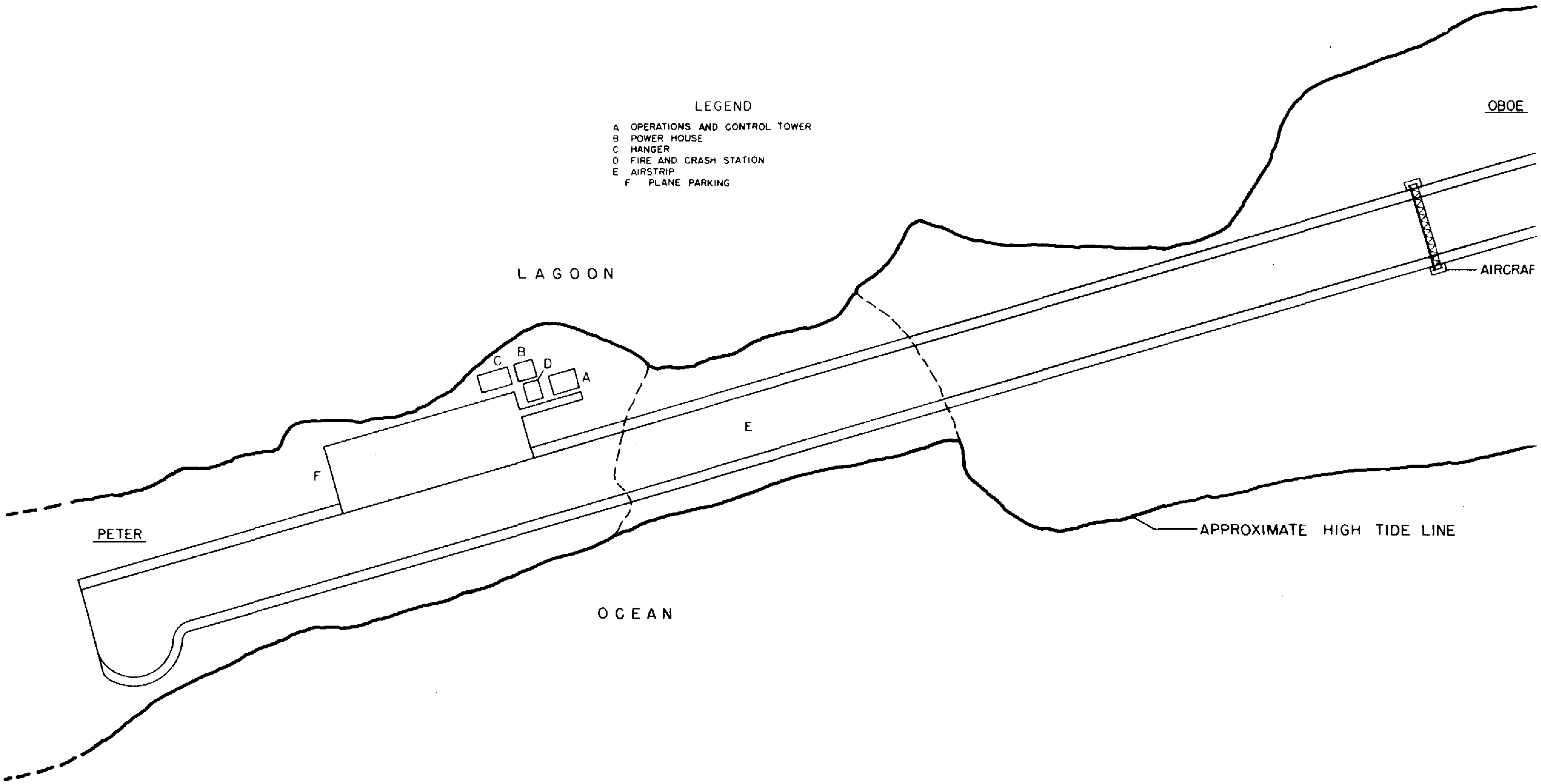


Figure 2-47. Map of Oboe-Peter Airport Facilities

Figure 2-48. Hangar Store Room

CONSTRUCTION. Construction was started on 1 April 1953 and completed on 1 July. Figure 2-47 is plan of the airstrip and facilities as undertaken.

CONTRACT ITEM NUMBERS A-36 THRU A-36.9 - CHARLIE CAMP

GENERAL. On 27 March 1953 a beachhead camp at site Charlie was authorized. This authorization included a marine ramp to provide access to and from the island. Figure 2-49 shows this ramp as 30% complete on 11 June. From this beachhead camp, a main camp was constructed for 300 men which served as an operation base for all work in sites Delta, Able, Baker and Charlie.

ENGINEERING. The Field Engineering Division prepared all drawings and field sketches required.

CONSTRUCTION. Work was started with the temporary camp on 27 March 1953. Figure 2-50 and Figure 2-48 shows the interior of one of its storerooms.

ENGINEERING. Field Engineering processed five field sketches. Seven drawings were prepared by the Home Office.

Figure 2-49. Landing Ramp - Site Charlie

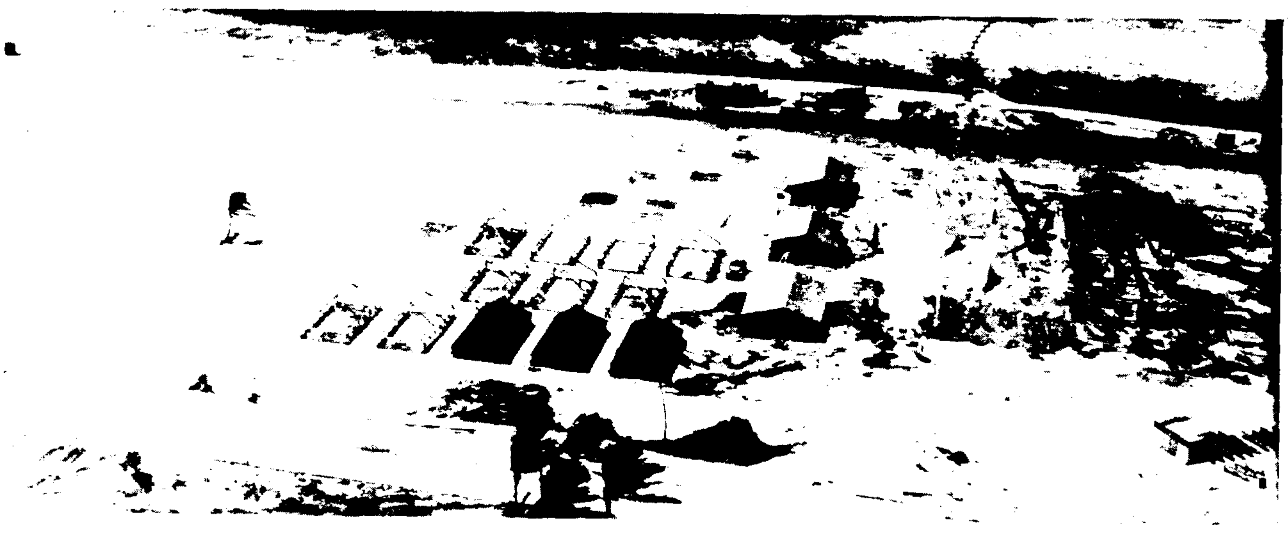


Figure 2-50. Progress Photograph - 11 June 1953

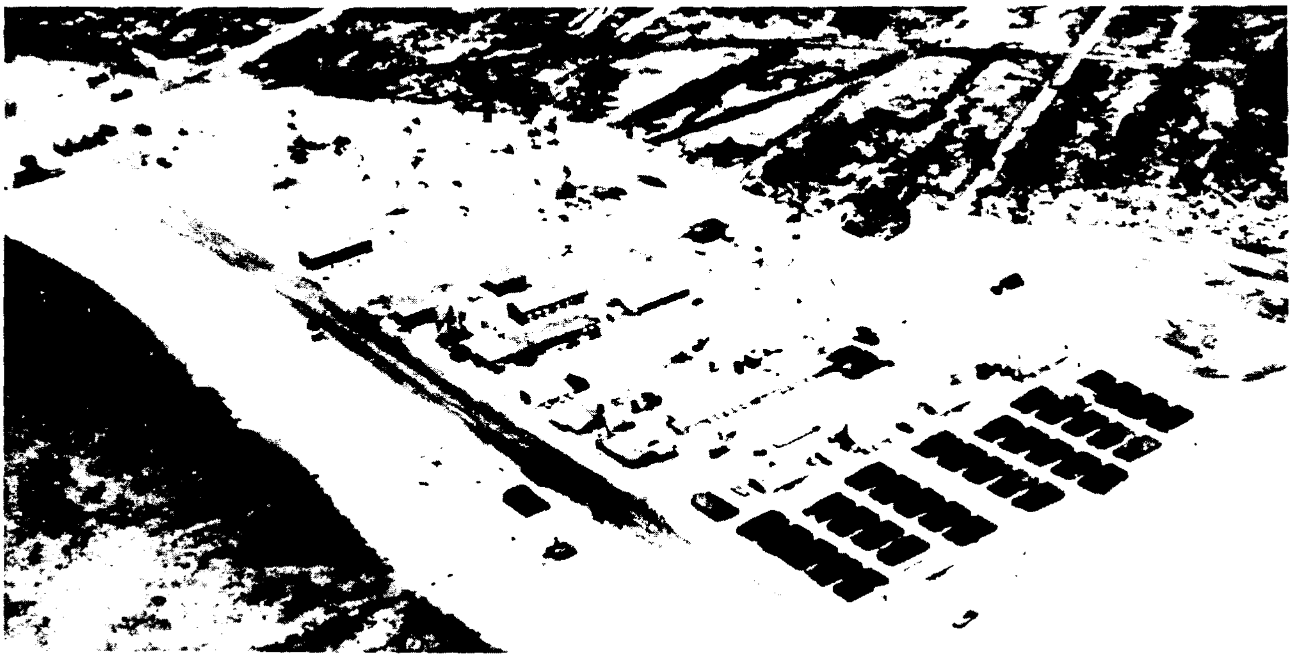


Figure 2-51. Aerial - Charlie Campsite Completed

notes the progress of work as of 11 June. By 22 July, the camp was occupied and operating. Expansion of some of the facilities continued until completion on 30 October. At the peak of the Operations, this camp accommodated over 300 men. Figure 2-51 is an aerial view of the campsite taken on 26 February 1954. Figure 1-6 is a plot plan of the completed camp.

CONTRACT ITEM NUMBERS A-39 THRU A-39.11 - TEMPORARY TEST SUPPORT FACILITIES - SITE ELMER

GENERAL. The temporary support facilities constructed under this account item consisted of an LST landing ramp and moorings, electrical wiring for tents 99A thru 99G, M. P. Orderly

Figure 2-52. Decontamination Pad - Fred Airfield

Figure 2-53. Fred Airfield with New Parking and Taxi Strips

Figure 2-54. Southwest Areas - Fred Airfield

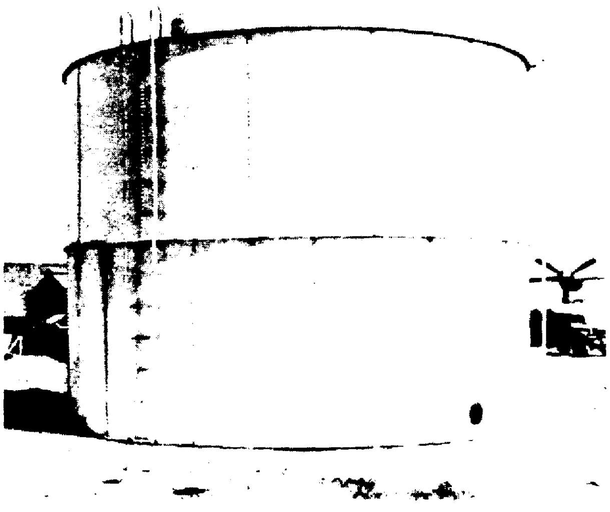


Figure 2-55. Water Tank for Decontamination Pad

Figure 2-57. Aerial View - POL Farm

Supply Tent 239, temporary shelter for and installation of portable distillation units in Building 401-A, increased capacity of coral bowl seating, a new swimming area, and additional Rad-Safe facilities. These facilities were required to accommodate the increased population for the support of the Operation.

ENGINEERING. Jobsite Engineering prepared ten field sketches and drawings.

CONSTRUCTION. The construction of the above facilities was continuous. Figure 1-4 shows these facilities with existing facilities plus those that were added under permanent construction.

CONTRACT ITEM NUMBERS A-40 THRU A-40.31 - TEMPORARY TEST SUPPORT FACILITIES - SITE FRED

GENERAL. These facilities consisted of 29 various jobs required for temporary support of the increased population occurring at the peak of the Operation; the larger construction items were airfield improvements, addition to distillation facilities, installation of Army owned reefers, rehabilitation of P. O. L. facilities, ad-

Figure 2-56. POL Farm - Site Fred

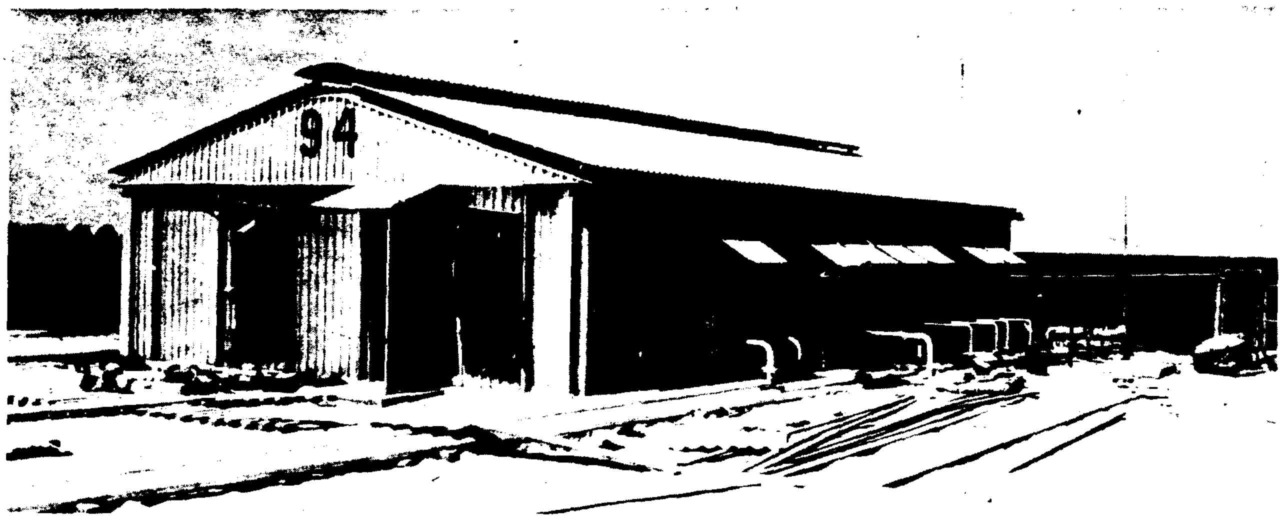


Figure 2-58. POL Pump House

ditional stabilized areas, floodlight plane parking area, P. O. L. office, additional 24 8-man tents, sealcoating decontamination pad, inspection and repair of three motor generator sets, and miscellaneous items. Figure 2-53 shows the new improvements completed on the Fred Airstrip (Contract Item A-40.1), including parking areas, taxi strips and additional pavement and marking. Figure 2-52 notes the Decontamination Pad (Contract Item A-40.8 and 40.18) at the northwest parking area on the Fred Airstrip. Figure 2-54 shows the southwest areas of the Fred Airstrip.

ENGINEERING. The necessary drawings and field sketches were prepared by Field Engineering.

CONSTRUCTION. This construction was continuous during the Operation and was done as work was authorized. Figure 2-55 notes the fresh water tank for the Decontamination Pad (Contract Item A-40.10). Figures 2-56 and 2-57 show the P. O. L. Farm on Fred (Contract Item A-40.3) completed as of 10 February 1954. Figure 2-58 shows Building 94, the P. O. L. Pump House. Figure 1-3 notes the temporary and permanent facilities that were required and added for the Operation. Existing facilities are likewise shown.

CONTRACT ITEM NUMBER A-44 INCIDENTAL SUPPORT FACILITIES BOTH ATOLLS

GENERAL. This item consisted of a group of approximately 49 items covering central power plants for scientific uses only on sites Charlie and Tare, and other construction for scientific support essentially, tents, trailer spaces and utilities.

ENGINEERING. The necessary drawings and field sketches were prepared by Field Engineering. Tent, trailer and utility locations were shown on plot plans or on electrical distribution drawings.

CONSTRUCTION. Work was started on 1 July 1953 and continued to completion on 31 December 1953.

CONTRACT ITEM NUMBERS A-57-C THRU A-57.16 — NAN CAMP

GENERAL. A temporary beachhead camp capable of supporting 40 men was built at site Nan. This camp was expanded to a construction camp of 100-man capacity. In January 1954 a peak population of 196 men was reached due to unforeseen Scientific Group occupancy. This camp was overcrowded and the facilities were inadequate for two weeks during this peak load.

ENGINEERING. The necessary drawings and field sketches were prepared by Field Engineering. Figure 2-59 depicts the camp as of 5 February 1954. The camp had expanded into an operating camp capable of accommodating 200 men.

CONSTRUCTION. The beachhead was started on 30 June 1953. The main camp construction started on 1 September and was completed on 1 December 1953. Figure 1-8 notes the camp arrangements upon completion of work.

CONTRACT ITEM NUMBERS A-63-C THRU A-63.9 — FOX CAMP

GENERAL. This camp was started on 1 May 1953 with a small beachhead camp located at the eastern end of Fox. A new location was established for the main 200-man camp and construction began on 18 June 1953. This camp was

Figure 2-59. Nan Camp

established to act as a construction base for the Dog, Easy, Fox, George group in constructing the Scientific Stations and User support facilities in that vicinity.

ENGINEERING. Typical minimum cost temporary construction plans were prepared by Field Engineering, similar to the other temporary camps.

CONSTRUCTION. The main camp was occupied and operating on 15 September. Figure 2-60 shows the floor slab of the mess hall being poured on 13 August. Figure 2-61 notes the progress in the construction of the Fox Camp on 14 September. Figure 2-62 is an aerial photograph of the Fox campsite taken on 26 February 1954. Figure 1-7 notes camp arrangements upon completion of work.

CONTRACT ITEM NUMBERS A-64-C thru A-64.3 - P. O. L. FACILITIES - SITE SUGAR

GENERAL. The P. O. L. storage facilities located on site Sugar consisted of a small open pump shelter with two electric motor driven pumps, four 1000-barrel bolted steel tanks, two 500-barrel bolted steel tanks, two elevated navy cubes, ships' buoys, two four-inch submarine

Figure 2-60. Pouring Mess Hall Slab - Fox Camp

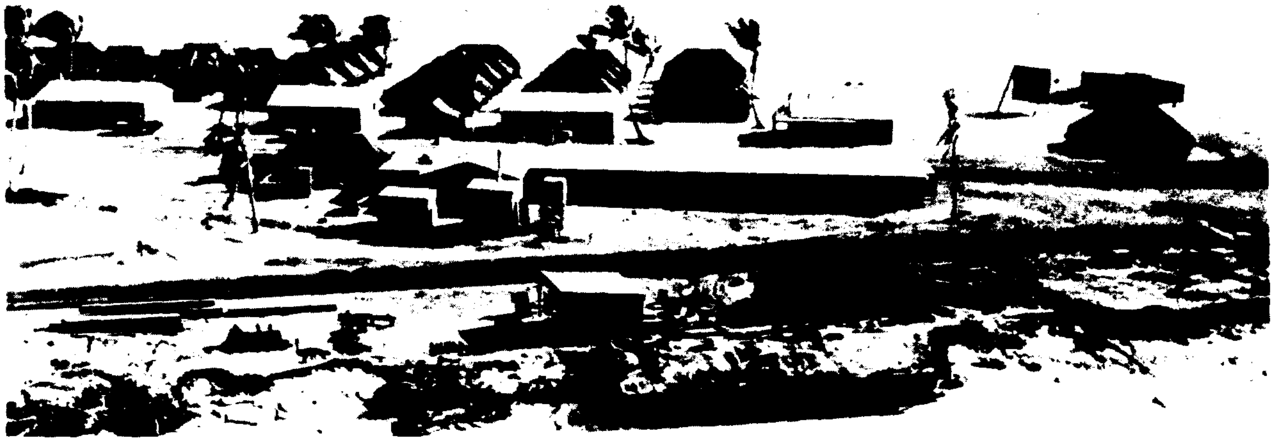


Figure 2-61. Progress Photograph, 14 September - Fox Camp

fuel lines with mooring buoys, all complete with valves, pipe and fittings, and power service from portable electric generator unit. This facility was established on a minimum basis at site Sugar as a central distribution point to supply fuel for motor vehicles, gas-driven generator units, helicopters and planes operating in the vicinity of the atoll, marine craft and construction equipment.

ENGINEERING. All drawings and field sketches were prepared by Field Engineering.

CONSTRUCTION. Work was started on 27 June and was completed on 31 December 1953. Additional minor work was authorized on 4 January 1954 and 9 February. All work was completed by 20 February 1954.

Figure 2-62. Aerial - Fox Camp Completed

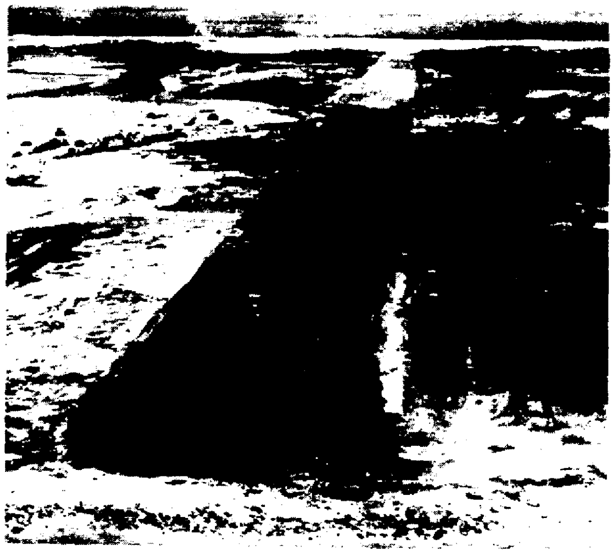


Figure 2-63. Airstrip - Site Janet

Figure 2-65. Parachute Tower - Site Fred

CONTRACT ITEM NUMBER A-67-C MISCELLANEOUS CONSTRUCTION BOTH ATOLLS

GENERAL. This Contract Item consisted of some 42 miscellaneous jobs. Some of the larger of these jobs consisted of navigational range lights, alterations to radiac building, decontamination barge, rehabilitation of airstrip on site Janet, storm damage repairs on Eniwetok and Bikini Atolls, cargo pier damage repairs, helicopter mat and clearing on site How, concrete deadmen, additional electrical wiring of various facilities, and recreational facilities on site How.

ENGINEERING. All drawings and field sketches were prepared by Field Engineering.

CONSTRUCTION. Work started on 1 July 1953 and all items were completed by March 1954. Figure 2-63 shows the airstrip at site Janet after rehabilitation. Figure 2-64 notes the

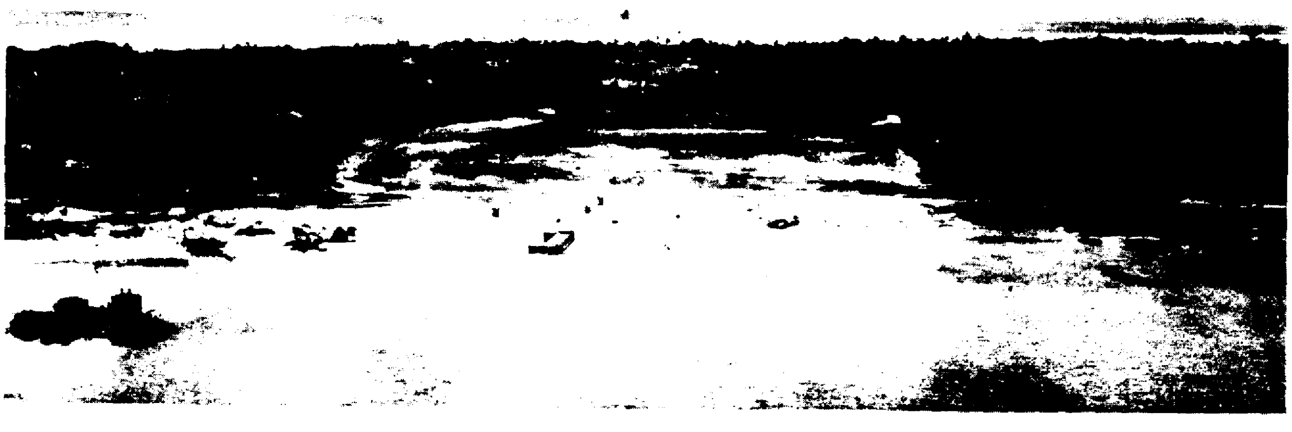


Figure 2-64. Helicopter Mat - Site How

Figure 2-66. Air Force Warehouse - Site Fred

clearing completed and helio mat installed on site How.

CONTRACT ITEM NUMBERS A-68-C THRU A-68.35 - J. T. F. CONSTRUCTION SITE FRED

GENERAL. Work under this Contract Item consisted of construction required at site Fred, principally by Task Groups 7.2 and 7.4, in support of the Operation and embraced some 31 separate items, the larger of which consisted of Supply Warehouse, eight wood prefab buildings, eight steel prefab buildings, Airfield Improvements, Parachute Drying Tower and Re-Pack Building, floor slab for Hangar Building, modification of Building 15 Cryptovault, Instrumentation Building, Photo Lab, Depot Supply Building, extend Air Operations Building, and miscellaneous construction. This construction, in conjunction with Contract Item A-40, enabled the Army and Air Force to maintain their headquarters at Fred in support of the Operation instead of basing part at Kwajalein and part at Fred as was done in past Operations. These facilities are shown in Figure 1-3.

ENGINEERING. Field Engineering made the investigations, reports and surveys of the various existing facilities to be rehabilitated. All necessary drawings were prepared at Jobsite.

CONSTRUCTION This construction was continuous as required from 1 June 1953 to 30 April 1954. Figure 2-66 shows Building 638, Air Force Warehouse on Fred (Item A-68.1) as completed on 10 February 1954. Figure 2-67 is a similar illustration. Figure 2-68 notes the

Figure 2-67. Building 638 - Site Fred

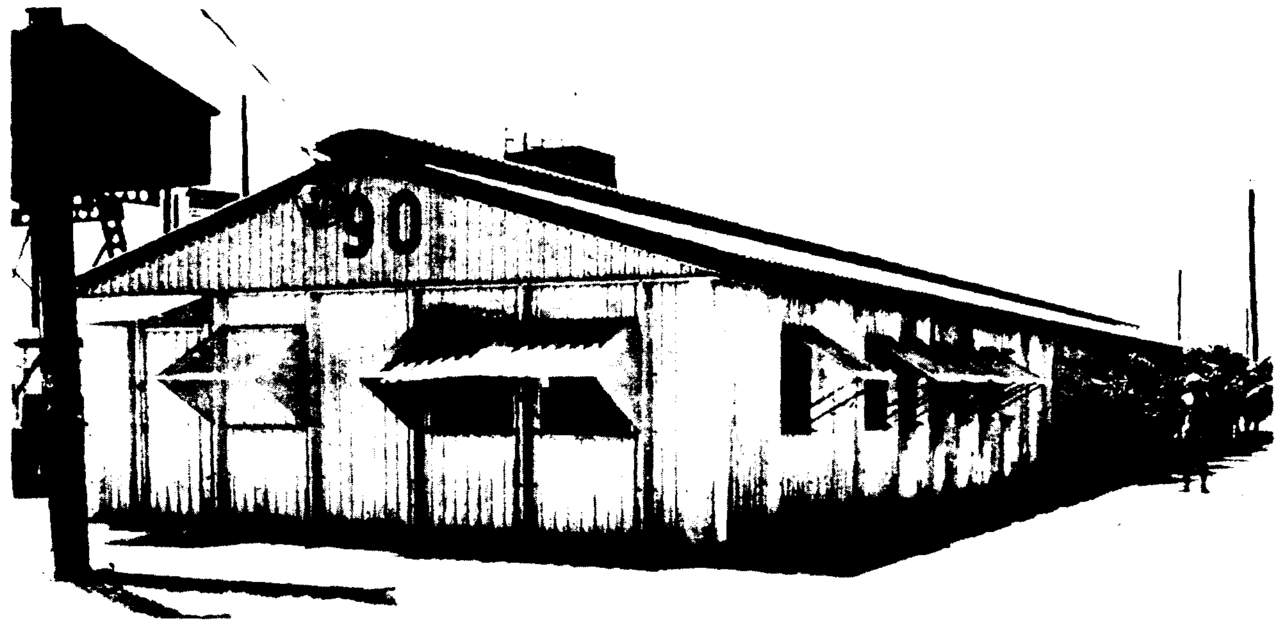


Figure 2-68. Building 90 - Addition to - Site Fred

addition to Building 90 (Item A-68.11) as completed. Figure 2-69 illustrates the Air Force Photo Lab. Building 610 (Item A-68.12) as completed. Building 639 as shown in Figure 2-65 shows the Parachute Tower on Fred (Item A-68.5) as completed on 10 February.

CONTRACT ITEM NUMBER A-69.1C - UCRL SLAB CAB

This item was for engineering work only on the UCRL mock-up building at Livermore, California, which was used for the assembly and testing of cab mock-ups.

The structure was a 41′-0″ x 60′-0″ x 33′-0″ high wood framed building. The roofing was wood sheathed and the siding was of corrugated aluminum.

Within the building there was a ten-ton bridge crane supported on steel crane girders. The girders spanned to wood columns which were ten-foot on center with alternates located at the building columns.

The floor of the building was a sparkproof reinforced concrete slab poured on grade. In the middle of the building and within the floor slab

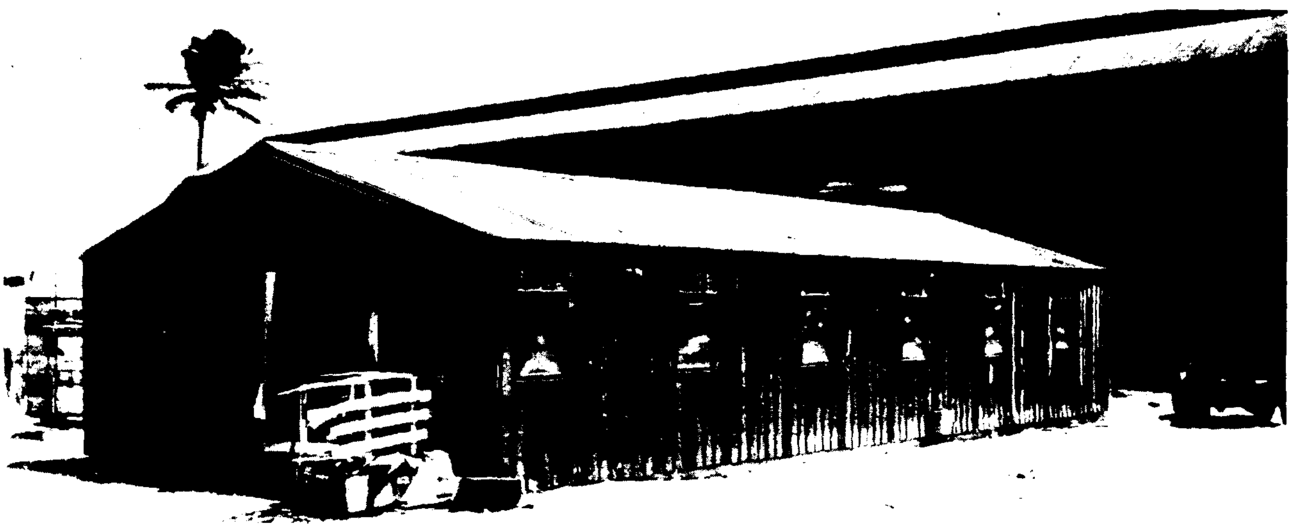


Figure 2-69. Air Force Photo Lab. - Site Fred

there was an 11'-0" x 34'-0" reinforced concrete bed frame two feet thick and flush with the top of the floor slab. In the bed frame there were many anchor bolts embedded which tied down three longitudinal User-furnished track assemblies.

The electrical service for this building was located underground from the transformer bank located in the cab compound. The service was 400 ampere, 120/208 volt, 3 phase, 4 wire to a full-standing switchboard located in the Electronics Room. Criteria required that the building be explosion-proof.

Special 100 ampere, 3 phase explosion-proof combination receptacle and breakers were located as directed by the User for use with the "Camco" trailers. Flood-lighting was provided as required to serve the area around the main building.

Three one-half H. P. roof ventilators were installed in this structure, providing one complete air change every five minutes. Banks of filters were provided in the north and south wall air intakes to minimize dust conditions. Original criteria were received on 29 January 1953, calling for roof ventilators providing approximately 30 air changes per hour and an explosion-proof crane of approximately 15-ton capacity. Criteria received on 1 May 1953 deleted the explosion-proof requirement from the roof ventilators provided motors were located outside of the air stream. The User also decided to furnish the explosion-proof crane. Criteria received on 12 May 1953, disclosed that the User had an air compressor which they would pipe to the air-operated crane.

General criteria were received 29 January 1953, which requested a schematic layout for a building 33'-0" x 100'-0". Additional criteria were received 22 April 1953, which superseded previous criteria and which requested two 60'-0" x 40'-0" x 33'-0" high buildings, separated by means of a breezeway, and two sheds, one at the side of each building. The crane and crane rails were to be furnished by the User. Criteria of 1 May 1953 deleted one of the two buildings and the breezeway. On 11 May 1953 the shed and door from the main buildings were deleted. Another shed was added and one of the sliding doors of the main building was increased in size. Also, rails and structural tees were added to the bed frame. Criteria of 14 May 1953 relocated the shed, revised dimensions and added a catwalk supported from the floor. On 4 June 1953 criteria for the anchor bolt plan of the bed frame were received. On 5 June 1953, criteria deleted the catwalk and revised the bedframe anchor bolt plan. The anchor bolt plan was revised again on 29 June 1953.

Nine drawings and five sketches were prepared. Design work proper started on 29 April 1953. The drawings were submitted on 20 May and were approved on 26 May.

CONTRACT ITEM NUMBER A-74-C SEAWALL - SITE FRED

GENERAL. The shore erosion on the lagoon side at site Fred, which resulted from wave action and storms from the southwest, was under close observation beginning early in 1952. By the fall of 1953, this erosion had become critical and the Field Engineering Division was requested to make recommendations, with various alternative methods, in order to provide adequate protection to the buildings and facilities. After taking all factors into consideration, it was decided from an economical, maintenance and protective standpoint to construct a reinforced concrete wall along the reef sections of critical erosion. The final design of the Seawall consisted of a reinforced concrete retaining wall that averaged approximately four feet in height and was keyed into a concrete footing. The footing was keyed into the coral reef by doweling. The Seawall was divided into eight separate sections totaling approximately 5200 feet, the longest of which was 1550 feet and the shortest 150 feet. These eight sections were given priority in the order of their immediate need.

CONSTRUCTION. During the construction of Section Priority No. 1, there was a stretch of the reef that had a break of approximately 50 feet that had no suitable coral shelf for foundation. This was solved by filling this length with large coral boulders up to required grade. In a portion of Section Priority No. 3 adjacent to the Cargo Pier, there was no suitable reef foundation for the length of approximately 30 feet, so in this length short steel piling was driven, extending the sheet piling wall of the Cargo Pier. In Section Priority No. 4, the same method was used as in No. 3 where the reef was so eroded that no suitable foundation was available. Work was started on 22 March 1954, and as of 8 May, 57% of the work was completed.

SECTION 5
SCIENTIFIC STRUCTURES

STATION 10 - ZERO STATION (BARGE) SITE FLORA CRATER - USER: DIRX

GENERAL. In the original plan for the Operation, H & N was advised that barges with a stabilized platform to support certain scientific equipment would be required. Tests were conducted at the planned location to determine the characteristics of a 500-ton barge, both in regard to pitch and roll as well as anchorage. The first criteria, which covered the loading of the barges, were received on 15 January 1953. On 6 February 1953, H & N recommended using a 500-ton open lighter type barge and a sketch was submitted showing the load capacities and draft characteristics. On 27 March, H & N was instructed to purchase four 500 - ton barges. These barges (for Stations 10, 30, 40 and 90) were made available by the Commander, JTF 7 and accordingly were not purchased by the Contractor. Large stable platforms (with the limits of stability desired) could be constructed in lieu of barges but the costs would have been prohibitive and the advantages not commensurate. The barge stability and acceleration tests continued at Jobsite until 22 May.

Station 10 was erected on a steel flush-deck cargo type non-propelled barge 120 feet long, 33 feet wide and 585 tons displacement. This Station consisted mainly of a steel frame superstructure supporting a platform deck approximately 33 feet wide by 44 feet long and located 20 feet above the barge deck. Scientific equipment was installed on the barge deck and in various areas on the platform deck. The area beneath the platform was enclosed by plywood-sheathed stud walls with a top connection designed to permit vertical deflection of the platform framing without inducing loads on the studs. Living quarters were provided on the barge deck and consisted of a single story wood-frame building with plywood sheathed stud walls and a composition roof carrying a Navy cube for water supply. Reinforcement of the deck was required, both in the area beneath the hatch and at the winches. Sidewall reinforcement was added to some of the more heavily loaded columns. Thirty-two thousand pounds of coral ballast were required in the hold to balance the superimposed loads.

MECHANICAL. Two 1 1/2-ton jib cranes, a 4 ton bridge crane and four gasoline engine-driven anchor winches were procured and installed. A 750-gallon diesel fuel oil tank was provided and included with the necessary equipment for the living and messing quarters.

ELECTRICAL. Power was supplied by two portable 30KW deisel engine generators. The design contemplated that both generators would be in

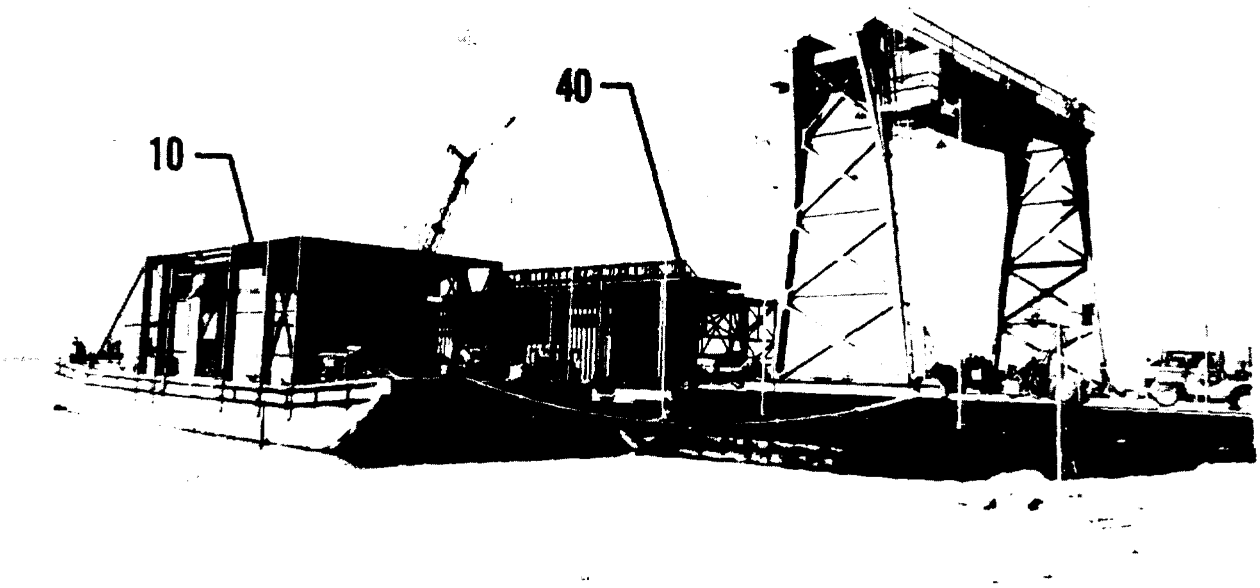


Figure 2-70. Stations 10 and 40 at Barge Slip

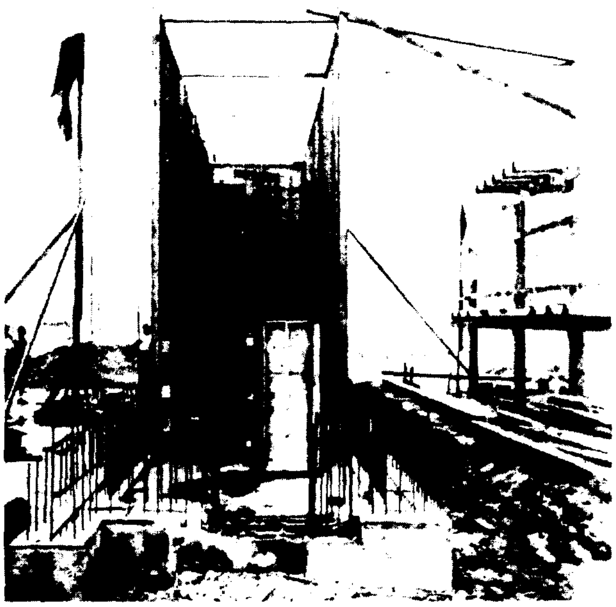


Figure 2-71. Station 20 - Floor Slab Poured

operation until zero time, with reverse power relay to prevent voltage fluctuation. Submarine signal cable attachments were provided, as well as general lighting with utility and special receptacles as required by the Users.

ENGINEERING. The design criteria for Station 10 were first received on 22 June. Additional criteria were received on 6 August, 22 October and 28 October. The criteria received on 22 October required a complete redesign of the deck reinforcement. Electrical criteria covering User furnished equipment were received 22 June. Sketches and design work started in January 1953 and developed into 17 drawings and 13 sketches. These drawings were submitted from 21 July to 1 December and were approved from 7 August to 8 December.

CONSTRUCTION. Work was scheduled to commence on 25 August and to be completed by 5 January 1954. Actual work started on 26 November at the Barge Slip, Assembly Area, Site Elmer and was completed on 22 January. Figure 2-70 notes Station 10 undergoing alterations at the barge slip; Station 40 is shown in the rear.

STATION 20 - ZERO STATION
SITE BAKER-CHARLIE REEF
USER: DIRX

GENERAL. This Station was a steel frame, two story building approximately 27 feet high, with the first floor level at elevation plus 10. Below elevation plus 30, the plan dimensions were about 22 feet by 47 feet. Above this level, the front and side walls were set back from the walls below so that a flat composition roof, U-shaped in plan, was formed by the setback. The second floor level (elevation plus 37) supported a plywood house (Station 1350). The rear wall below elevation plus 30 was one of the concrete walls of Station 1202. The major portion of the first floor was a three foot thick re-

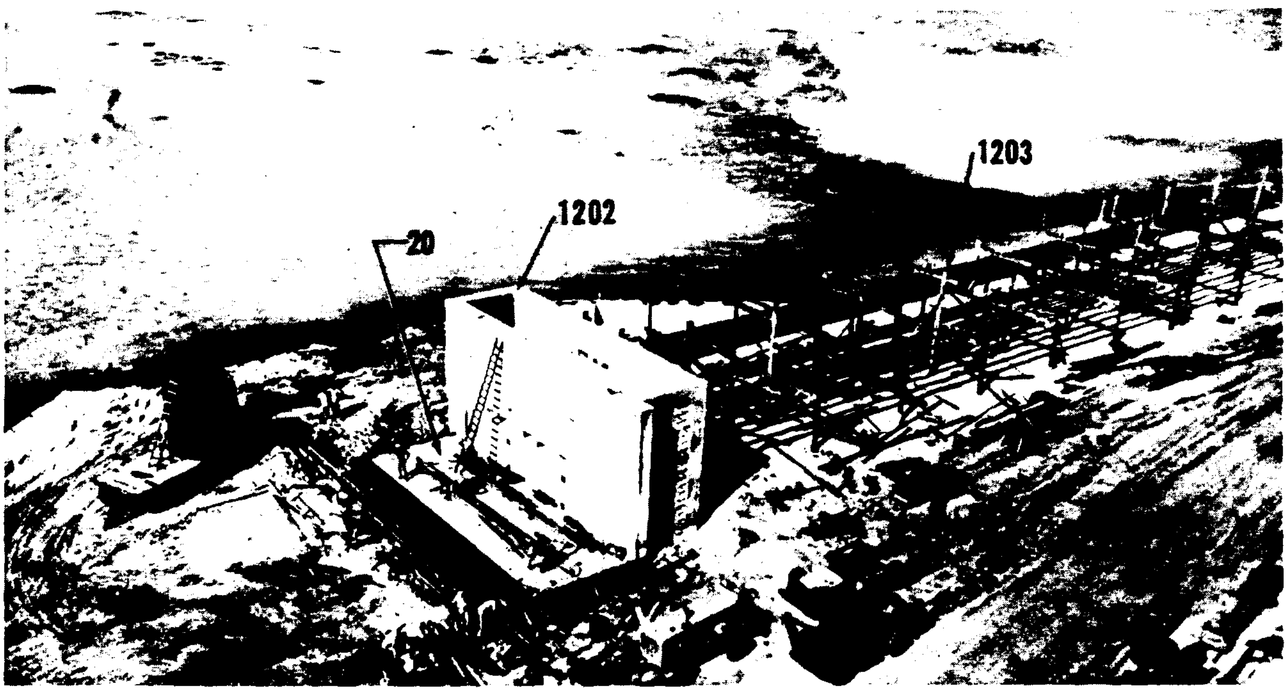


Figure 2-72. Station 20 - 28% Completed

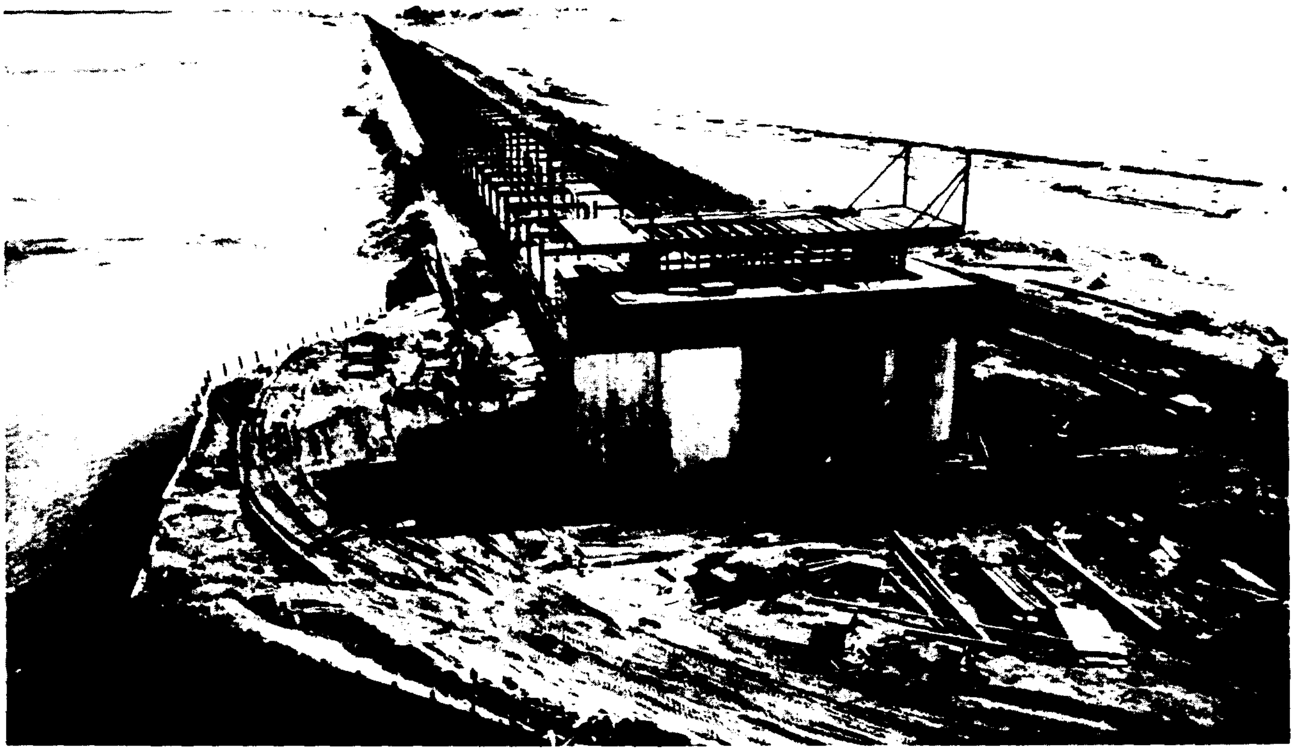


Figure 2-73. Station 20 - 58% Completed

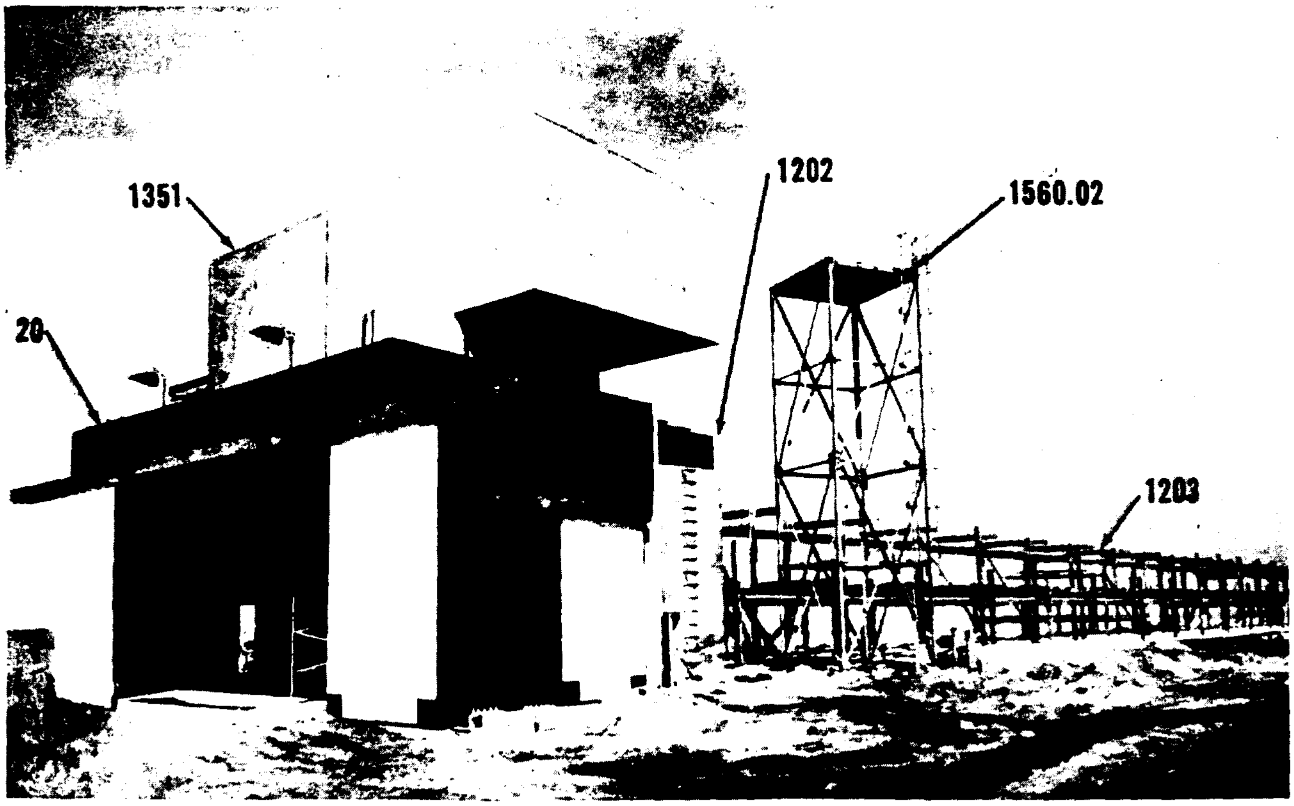


Figure 2-74. Stations 20, 1351 and 1202

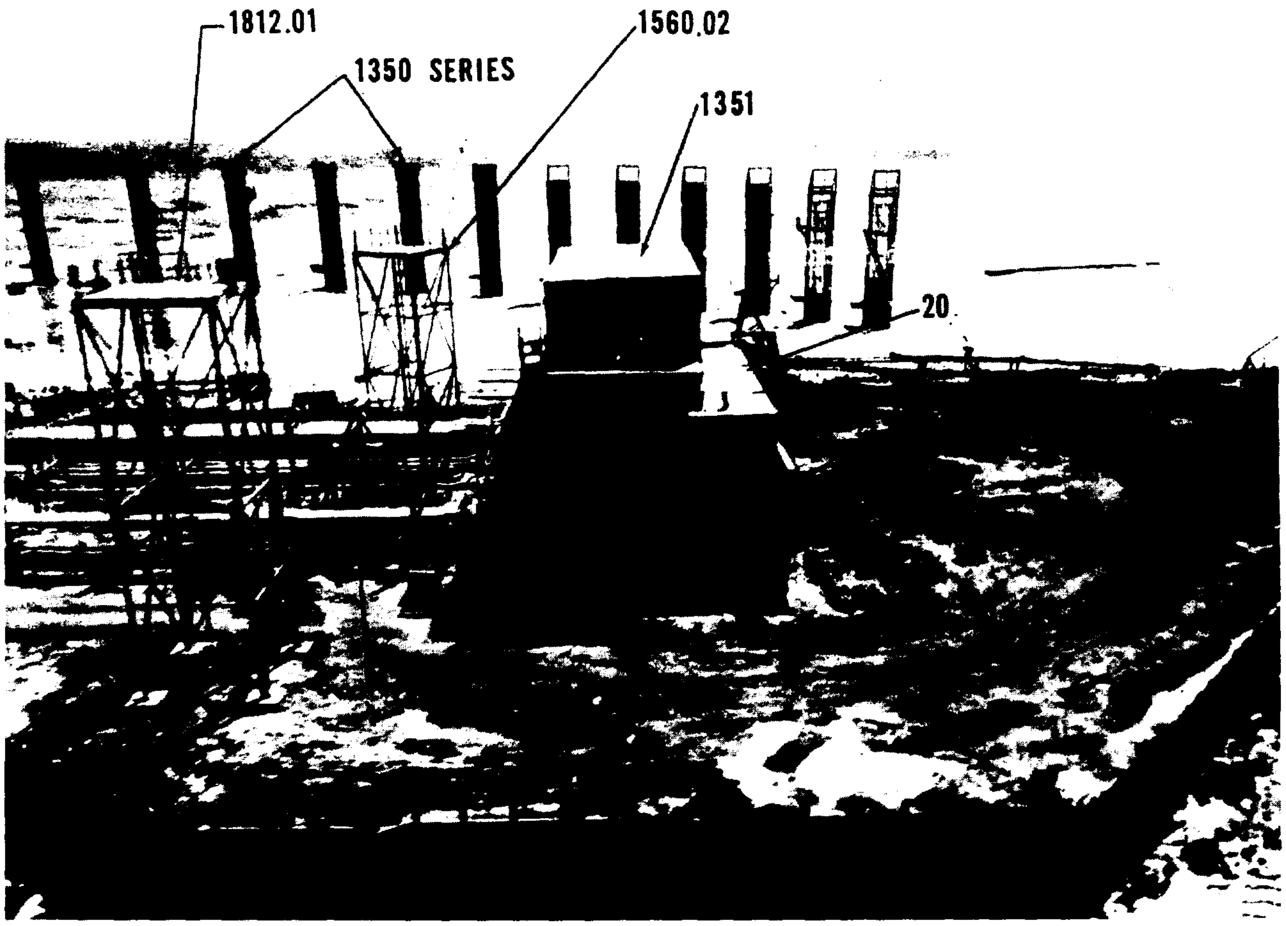


Figure 2-75. Stations 20, 1202 and 1350 Series

inforced concrete slab supported on steel H-piles. On the first floor two steel racks were provided for storage of a total of 11 heavy cylinders (Station 1110).

ELECTRICAL. Power was supplied from site Charlie (CH-500) at 2400 volts to a 300 KVA transformer bank. Station 20 was the distribution power center for that area. General illumination, utility and special receptacles were provided.

ENGINEERING. Preliminary design criteria were received on 15 April. Revisions and additional criteria were received on 26 June, 16 July, 21 July, 26 August, 8 September and 23 October. Design work was started in April. However, revised criteria required extensive revisions, and nine plans and three sketches in all were prepared and submitted from 17 July to 18 November; approvals were dated from 13 August to 21 December.

CONSTRUCTION. Construction was scheduled to commence on 1 November and to be completed by 31 December. Actual work started 3 September and was completed on 25 January 1954. Figure 2-71 shows the slab poured for Station 20 (at left); the forms in the center are for Station 1202. Figure 2-72 shows the relation between Stations 20 and 1202. The rear wall of Station 20 (which is the front wall of 1202) is shown poured. Figure 2-73 shows Station 20 as 58% completed on 19 December. The framing on the penthouse (Station 1351) is started. Figure 2-74 notes status on 4 January 1954. Station 20 was 90% completed. Figure 2-75 notes progress on 6 January and the relationship of the various Stations to each other.

STATION 30 - ZERO STATION (BARGE) SITE BIKINI LAGOON - USER: DIRX

GENERAL. This Station was similar to Station 10 with the main exceptions being: (1) a platform deck was located 19 feet above the barge deck; (2) a concrete baffle wall 23 feet high, 20 feet long and three feet thick was installed at the rear of the platform; (3) 142,500 pounds of coral ballast was required to balance the superimposed loads.

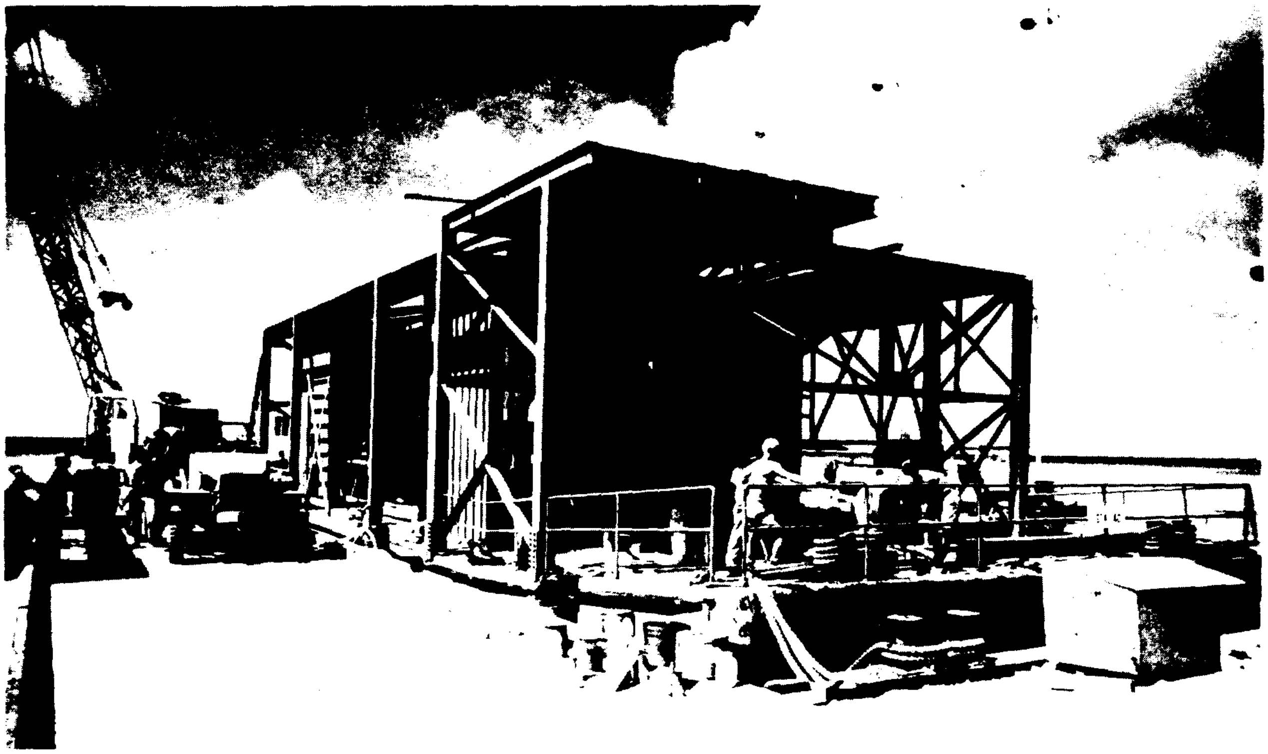


Figure 2-76. Station 40 Under Construction

MECHANICAL AND ELECTRICAL. Same as Station 10 with the exception of omission of 4-ton bridge crane.

ENGINEERING. The initial criteria of 22 June indicated that this Station would be identical with Station 10. The revised criteria of 26 August resulted in major design problems, especially due to the inclusion of a concrete wall. The design and plan work is reported in part under Station 10. Due to revised criteria, 13 additional plans were prepared and were submitted from 11 September to 4 November. The plans were approved from 25 September to 24 November.

CONSTRUCTION. Construction was scheduled to commence on 10 October and to complete by 15 January. Actual work started on 3 November and was completed on 22 January 1954.

STATION 40 - ZERO STATION (BARGE) SITE - BIKINI LAGOON - USER: DIRX

GENERAL. This Station was similar to Station 10 with the main exceptions being: (1) several platform decks were constructed at various levels above the main deck; (2) User's requirements necessitated a complex longitudinal 54-ft. truss; (3) a mezzanine platform, five feet wide by 40 feet long, was suspended from the platform above; (4) 61,700 pounds of coral ballast was placed in the hold.

MECHANICAL. Same as Station 10 except that the four-ton crane was replaced with a monorail, 20 feet long. The diesel fuel tank was increased to 1,000 gallons.

ELECTRICAL. Same as Station 10 except that two portable 60KW generator sets supplied the power.

ENGINEERING. Initial criteria were received on 19 August 1953. Additional criteria were received 4 September, 9 September and 22 October. Design work started on 19 August. Plans were detailed in part under Station 10. In addition, 14 plans were prepared and submitted from 9 September to 1 December. Approvals were dated from 25 September to 8 December.

CONSTRUCTION. Construction was scheduled to commence on 5 October and to be completed by 25 January 1954. Actual work started on 9 November and was completed on 22 January. Figure 2-76 shows Station 40 under construction at the Barge Slip, Assembly Area, on site Elmer.

STATION 50 - ZERO STATION SITE TARE - USER: UCRL

GENERAL. This Station was a steel frame building 30'-0" x 40'-0" x 35'-0" high. The roof was framed with steel trusses, and A-frame construction at the ends of the building was provided to take care of the lateral loads. The roof and end walls were covered with corrugated aluminum. The ends of the building contained manually-operated sliding doors; on each side

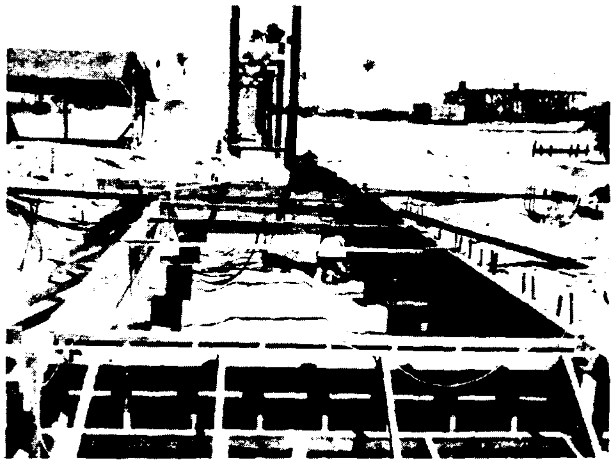


Figure 2-77. Station 50 - 22% Completed

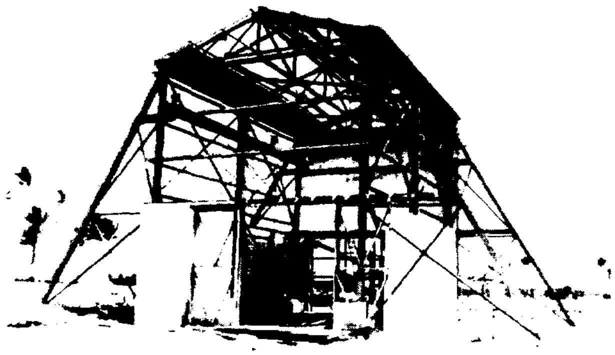


Figure 2-78. Station 50 - 72% Completed

of the building there was a pair of roll-down curtains. An explosive link was provided in each curtain assembly which if exploded, when the curtain was in the rolled-up position, would allow the curtain to fall freely. The floor of the building was a concrete slab, and incorporated an 11-foot by 34-foot bed frame foundation supported on eight piles.

MECHANICAL. A ten-ton pneumatic bridge crane was installed in the building, using rail girders supported on steel brackets fastened to the columns.

ELECTRICAL. The Electrical design features were predicated on a mock-up structure built by UCRL at Livermore, California. Consideration was given to the installation of a spark-proof floor. Investigation of existing installations showed that spark-proofing was not necessary for slabs mixed with salt water and in a high humidity atmosphere. A ground grid was installed around the building, and all building structural members and siding were grounded. This ground grid was also used for a neutral ground and equipment ground. The Station was provided with a signal terminal cabinet with telephone provided for direct communication along the length of Station 2220 and to Station 2310. Two additional telephones were provided for the interisland telephone system. A series street lighting system using directional street lighting luminaires was installed for the area security and fence lighting system. Station criteria called for a large tent and trailer camp

Figure 2-79. Station 50 - 95% Completed

Figure 2-80. Station 50 and Security Area Completed

outside the Station all within a fenced security lighted area. Power was supplied from power plant, TA-500, to a 112.5 KVA Substation adjacent to Station 50. This Substation supplied the power for that area.

ENGINEERING. Initial criteria were received on 26 May 1953. Additional criteria were received on 31 July, 5 August and 19 August. As additional building protection was desired, it was decided to provide a 45-foot by 26-foot high blast wall. On 20 November the blast wall was replaced by canvas siding. The initial design work started on 27 May, the mechanical designs started on 1 June, and the electrical design work started on 16 July after the structural features were firm. Sixteen drawings and one sketch were prepared and they were submitted from 7 July to 24 December. Approvals were dated from 7 August to 8 January 1954. Remote controlled canvas siding was provided which presented a difficult design problem. Results of tests on the curtain fall and latching were satisfactory to the User on the initial test.

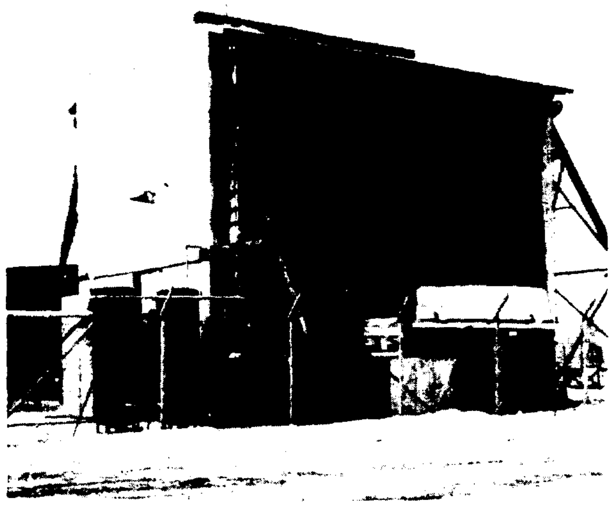


Figure 2-81. Station 50 with Canvas Siding

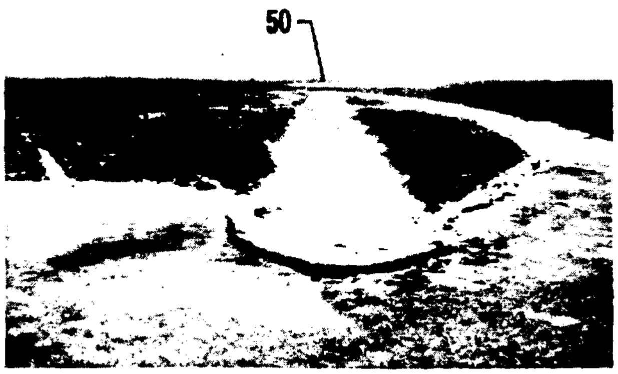


Figure 2-82. Site Uncle with Clearing Towards Station 50

The ten-ton pneumatic crane was subjected to a detailed performance test for safety and capacity.

CONSTRUCTION. Construction was scheduled to start on 1 August and to be completed by 31 December. Actual work started on 22 September and was completed on 26 January 1954. Figure 2-77 notes the 12-inch H-piles driven and foundation forms in place on 7 October. Figure 2-78 notes metal framework installed as of 8 November. Figure 2-79 shows Station 50 as 95% completed on 5 January. Security fencing is shown in foreground. The security area is at the far right. Figure 2-80 notes the security area with Station 50 (in rear) completed as of 5 February. Figure 2-81 shows a late change in criteria (noted above) in which the metal siding was replaced by canvas. This photograph was taken on 27 February. Figure 2-82 notes the clearing required at site Uncle in order to obtain a line of sight on Station 50 for Stations located on sites Victor, William and other islands. On the extreme rear center is Station 50 on site Tare.

STATION 60 AND 62 - ZERO STATION & TV ROOM STATION - SITE RUBY
USERS: UCRL AND EG&G

GENERAL. Station 60 was a steel framed 40'-0" x 60'-0" x 35'-0" high. The building had wood purlins and was covered with corrugated aluminum. The floor was a concrete slab poured on grade and supported on eight piles. Adjacent to and attached to Station 60 was a wood framed, wood sheathed building 31'-0" x 26'-0" x 10'-0" high, within which was Station 62, a 15-foot by 20-foot room.

MECHANICAL. Station 62 had a ten-ton bridge crane inside the building which ran on a rail girder. The television and electronic equipment rooms in this Station had dehumidification units.

ELECTRICAL. The electrical layout was predicated on a mock-up structure built by UCRL at Livermore, California, similar to Station 50. Power was supplied from the power house on site Ursula. A substation at Station 60, consisting of three 75 KVA transformers, supplied the power for that area.

ENGINEERING. The initial criteria were received 1 May. Additional criteria were received 27 May, 5 June, 18 June, 29 June and 5 August. The initial design work started 21 May. Ten drawings and two sketches were prepared and submitted from 24 June through 18 November. The plans were approved from 4 Aug. through 21 December.

CONSTRUCTION. Construction was scheduled to commence on 1 August and to complete by 31 December. Actual work started on 21 August and was completed on 23 January 1954. Figure

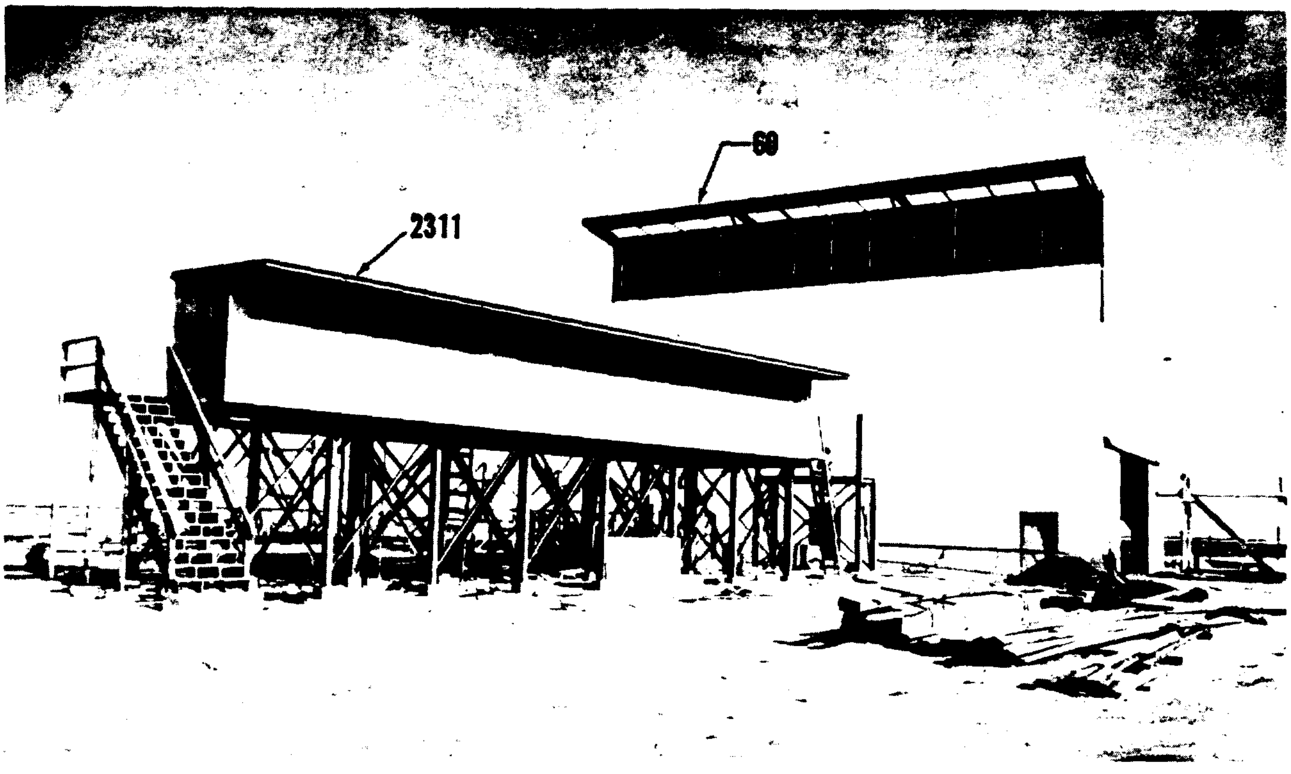


Figure 2-83. Station 60 - 66% Completed

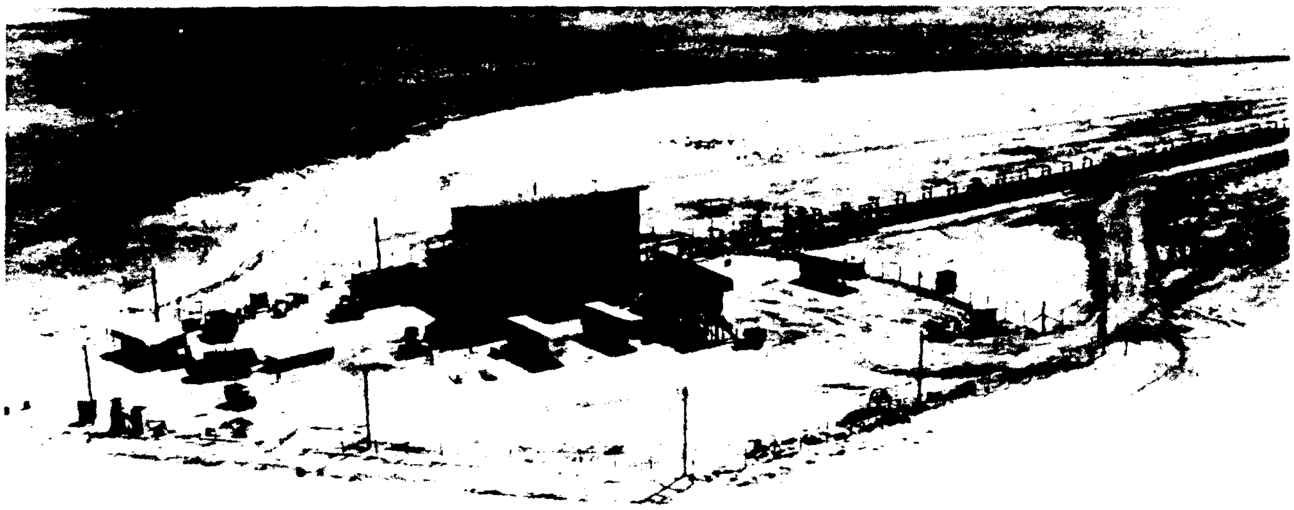


Figure 2-84. Station 60 Aerial View

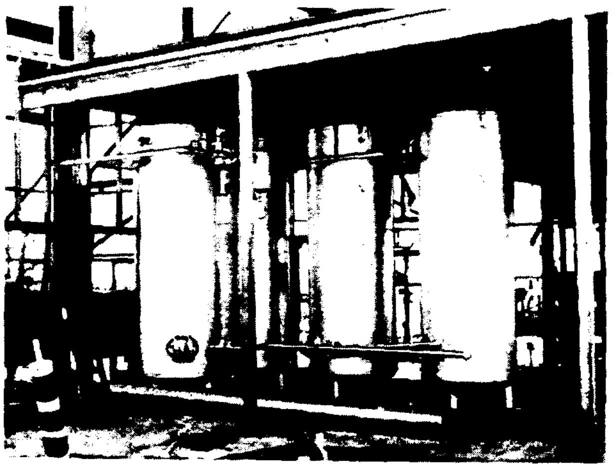


Figure 2-85. Station 60 - Air Receivers Installed

2-83 shows the west wall of Station 60. The Station was estimated 66% completed as of 8 December. Figure 2-84 shows Station 60 and area compound looking from the ocean towards the lagoon. Figure 2-85 notes the air receivers installed in Station 60.

STATION 63 - TV TRANSMITTER
SITE TILDA - USER: EG&G

GENERAL. This Station was originally built for OPERATION SANDSTONE. It was modified for OPERATION GREENHOUSE as a Timing Station (Station 6a). For OPERATION IVY it was modified for spectroscopy (Station 802). For OPERATION CASTLE it was rehabilitated and modified as a TV Transmitter Station to meet User's requirements.

ENGINEERING. One drawing was submitted

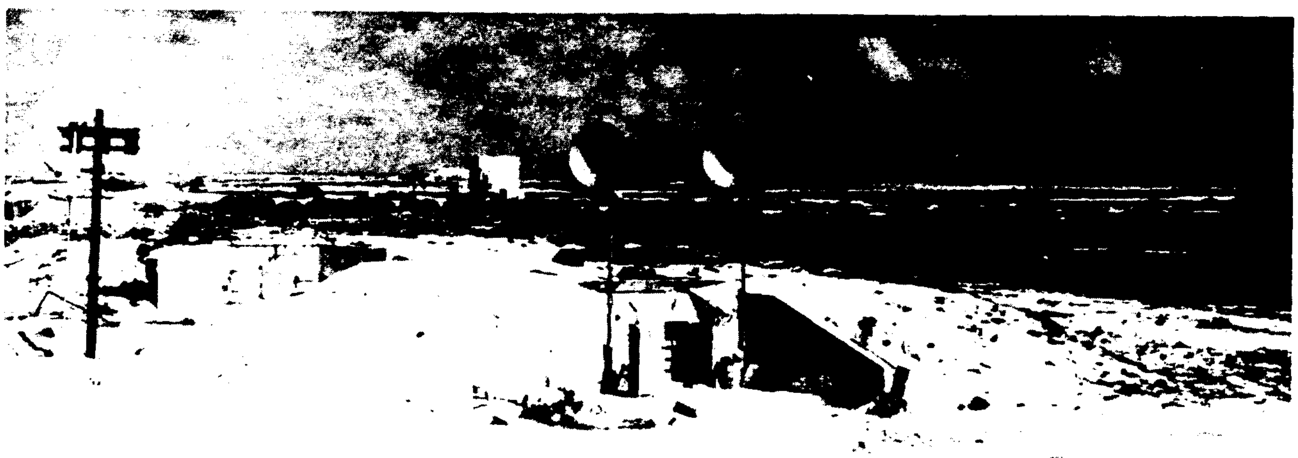


Figure 2-86. Station 63 - Completed

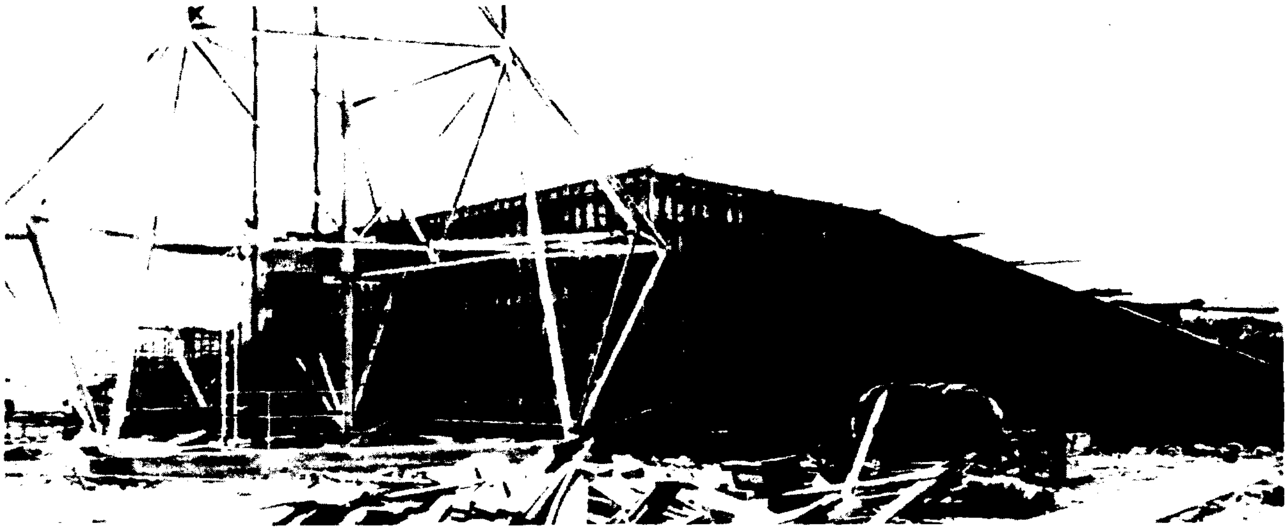


Figure 2-87. Station 70 - Entrance

on 29 September, and it was aproved 28 October.

CONSTRUCTION. Work started on 1 November 1953 and was completed on 6 February 1954. Figure 2-93 shows the Station completed.

STATION 70 - TIMING AND
COMMUNICATIONS BUILDING
SITE NAN
USERS: TU-15, TU-6, JFT. NRLS and H&N

GENERAL. The Timing and Communications Building was located on site Nan and was used for the timing and firing of all Bikini shots. This one-story reinforced concrete structure measured 44′ x 72′ x 12′ high and was covered with a five-foot, seven-inch earth fill. Figure 2-87 shows Station 70 as 53% completed on 3 December. In the left foreground is the 300-foot tower, Station 1300. There were nine rooms in Station 70 with access to each room by an L-shaped corridor. The largest room was 23 feet by 27 feet. Eight rooms were constructed of wood studs and plywood. Access to the building was through blast-resistant type doors located in the side retaining walls. These doors may be

Figure 2-88. Station 70 - Completed with Earth Covering

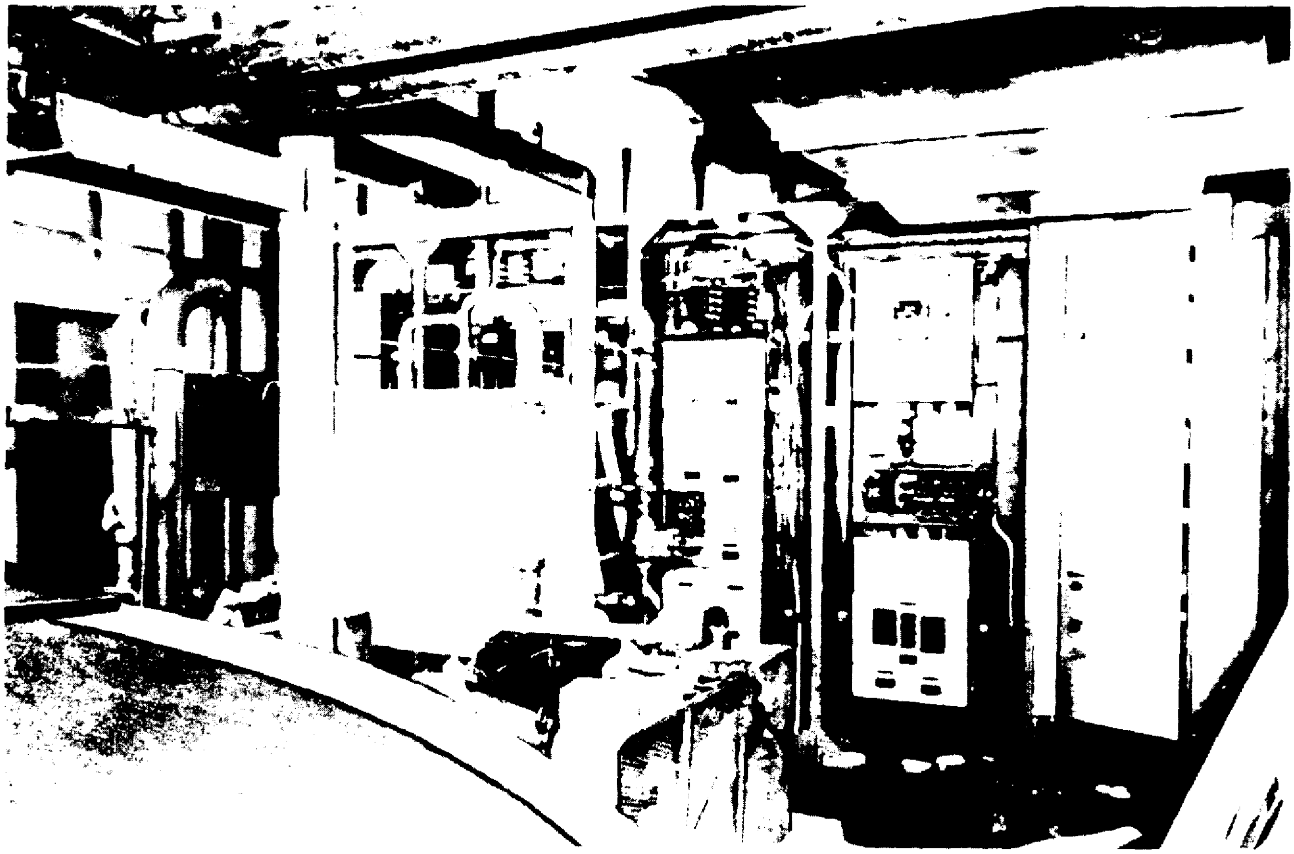


Figure 2-89. Station 70 - Interior of Room Four

noted in Figure 2-88. This photograph was taken on 4 February and shows wing walls and earth fill in place as completed.

MECHANICAL. A dehumidification system serviced the entire station.

ELECTRICAL. As this Station was the communication center, a large amount of electrical wiring and equipment was installed. Power was furnished from a 300 KVA Substation located in a concrete vault adjacent to Station 70.

ENGINEERING. The original basic design criteria were received on 22 January and 27 March 1953. Major and minor changes in criteria were received on 15 April, 14 May, 18 May, 20 May, 11 August, 14 August, 2 September and 25 November. Electrical design criteria were received on 27 March. Major revisions were required on 15 April and electrical drawings were approved on 6 August. Subsequent to approval, major changes were required on 26 August and 1 November. Twelve drawings were designed and detailed with starting dates varying from 30 April to 11 August, completion dates varied from 22 May to 20 October, approval dates varied from 9 June to 19 November. Some of the drawings had from three to six revisions; the date of the last revision was on 3 December. Figure 2-89 shows partial installation of User's and Contractor's equipment in Room No. 4. This figure is as of 9 January 1954 with the entire structure reported at 96% completed.

CONSTRUCTION. Construction work was scheduled to commence on 1 September and be completed on 7 January 1954. Actual construction started on 7 October and was completed on 12 January.

STATION 71 - TIMING AND FIRING - SITE ELMER - USER: EG&G

GENERAL. This station is the existing Control Building 311, and is the control center for the atoll. No work was required except support.

STATIONS 72.01 - 72.04 - TIMING AND FIRING - SITES VARIOUS - USER: EG&G

GENERAL. These stations were rehabilitated from IVY Timing Stations 1001.01 (Janet), 1001.02 (Ursula) and 1001.03 (Yvonne).

ENGINEERING. One drawing was prepared and was submitted on 29 September 1953. It was approved on 28 October. Station 72.04 on site Mary was changed to a submarine cable terminal Station ST 4.1.

CONSTRUCTION. Work started on 31 December 1953 and was completed on 6 February 1954.

STATIONS 73.01 THRU 73.03 - TIMING STATIONS - SITES VARIOUS - USER: EG&G

GENERAL. These three Timing and Firing Stations were located on sites Charlie, Alice and Able. Each station consisted of an 8′-0″x12′-0″ x 8′-0″ high wood frame building erected on a concrete slab. Each station housed a cable terminal for interconnecting communications and signal cables.

ENGINEERING. The design criteria were received on 6 May. Structural plans were started on 26 June, submitted on 1 July and approved on 20 July. The electrical plans were started on 29 June, submitted on 11 August, approved and issued on 11 September. Three revisions were required for the structural work and six revisions for electrical. The last revision was on 17 November.

CONSTRUCTION. Construction work was scheduled to commence 15 August and to complete on 1 January. Actual construction starting dates varied from 21 August to 1 November, completion dates varied from 25 January to 6 February 1954.

STATIONS 74, 74.01, 74.02 AND 74.03 - TIMING STATIONS - SITE OBOE - USER - EG&G

GENERAL. These Timing and Firing Stations were used for all Bikini shots and were identical with the 73 series with the exception that the 74 series were built of reinforced concrete and had an earth fill to the roof on three sides. Plans were included with the 73 series.

ENGINEERING. Station 74.03 was deleted on 1 July. Station 74.01 was deleted on 1 October and Station 74.02 on site Oboe was renumbered to Station 74. The design and drafting work is covered under Station 73 series.

CONSTRUCTION. Work was scheduled to commence on 1 September and to be completed on 15 January. Actual construction work was started on 20 October and was completed on 23 January 1954.

STATIONS 75.01 AND 75.02 - TIMING STATIONS - SITES DOG AND HOW USER: EG&G

GENERAL. These two Timing and Firing Stations were identical with the 74 series.

ENGINEERING. Reported under Station 73 series.

CONSTRUCTION. Work was scheduled to commence on 1 November with completion by 31 December. On Station 75.01, site Dog, actual construction started on 9 September and was completed on 25 January 1954; Station 75.02, site How, started on 23 November and was completed on 6 February 1954.

STATION 76 - TIMING STATION SITE GEORGE - USER: EG&G

GENERAL. This Station was similar to the Station 74 and 75 series.

ENGINEERING. Reported with Station 74 series.

CONSTRUCTION. Construction work was scheduled to commence on 1 September and be completed on 1 December. Actual construction started on 9 September and was completed on 3 February 1954. On 6 February 1954 revisions were required to include wing wall buttresses. This modification was completed on 16 February.

STATIONS 80.01 AND 80.02 - INTERATOLL ANTENNA ARRAY - SITES NAN AND ELMER - USER: EG&G

GENERAL. These Antenna Array Stations were used for communications and consisted of five steel antenna towers, 75 feet high. The towers were mounted on a triangular footing. Three levels of guys with reinforced concrete anchorage supported each tower.

ENGINEERING. The original design criteria were received on 29 May. One drawing was started on 22 July, submitted on 24 July and approved on 19 November.

CONSTRUCTION. Construction work was scheduled to commence on 1 November and to be completed on 15 December. Actual constuction for Station 80.01 started 20 November and was completed on 2 January 1954. Station 80.02 started on 1 September and completed on 19 November.

STATION 81 - INTERATOLL ANTENNA ARRAY - SITE ELMER - USER: EG&G

GENERAL. This Station was used for communications and consisted of a wood-frame building 24′ - 0″ x 24′ - 0″ x 10′ - 0″ high, with concrete slab, plywood siding and aluminum roofing. The interior was vapor sealed.

MECHANICAL. One dehumidification unit was installed.

ELECTRICAL. One 15 KW engine generator was installed.

ENGINEERING. One drawing was submitted on 20 August and was approved on 18 September.

CONSTRUCTION. Work was scheduled to start on 26 September and to be completed by 31 December. Actual construction started on 18 September and was completed on 22 January.

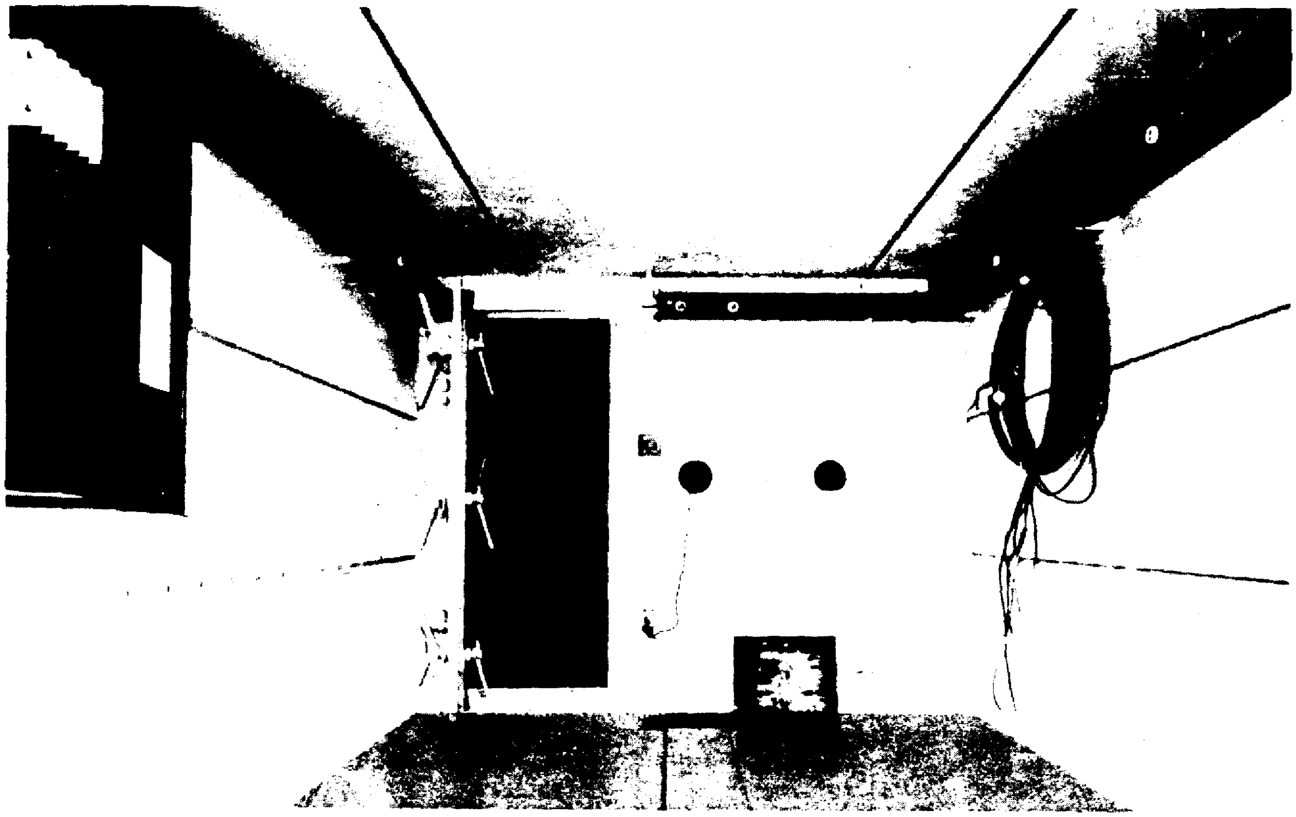


Figure 2-90. Station 101 - Typical Interior

STATION 90 - ZERO STATION (BARGE) SITE BIKINI LAGOON OFF CHARLIE - USER: DIRX

GENERAL. This Station was similar to Station 10. Twenty-four thousand, six hundred pounds of coral ballast was required to balance the superimposed loads.

ELECTRICAL. Same as Station 30.

MECHANICAL. Same as Station 30.

ENGINEERING. Initial criteria were received on 1 October 1953. Design problems were generally solved on the other barges. However, nine additional plans were required and these plans were started on 1 October, submitted from 15 October to 18 November and approved from 6 November to 21 December.

CONSTRUCTION. Construction was scheduled to commence on 15 October and to be completed by 15 February 1954. Actual work started on 1 December and was completed on 25 January.

STATION 101 - RECORDING STATION - SITE GEORGE - USER: SANDIA

GENERAL. The Station was a reinforced concrete building 12' - 0" x 19' - 0" x 11' - 0" high. All of the exterior walls and roof were 2' - 0" thick and the building rested on a 2' - 6" thick reinforced concrete slab foundation. A pair of skewed wing walls were located at one end of the building, projecting out 24 feet from the building. The Station was embedded 5' - 6" below the natural grade and covered with a minimum of 3' - 6" of earth fill. The wing walls acted as retaining walls for the fill. The building was equipped with a pair of blast doors. A pair of steel pipes, one 8" I. D., the other 10" I. D., extended up from the ceiling of the roof to the top of the fill.

MECHANICAL. Forced air ventilation was supplied. The original criteria provided for dehumidification but on 2 July this item was eliminated.

ELECTRICAL. Two portable generators supplied power to the Station. Incandescent lighting and receptacle outlets were provided as requested by the User.

ENGINEERING. Criteria were received on 28 April, 1 May and 6 May, and four drawings were started on 8 May. These were submitted on 9 June and approved on 7 July.

CONSTRUCTION. Work was originally scheduled to commence on 1 August and to be completed by 5 January. Actual work started 14

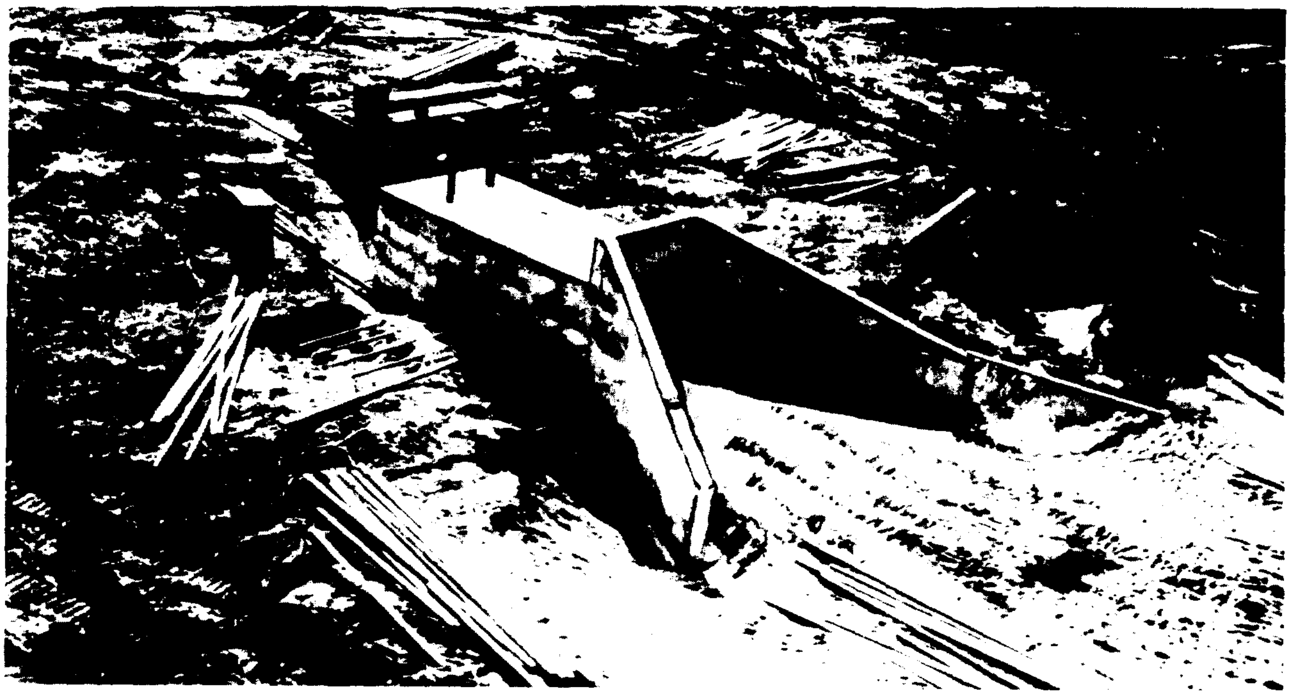


Figure 2-91. Station 102 - Exterior View

August and was completed on 23 January 1954. Figure 2-90 notes the interior which was typical of the Recorder Station series. A pair of 6" pipe sleeves were located on the rear wall, adjacent to the blast door. In the floor, with cover plate, was a 6" x 6" trench.

STATION 102 - RECORDING STATION
SITE OBOE - USER: SANDIA

GENERAL. Similar to Station 101.

ELECTRICAL. Similar to Station 101.

MECHANICAL. Similar to Station 101.

ENGINEERING. Reported under Station 101.

CONSTRUCTION. Work was originally scheduled to commence on 1 August and to be completed by 15 January. Actual work started on 2 September and was completed on 6 February. Figure 2-91 shows the Station as 95% completed as of 8 January. The wing walls and pipes are shown prior to the earth fill. Figure 2-92 is typical of the series as completed with earth fill.

STATION 103 - RECORDING STATION
SITE OLIVE - USER: SANDIA

GENERAL. Same as Station 102.

ELECTRICAL. Same as Station 102.

MECHANICAL. Same as Station 102.

ENGINEERING. Because of an error in the construction survey, which was not discovered until final checking of the field notes, this Sta-

Figure 2-92. Station 102 - Typical of Series

tion was misoriented by approximately 12°. Since the orientation was only for structural purposes and was not critical, the User approved the new orientation. Special instructions were issued to all party chiefs and this error was not repeated.

CONSTRUCTION. Work was originally scheduled to commence on 1 August and to be completed by 15 February 1954. Actual work started on 28 July and was completed on 6 February.

STATION 104 - RECORDING STATION
SITE IRENE - USER: SANDIA

GENERAL. This Station was added in March 1954 due to the rescheduling of the Test Program. The work involved consisted of reactivat ing IVY Recording Station 600 and connecting up to the 120 series Stations located on sites Gene, Helen and Irene. (Stations 120.24 thru 120.28).

ENGINEERING. Field Engineering prepared drawings and field sketches as required.

CONSTRUCTION. Work was started on 19 April 1954 and was completed on 20 April.

STATIONS 110.02 - 110.05 - ROCKET
LAUNCHERS - SITES VARIOUS
USER: NOL

GENERAL. These Stations were located on sites Charlie, Dog, Uncle and Pearl and each Station consisted of two type A-1 tents equipped with work benches and electrical outlets; these Stations were used for rocket trail photography. Five KW engine generators were provided for the power supply.

ENGINEERING. One drawing was submitted on 22 July and was approved on 14 August.

CONSTRUCTION. Starting dates varied from 7 September to 15 December 1953. Completion dates varied from 30 January to 3 February 1954.

STATIONS 120.01 - 120.29 - GROUND
BAFFLES - SITES VARIOUS
USER: SANDIA

GENERAL. These Ground Baffle Stations were located on various islands of both atolls. Each Station consisted of a precast reinforced concrete cube which contained User's equipment embedded inside the cube. This equipment recorded surface pressure versus time. The cubes measured 1'-6". Figure 2-93 shows Station 120.13 on site Sugar as 80% completed on 5 January 1954. When completed the top of the cube was flush with the finished grade.

ENGINEERING. The criteria were received 11 May for Stations 120.01 thru 120.22. On 9 September, Station 120.23 was added. On 1 March 1954 Stations 120.24 thru 120.29 were added. Station 120.29 was later deleted. Minor detail plans were included with other Stations.

Figure 2-93. Station 120.13 - Typical of Series 80% Completed

CONSTRUCTION. Work was scheduled to commence on 1 October and to be completed on 31 December. For Stations 120.01 thru 120.23, actual start of construction varied from 7 September to 9 November. Completion dates varied from 14 January to 30 January. For Stations 120.24 thru 120.28, construction started on 6 April and was completed on 22 April.

STATIONS 122.01 - 122.35
SELF RECORDING GAGES
SITES VARIOUS - USER: BRL

GENERAL. The work involved consisted of locating and embedding four 6" I. D. steel pipes in a two-foot square configuration. The pipes were embedded three feet into the ground and instruments were attached which recorded pressure versus distance.

ENGINEERING. The original design criteria received on 30 April were for Stations 122.01 thru 122.27. On 9 July, Stations 122.01 thru 122.24 were deleted and Stations 122.28 thru 122.34 were added. Criteria of 2 September relocated Station 122.08. On 5 October, Stations 122.16 and 122.17 were relocated. On 23 October, Stations 122.28 thru 122.35 were deleted. One drawing was started 16 June, submitted on 24 June and approved and released on 14 July.

CONSTRUCTION. The schedule contemplated work to start on 10 January 1954 and to be completed on 5 February. Actual construction starting dates varied from 1 December to 18 January and completion dates varied from 8 January to 6 March 1954.

STATIONS 123.01 - 123.07 - REEF GAGES
SITE CHARLIE-DOG REEF - USER: BRL

GENERAL. These Reef Gage Stations consisted of a 6" I. D. steel pipe embedded ten feet into the reef and projecting six inches above high water, to which were attached instruments which recorded pressure versus distance.

ENGINEERING. The original criteria were received on 30 April 1953. On 29 June Stations

123.06 and 123.07 were deleted. On 9 September Station 123.01 was relocated and Stations 123.04 and 123.05 were deleted. Drawings were started 16 June and were included with the Station 122 series.

CONSTRUCTION. Work was scheduled to commence on 1 November and to be completed by 10 February 1954. Actual construction started 11 November and was completed on 26 December.

STATIONS 130.01 - 130.07 - PITOT GAGES
SITES VARIOUS - USER: SANDIA

GENERAL. These Pitot Tube Gage Mount Stations were identical to the Station 315 series; description is reported under the 315 series. These gages were to be used to record shock winds and after winds.

ENGINEERING. Criteria for Stations 130.01 thru 130.05 were received on 11 May. On 9 July, Station 130.06 was added and on 9 September

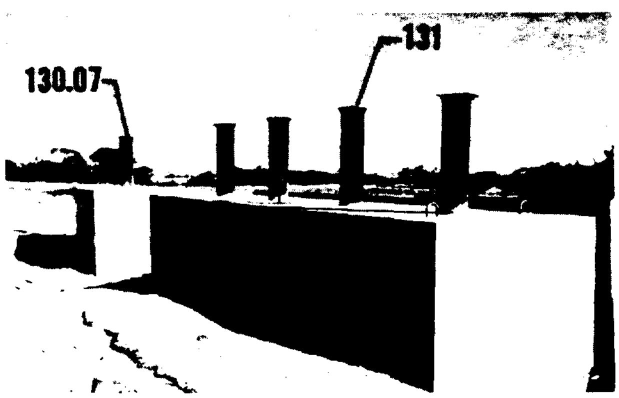


Figure 2-94. Stations 130.07 and 131 90% Completed

Station 130.07 was likewise added. Figure 2-94 includes Station 130.07 on site George and it is shown 90% completed on 5 December. Design data is reported under the 315 series.

CONSTRUCTION. Work was scheduled to commence on 1 October and to be completed on 10 January 1954. Actual construction starting time varied from 7 September to 15 December. Completion dates varied from 9 January to 25 January 1954.

STATION 131
MULTIPLE PITOT TUBE MOUNT
SITE GEORGE - USER: SANDIA

GENERAL. This Station consisted of a concrete footing 5′ x 20′ x 5′ deep with four 8″ I. D. pipes embedded in the footing and projecting three feet above the top of the footing. Each pipe had a three-inch round conduit embedded in the concrete and extending to the side of the footing to which were attached gages for calibrating force, drag, temperature and density. Figure 2-94 shows this Station as 90% completed on 5 December. The Station was located on the shore line and required protection from possible tidal and wave damage. Extra concrete was poured in front of the Station as noted in the photograph.

ENGINEERING. The original design criteria were received on 9 September. One drawing was required which was started on 10 September, and included with the Station 130 series.

CONSTRUCTION. Work was scheduled to commence on 15 September and to be completed on 30 January 1954. Actual construction started on 19 November and was completed on 23 January 1954.

STATION 142.02 - TEST HOLE PIT
SITE FOX - USER: ONR

GENERAL. This Station was a test hole, or pit, and was used for determining underwater pressure versus time.

ENGINEERING. This Station was relocated from George to Fox, as an elevation of plus ten feet was required. Test hole No. 6 was available and used.

CONSTRUCTION. Work was started on 20 December 1953 and was completed 23 January 1954.

STATIONS 143.01 - 143.44
BUOY WITH ANCHOR
SITE BIKINI LAGOON - USER: ONR

GENERAL. These Stations were reinforced concrete buoy anchors with a hooped bar projecting above and below the anchor to which were attached instruments for measuring underwater pressure versus time.

ENGINEERING. The original design criteria were received on 29 June 1953. One drawing was required which was started on 24 July, submitted on 5 August and approved and released on 2 September.

CONSTRUCTION. Work was scheduled to commence on 15 September with completion on 31 December. Actual construction started 10 December and all Stations were completed and placed by 2 January 1954.

STATION 144.01 - 144.16
BUOY ANCHORS
SITE BIKINI LAGOON - USER: ONR

GENERAL. These Stations were reinforced concrete buoy anchors and were used to record underwater pressure versus time.

ENGINEERING. The criteria were received on 23 July. Drawings required were included with the Station 143 series.

CONSTRUCTION. Work was scheduled to start on 15 September and to be completed on 31 December. Actual construction started on 10 December and was completed on 2 January 1954.

STATIONS 145.01 - 145.07
INSTRUMENT CANS
SITE ENIWETOK LAGOON
USERS: ONR and NOL

GENERAL. Each Station consisted of a five-ton instrument can placed in the Eniwetok Lagoon as designated by the User.

ENGINEERING. The Survey Department spotted the locations.

CONSTRUCTION. The Marine Department placed the moorings furnished by the User and assisted the User in securing the cans to the moorings. Work was started on 7 April 1954 and was completed on 14 April.

STATION 145.27 - 145.29
INSTRUMENT CANS
SITE BIKINI LAGOON
USERS: ONR and NOL

GENERAL. These Stations were located off site George in the Bikini Lagoon and were similar to the 145 series. These Stations were authorized on 6 June 1954 and were used in connection with the Station 30 detonation.

STATIONS 162.01 AND 162.02
SHORE RECORDER
SITES NAN and TARE - USER: ONR

GENERAL. The Stations consisted of recorder units furnished by the User.

ENGINEERING. One drawing was submitted on 18 August and was approved 3 November.

CONSTRUCTION. The work involved consisted of furnishing wiring and assistance in the installation. Work was undertaken in December 1953.

STATIONS 170.01 - 170.05
ACCELEROMETER STATIONS
SITES - VARIOUS - USER: SANDIA

GENERAL. These five Stations were located as follows: 170.01 on site Tare, 170.02 and .03 on site Sugar and 170.04 and .05 on site Pearl. The work involved consisted of placing User equipment from 15 to 30 feet in the ground and encasing this equipment in concrete. This equipment measured ground accelerations.

ENGINEERING. The original design criteria were received on 11 May 1953. Drawings required were included with Station 220 series.

CONSTRUCTION. Work was scheduled to commence on 1 October and to be completed on 15 January 1954. Actual construction starting dates varied from 7 September to 2 December. Completion dates varied from 10 December to 10 April.

STATIONS 210.01 - 210.61
FILM BADGE STATIONS (ON STAKES)
SITES VARIOUS - USER: ESL

GENERAL. Stations 210.01 thru 210.41 and 210.53 thru 210.56 were located on the various islands and reefs of the Bikini Atoll. Stations 210.42 thru 210.52 and 210.57 thru 210.61 were located on the various islands and reefs of the Eniwetok Atoll. These Stations were Film Badge Stations to measure the gamma total dose, and each Station consisted of a two-inch aluminum rod embedded four feet into the land or reef. The land Stations projected two feet above grade; the reef Stations projected four feet above the high water line.

ENGINEERING. Criteria were received on 12 May 1953, drawings were started on 7 July and submitted for approval on 9 July. AEC approved same on 28 July and prints were issued on 31 July. Originally only Stations 210.01 thru 210.52 were authorized. On 28 October, Stations 210.53 thru 210.59 were added and on 1 March 1954, Stations 210.60 and 210.61 were likewise added. Figure 2-95 is typical for the series and shows Station 210.23 on Oboe as completed on 5 January 1954.

CONSTRUCTION. Work was scheduled to commence on 1 November and to be completed on 31 January 1954. The starting dates of the individual Stations on Bikini varied from 11 November to 31 December. The completion dates varied from 5 January to 29 January. On Eniwetok, the starting dates varied from 31 December to 19 January 1954 and Stations were completed on 25 January with the exception of Stations 210.60 and 210.61. These two latter Stations were started on 1 March 1954 and were completed on 6 March.

STATIONS 220.01, 220.06 - 220.14
DOUBLE DETECTOR STATIONS
SITES VARIOUS - USER: ESL

GENERAL. These Stations were located on various islands in the Bikini Atoll. The work involved consisted of embedding User's equipment in approximately three cubic yards of reinforced concrete. The equipment measured gamma dose versus time.

ENGINEERING. The original design criteria were received on 29 May and a revised list of Station numbers and locations was received on 2 July. One drawing was started on 7 July, submitted on 9 July and approved on 28 July. One detail drawing was submitted on 29 November and approved on 22 December.

CONSTRUCTION. Work was scheduled to commence on 1 November and to be completed by 15 January. Actual starting dates varied from 9 November to 18 January; completion

Figure 2-95. Stations 210.23 and 220.08 Typical

dates varied from 2 January to 23 January 1954.

STATIONS 221.01 - 221.05
SINGLE DETECTOR STATIONS
SITES VARIOUS - USER: ESL

GENERAL. These Stations were located on sites William, Yoke, Zebra, Alfa and Bravo. The work involved consisted of embedding User equipment which measured gamma dose versus time in the ground. No concrete was required.

ENGINEERING. The original design criteria were received on 9 July and are reported in the Station 220 series.

CONSTRUCTION. Work was scheduled to commence on 1 December and to be completed on 31 Janary 1954. Actual construction started on 31 December. Completion dates varied from 5 January 1954 to 23 January.

STATIONS 231.01 - 231.15
WIDE FLANGE MOUNT
SITES VARIOUS - USER: NRL

GENERAL. For land Stations, a 20-foot pile was used with a five-foot projection. On reefs, a 25-foot pile was used with a ten-foot projection. These Stations were for neutron flux and spectrum measurements.

ENGINEERING. The original criteria for Stations 231.01 thru 231.08 were received on 1 May 1953. The User desired a wide flange beam capable of withstanding 25 psi pressures. This required a steel H-pile embedded for 15 feet in depth. On 29 July 1953, new criteria required the addition of an aluminum rod which projected four feet above each pile. On 2 September 1953, criteria changes increased the number of Stations thru 231.15. On 22 October 1953, all Stations, except 231.02 thru 231.05 and 231.13 thru 231.15, were cancelled. On 2 January 1954, Stations 231.13 thru 231.15 were relocated to a different site. One drawing was started on 7 July 1953, submitted on 9 July, and approved by AEC on 23 July; the drawing was issued on 31 July.

CONSTRUCTION. Originally, construction was scheduled to commence on 1 November 1953 and to be completed by 31 December. Due to the low priority assigned to this construction, the completion date was advanced to 10 February 1954. The construction starting dates of the individual Stations varied from 11 November to 28 January. The completion dates varied from 21 January to 8 February.

STATIONS 250.01 - 250.59
MOORING WITH FLOAT
SITES VARIOUS - USER: NRDL

GENERAL. Each Station of this series consisted of a 55-gallon drum float, painted yellow, secured in place by a concrete cube anchor with cable and used to measure fallout distribution.

ENGINEERING. The original criteria were received on 30 April 1953 for Stations 250.01 thru 250.26. On 23 July the criteria was amended to increase the number of Stations to 59. On 10 September one Station was deleted; the remaining Stations were renumbered so that Stations 250.01 thru 250.26 were located in the Bikini Lagoon and Stations 250.27 thru 250.28 were assigned to the Eniwetok Lagoon. One drawing was started on 12 June, completed on 24 June and approved on 13 July.

CONSTRUCTION. The work was originally scheduled to start on 15 September and to be completed by 31 December. Due to its low work priority, the completion date was extended to 25 February 1954. Construction for Stations in the Bikini Lagoon was started on 9 September and completed on 16 January. For the Eniwetok Lagoon, the Stations were started on 8 September and were completed on 23 January. All work was completed in January, but by 25 February, 12 floats at Eniwetok and seven floats at Bikini had broken loose. This was caused by cable abrasion against the coral. The cable size was increased from ¼ to ½-inch and moorings were relocated. After the initial test at Bikini, many of the floats were lost. On 26 March 1954, Stations 250.29, .40, .52, .53 and .56 were deleted.

STATIONS 251.01 - 251.10
CONCRETE BOX
SITES VARIOUS - USER: NRDL

GENERAL. These land instrument Stations were located on various islands in the Bikini Atoll to measure fallout distribution. Each Station consisted of a reinforced concrete box 8′-4″ x 8′-4″ x 5′-0″ high. There was no top or bottom to the box, which was embedded four feet into the ground; the lower two feet of the box was filled with coral sand. Figure 2-96 shows Station 251.02 completed on Fox; this example is typical of the series.

ENGINEERING. The original design criteria were received on 30 April 1953. Minor revisions were made on 29 July. One drawing was required and was started on 7 July, submitted on 9 July, approved on 28 July, and issued on 31 July.

CONSTRUCTION. Work was originally scheduled to start on 1 September and to be completed by 1 November. Due to low construction priority, the completion date was advanced to 1 February 1954. Actual starting dates varied from 3 October to 5 December. Completion dates varied from 28 November to 23 January 1954.

STATIONS 252.01 - 252.14
CONCRETE PLATFORMS
SITES VARIOUS - USER: CRL

GENERAL. These Stations were Double Collector Pits used in OPERATION IVY (541 series) and moved to Bikini for re-use to measure fallout distribution. These Stations consisted of a trapezoidal-shaped concrete slab about 6′-10″ long. Each slab had anchor bolts at each corner. At one end was a battery pit and cover,

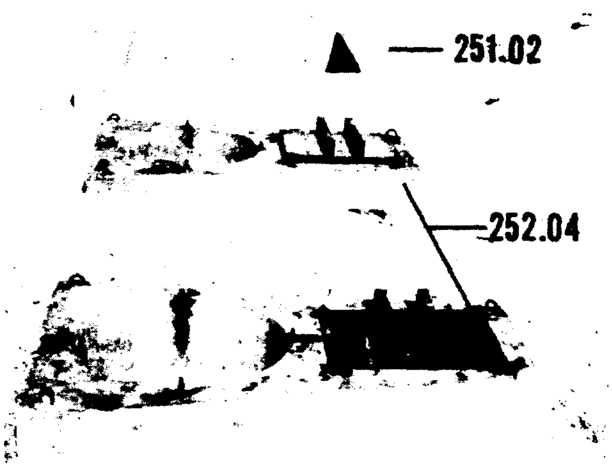


Figure 2-96. Stations 251.02 and 252.04 Typical

at the other end a collector hole. Figure 2-96 shows Station 252.04 at Fox and completed. This Station is typical of the series.

ENGINEERING. The original criteria were received on 30 April 1953; one drawing was required. It was started on 10 June, submitted on 16 June, and approved and issued on 13 July. On 7 October, Station 252.07 was relocated.

CONSTRUCTION. Work was originally scheduled to start on 1 September and to be completed 1 November. The completion date was later re-scheduled for 1 February 1954. Actual starting dates varied from 1 October to 20 October. Completion dates varied from 5 December to 20 January 1954.

STATIONS 253.01 - 253.03
OPEN BOX - SITES VARIOUS - USER: CRL

GENERAL. These Stations were located on sites Victor, William and Yoke and were referenced for all tests in the Bikini Atoll for measuring fallout distribution. Each Station consisted of a reinforced concrete wall, 5′-6″ high and embedded two-feet below grade. An eight-inch slab projected two-feet in front of the Station and four feet in the rear. This slab acted as a footing for two wing walls which projected down and behind the main wall.

ENGINEERING. The original design criteria were received on 30 April 1953. One drawing was required, which was started on 29 May, submitted on 1 July, approved on 30 July and released on 31 July. One revision was made on 31 July 1953.

CONSTRUCTION. Work was scheduled to commence on 1 January 1954 and to be completed on 10 March. Actual construction work started on 24 December. Station 253.02 was completed by 9 January; the remaining two Stations were completed on 23 January.

STATIONS 255.01 - 255.07
GUY ANCHOR
SITES VARIOUS - USER: CRL

GENERAL. Each Station consisted of four guy anchors, equally spaced and all lying on the circumference of an 18-foot diameter circle. The purpose of these Stations was to measure fall out distribution.

ENGINEERING. The original design criteria were received on 15 October 1953. One drawing was required, which was started on 20 October, submitted on 22 October and approved on 17 November.

CONSTRUCTION. All work was accomplished by the Military.

STATION 300
RECORDER SHELTER
SITE UNCLE - USER: SRI

GENERAL. This Station was similar to Station 101 but was used for recorder loading and damage to structures, Project 3.1.

ENGINEERING. Reported under Station 101.

CONSTRUCTION. The work was originally scheduled to commence on 1 December and to be completed by 28 February 1954; User occupancy was desired by 15 February. Actual work started on 7 December and was completed by 13 February. Station 102, Figure 2-91 shows a typical exterior for this series and Figure 2-90 shows a typical interior.

STATION 310 - TARGET
SITE UNCLE - USER: SRI

GENERAL. This Station was an earthfilled, reinforced concrete box 6′- 0″ x 12′-0″ x 9′- 0″ high with no openings except a removable 2′- 0″ x 3′0″ steel panel. The floor of this Station was below grade, located so that only the upper six feet of the structure was exposed. This structure housed pressure gages which were connected with conduits to a junction box equipped with a cover plate, and accessable from outside the structure.

ENGINEERING. The original criteria were received on 30 April and design work of three plans and one sketch started on 1 June. On 7 July, this Station was cancelled and then re-established on 21 October. Plans were completed on 28 October and approved on 17 November.

CONSTRUCTION. Construction work was scheduled to commence on 1 January and to be completed by 28 February. Actual construction started on 1 December and was completed on 13 February.

STATIONS 311.01 AND 311.02
10 FOOT HIGH GAGE TOWERS
SITE UNCLE - USER: SRI

GENERAL. Each Station consisted of a 2′ - 6″ cube concrete footing. A 3″ I. D. steel pipe was embedded into this footing and projected out of the side by bends and extended ten feet above the grade. This pipe was guyed in three directions and at two levels. These towers were used for Project 3.1.

ENGINEERING. The original design criteria were received on 30 April. On 7 July, these Stations were relocated. On 5 August, Station 311.02 was deleted and on 23 October, Station 311.01 was likewise deleted. On 27 October, both Stations were reinstated but at a new location. One drawing was started on 26 May, submitted on 29 May and approved on 19 June.

CONSTRUCTION. Construction work was scheduled to commence on 10 November and to be completed by 28 February. Actual construction started on 24 December. The User requested occupancy by 15 February. All work was completed by 6 February.

STATIONS 315.01 AND 315.02
PITOT TUBE MOUNTS
SITE UNCLE - USER: SRI

GENERAL. The structure consisted of a cube block of reinforced concrete, 5′- 0″ x 5′- 0″ x 5′- 0″ An 8″ I. D. round steel pipe projected 3′-0″ above the top center with a three-inch conduit out to the side of the Station. Used for Project 3.1.

ENGINEERING. Original design criteria were for Station 315.01 and were received on 5 August. On 23 October this Station was deleted. On 27 October this Station was reinstated and Station 315.02 was added. The drawing required was included with the drawing for the Station 120 series.

CONSTRUCTION. Construction work was scheduled to commence on 15 November and to be completed by 15 February. Actual construction started on 19 December and was completed on 9 January 1954.

STATION 322
RAYDIST EQUIPMENT SHED
SITE NAN - USER: SRI

GENERAL. This Station was a 9′-0″ x 13′-0″ wood-frame structure with plywood sides and aluminum roof. The Station was mounted on six-inch by six-inch wood skids and was used in connection with Project 3.2.

ENGINEERING. One field sketch was prepared by Field Engineering.

CONSTRUCTION. Work started on 1 February 1954 and was completed on 6 February.

STATIONS 620.01 - 620.05
RAYDIST EQUIPMENT
SITES VARIOUS - USER: WADC

GENERAL. These Stations, located at sites Fred, Glenn, LeRoy and Elmer were added in March 1954 due to the rescheduling of the Test Program. The work involved consisted of installing Raydist equipment, motor generator sets and providing fuel tanks for Project 6.2.

ENGINEERING. Field Engineering prepared drawings and field sketches as required.

CONSTRUCTION. Work was started on 12 April 1954 and completion dates varied from 13 April to 15 April.

STATION 650 - MOOR BARGE 125
SITE ENIWETOK LAGOON - USER: CRL

GENERAL. This Station was added in March 1954 due to the rescheduling of the Test Program. The work involved consisted of furnishing a barge with fittings and mooring in location selected for Project 6.5.

ENGINEERING. Field Engineering prepared field sketches as required.

CONSTRUCTION. Work commenced on 5 April 1954 and was completed on 21 April.

STATION 661 - ANTENNA POLE
SITE ELMER - USER: ESL

GENERAL. This Station consisted of a wood pole set securely in the ground with a braced cross-arm 50 feet above the ground for ionosphere study, Project 6.6.

ELECTRICAL. This Station was supplied power originally from an engine generator unit, but on 15 April 1954, it was tied into the island power distribution system.

ENGINEERING. Two plans were submitted on 20 October 1953 and were approved on 24 November.

CONSTRUCTION. Work was started on 3 November 1953 and was completed on 16 January 1954.

STATION 710 TRAILER - SITE NAN
USER: AFOAT-1

GENERAL. The work involved consisted of installing a trailer and type A tent with electrical connections as desired by the User for Project 7.1, electromagnetic radiation.

CONSTRUCTION. Work started on 25 January 1954 and was completed on 5 February.

STATION 711 - TRAILER AND TENT
SITE ELMER - USER: AFOAT-1

GENERAL. Same as Station 710 with the exception that support work only was required.

STATION 712 - TRAILER AND STATION
SITE YVONNE - USER: AFOAT-1

GENERAL. This Station was reactivated from IVY Station 605 in March 1954 due to the rescheduling of the Test Program. The work involved consisted of installing cables to Station 72.03, installing power units and air conditioning unit and replacing earth fill for Project 7.1. Figure 2-97 shows the south and east walls with power connections.

ENGINEERING. Field Engineering prepared field sketches as required.

CONSTRUCTION. Work commenced on 30 March 1954 and was completed on 13 April 1954.

STATION 1110 - 1114
UF6 IN CYLINDERS - SITES VARIOUS
USER: LASL

GENERAL. Station 1110 was located inside of Station 20 and the other Stations were located on each of the four barges. The work involved consisted of installing bolted steel frames to support cylinders. Each cylinder was held down

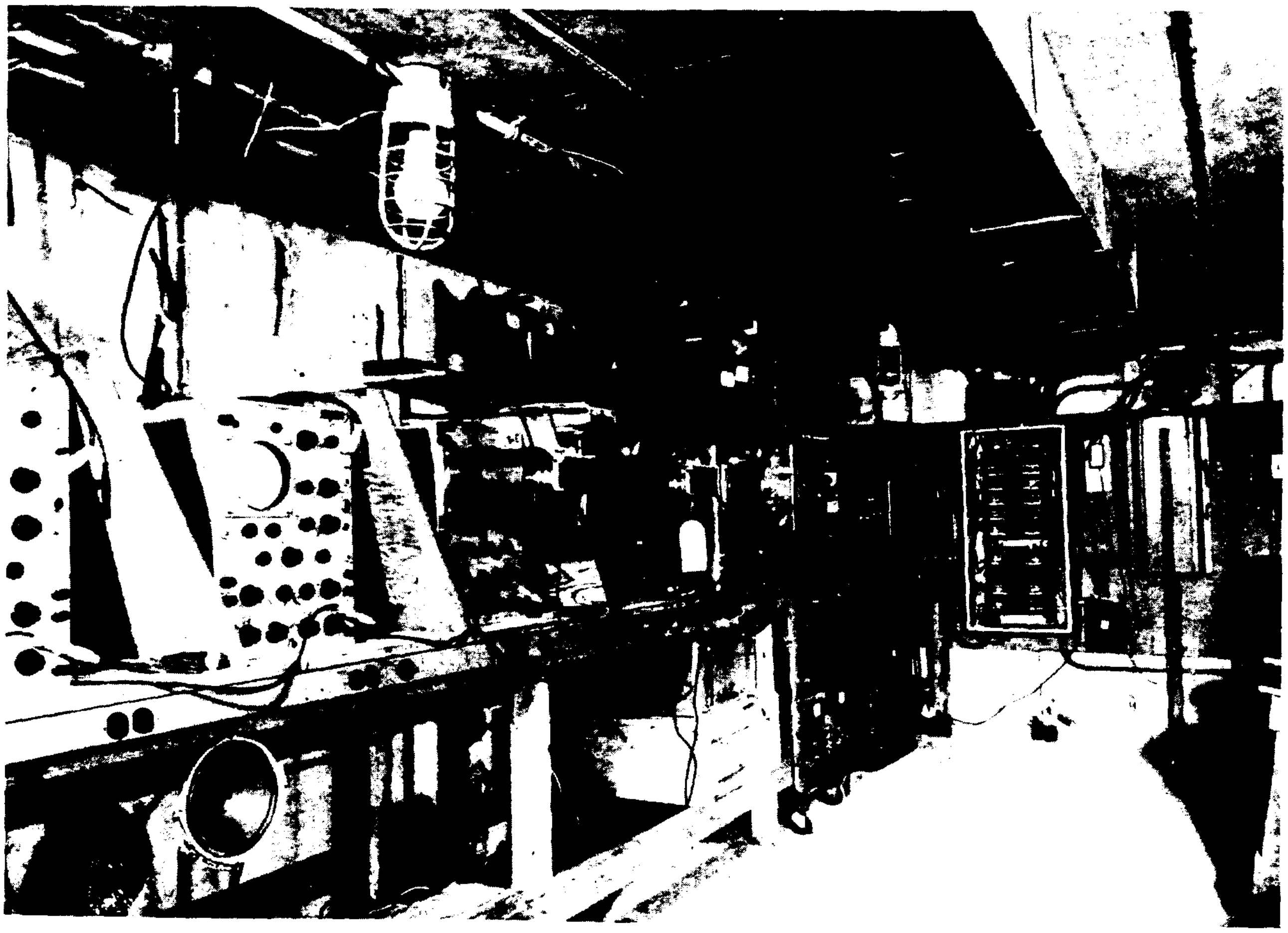


Figure 2-97. Station 712 - Interior

Figure 2-98. Station 1200 - 25% Completed

by tie rods. These Stations were for Rad Chem analysis, Project 11.1.

ENGINEERING. The criteria were received on 1 October. Two drawings were started on 27 October. The drawing for Station 1110 was submitted by 3 November and approved on 21 December. The drawing for the other Stations was submitted on 27 October and approved on 17 November.

CONSTRUCTION. Work was scheduled to commence on 1 November and to be completed by 31 December. Actual construction starting dates varied from 6 to 20 January. All Stations were completed on 30 January 1954.

STATION 1120.01
PORTABLE COLLECTOR - SITE ZEBRA
USER: LASL

GENERAL. An area with a 25-foot radius was staked out and cleared in the center of which a geographic position was determined. This Station was for a sample collection, Project 11.2.

STATION 1200 - RECORDING STATION
SITE CHARLIE - USER: UCRL

GENERAL. This was a heavy reinforced, earth covered rectangular structure, 41′-0″ x 49′-0″ with a tunnel entrance. It was divided into three rooms and opened at one end into a corridor and utility room that housed the electrical and mechanical equipment. Access to the utility room was provided through a 4′ - 2″ wide x 9′ 0″ high tunnel. At about 18 feet from the end of the utility room, the tunnel turned 90° and extended for about 40 feet on a slight upward grade to a covered entrance. The tunnel entrance had two openings, each enclosed by a steel, blast-resistant door. A 5′-0″ x 7′-0″ protected area outside the opening was completely housed by a small reinforced concrete box-like structure called the vestibule. The main entrance opened onto a reinforced 16′-0″ x 20′-0″ concrete loading platform and a 20′-0″ x 68′-0″ loading ramp. This Station was used for Reaction History, Project 12.1.

MECHANICAL. Dehumidification was provided in the three instrument rooms. The corridor utility room was ventilated with filtered fresh air. The rooms were kept under a dry air pressure preventing infiltration of large quantities of humid corridor air whenever the doors to these rooms were opened. Conditioning units in each room recirculated, cooled and reheated the room air as required to maintain desired conditions.

ELECTRICAL. The power to the Station was received from the generators at Station CH-500 through three 75 KVA transformers in Substation CH-1200-X. One feeder served the light-

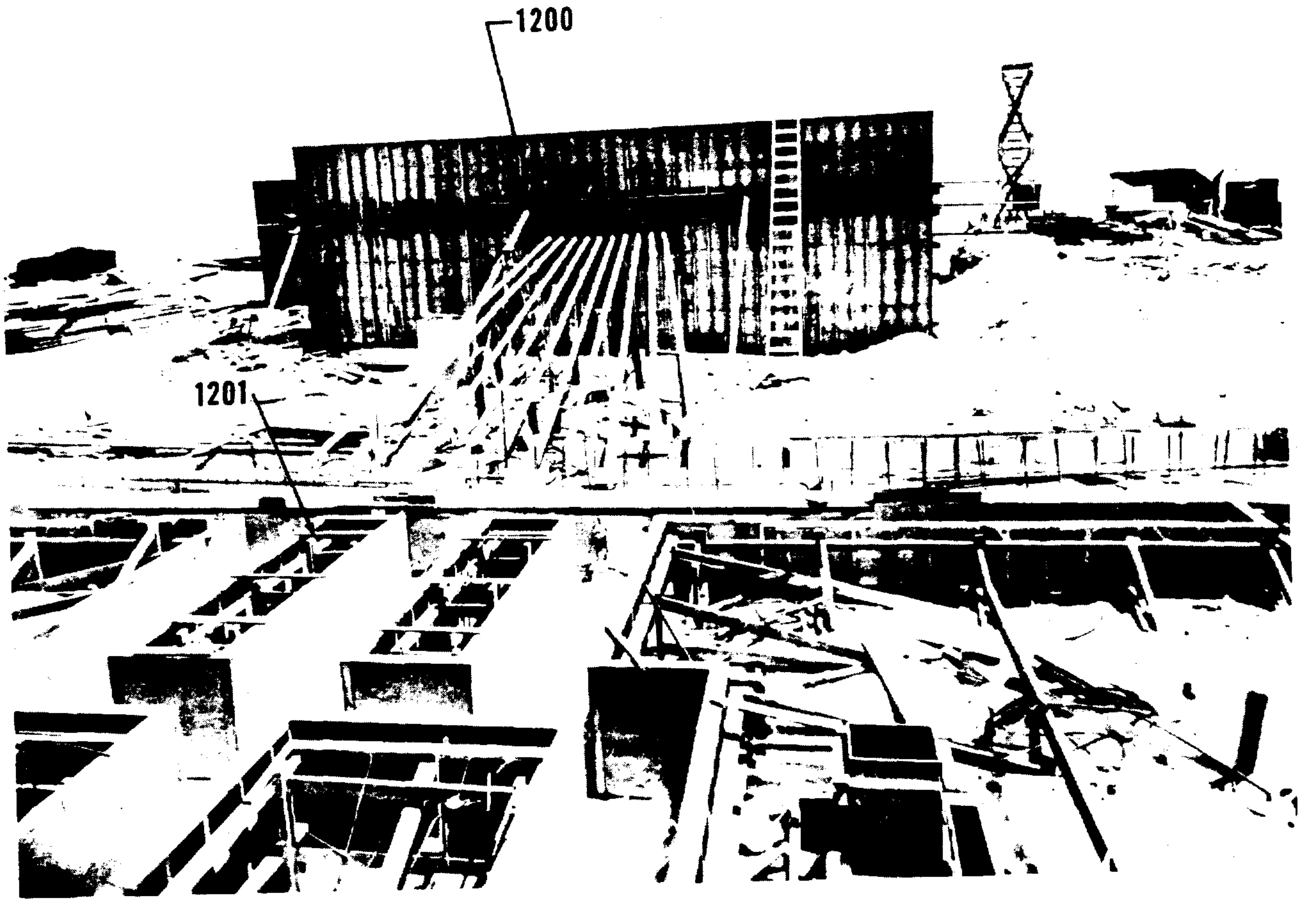


Figure 2-99. Station 1200 - 36% Completed

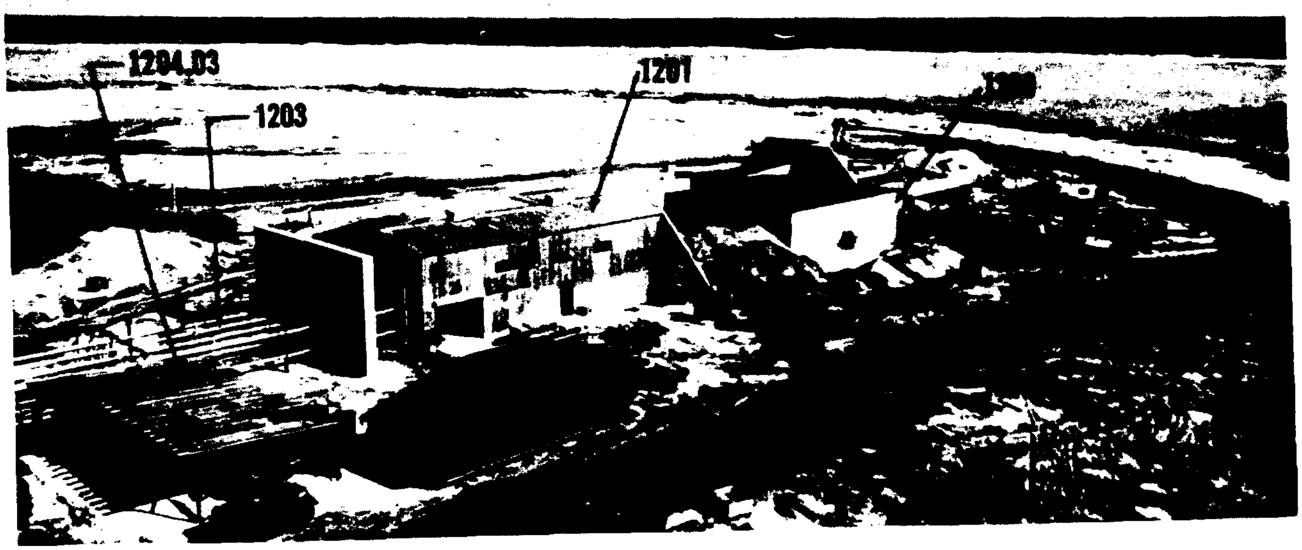


Figure 2-100. Station 1200 - 82% Completed

ing and utility power through a full standing switchboard. A second feeder was for scientific power and entered the Station through a User-furnished power filter and then to its main distribution board. All electrical work was of the rigid conduit type and general lighting with vapor-proof fixtures was provided. Ten three-inch rigid conduits tied this Station to Station 1201 for use of User-furnished coax cable.

ENGINEERING. On 27 March 1953 various changes were desired by the Users in regard to preliminary functional drawings previously furnished to them. These changes consisted of adding a lead door in the tunnel, sealed against radiation, and additional reinforcements. Additional criteria were received on 20 April, 11 May and 15 July. The original electrical criteria were received on 17 February. Changes in electrical criteria were received on 27 July and on 12 August. Twenty-one plans and one sketch were prepared. Drawings were submitted from 8 May to 25 September. Approvals were from 9 June to 9 October.

CONSTRUCTION. Work was scheduled to commence on 1 July and to be completed by 31 January 1954. The User requested occupancy by 5 January. Actual construction work started on 8 July and work was completed on 25

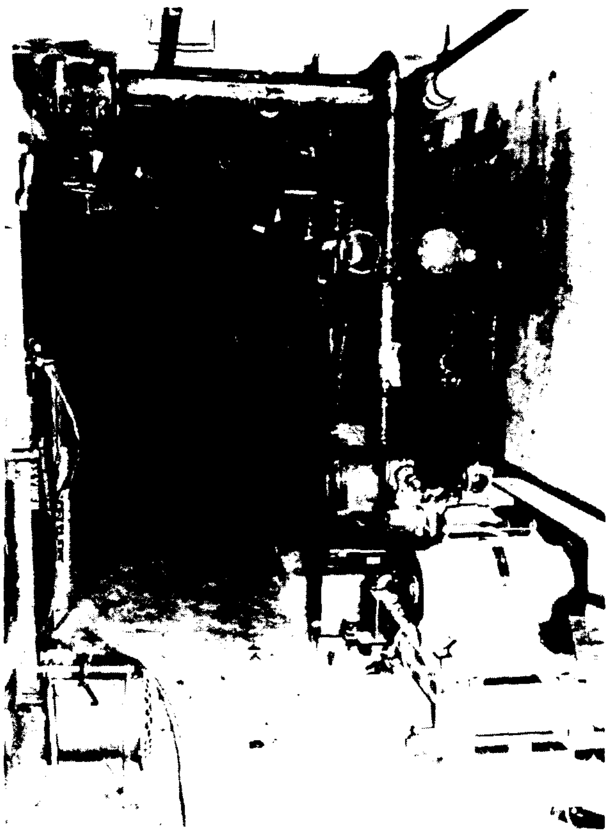


Figure 2-101. Station 1200 - Interior Utility Room

January. Figure 2-98 notes 25% progress as of 10 September. The figure shows the west side of the Station with the forms for the side walls being erected. Figure 2-99 notes 36% completion as of 5 October The front wall of Station 1200 is shown with its relation to Station 1201. Figure 2-100 notes 82% completion as of 19 December. The relation of Station 1200 to Stations 1201, 1203 and 1204.03 is shown. Figure 2-101 shows the interior of the utility room looking towards the entrance tunnel. Figure 2-102 shows Stations 1200, 1201 and 1204.03 completed as of 5 February. The earth fill for Station 1200 is shown. When compacting the earth cover over this Station a leak developed in the concrete roof slab, requiring removal of a portion of the cover and waterproofing of the slab. Waterproofing will be specified for future work of this sort. In the foreground of Figure 2-102 are the User's trailers alongside the loading ramp.

STATION 1201
DETECTOR STATION - SITE CHARLIE
USER: UCRL

GENERAL. The Station, used for reaction history, was a steel framed building 60′-0″ x 26′-0″ x 20′-0″ high with corrugated aluminum roofing and siding. From the underside of the roof beams, crane girders were hung for a two-ton bridge crane moving from end to end of the building. One of the end walls was a reinforced concrete retaining wall which followed the roof slope of the building and sloped to the grade from the eave strut. At the center of the wall, a reinforced concrete cave extended 8′-0″ into the earth fill. This cave was five feet high. At the end farthest from the retaining wall there was a 38′-0″ x 22′-0″ high reinforced concrete shield wall 14 feet in front of the end wall. The floor of the building was a reinforced concrete slab poured on grade.

MECHANICAL. The mechanical features included a two-ton bridge crane, a half-ton monorail hoist, forced air ventilation and sump pump.

ELECTRICAL. Power was sub-fed from Station 1200.

ENGINEERING. Original criteria were received on 10 April 1953. Additional criteria were received on 15 July, 31 July, 7 August, 14 August and 19 August. Engineering design started on 23 June. Six drawings were submitted from 1 July to 27 August and were approved from 4 August to 2 September.

CONSTRUCTION. Construction was scheduled to commence on 20 September and to be completed by 31 December. Actual work started on 23 September and was completed on 23 December. The foundation progress photograph is shown under Station 1200 (Figure 2-99). Figure 2-103 shows the baffle wall for

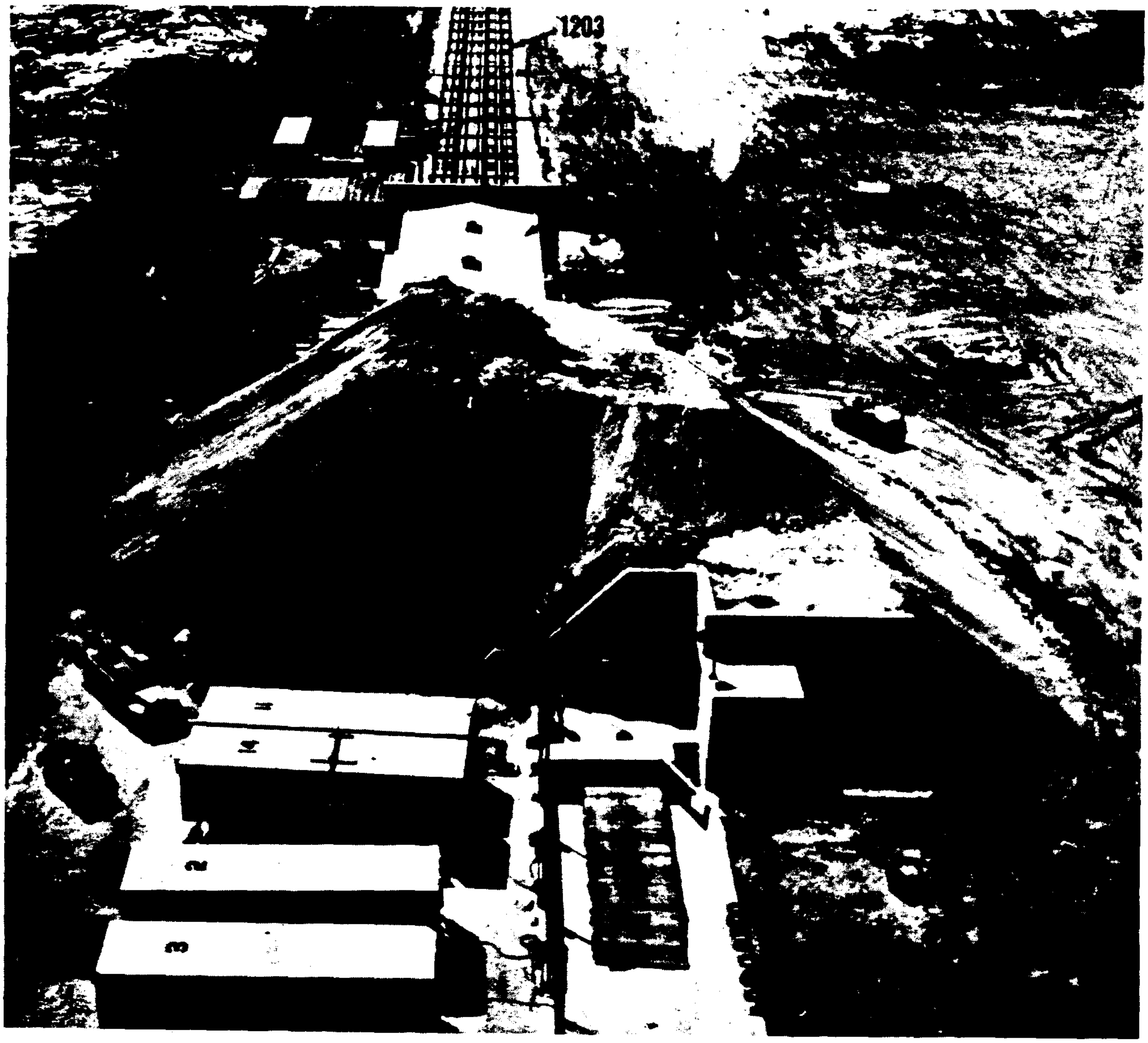


Figure 2-102. Stations 1200, 1201 and 1204.03 Completed

Station 1201 poured as of 5 November. Figure 2-104 notes the entrance to the Station. In the rear is the 12 pipe array. The Station, as shown on 4 December, was 79% completed. Figure 2-105 shows the Station completed as of 3 February with Station 1200 (at right) earth covered. Other views of Station 1201 completed are shown under Station 1200, Figures 2-100 and 2-102.

STATION 1202
SHIELD WITH CONVERTERS
SITE BAKER-CHARLIE REEF
USER: UCRL

GENERAL. This Station, used for reaction history, consisted of an earth-filled 12'-0" x 44'-0" x 22'-0" high reinforced concrete structure supported on H-bearing piles. A concrete chute extended into Station 20. Equipment was supported on tall concrete piers. There was no roof over the building.

ENGINEERING. The original design criteria were received on 19 May. New criteria were received on 23 June, 12 August and 18 September. Design work was started on 23 June. Four drawings were prepared and submitted from 17 July to 14 September. Approvals were dated from 31 July to 19 November. Figure 2-106 shows the Station as 89% completed as of 4 December. The figure shows the south and east walls of Station 1202.

CONSTRUCTION. Work was scheduled to commence on 1 October and to be completed

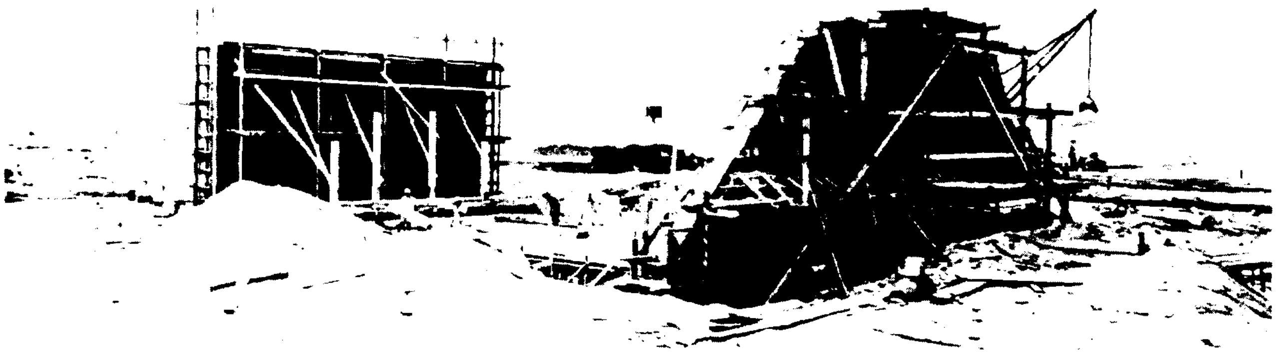


Figure 2-103. Station 1201 - 42% Completed

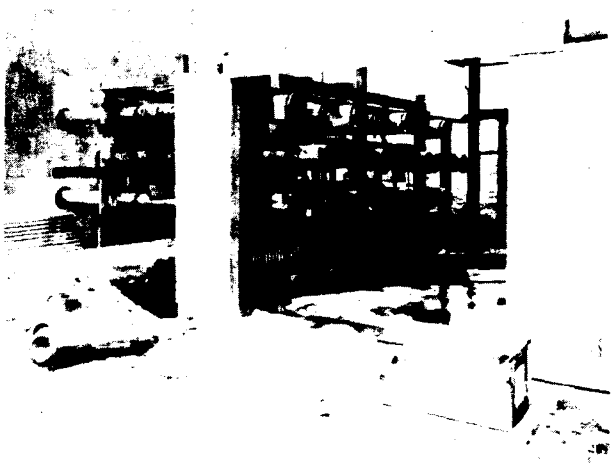


Figure 2-104. Station 1201 - Entrance to

by 31 December. Actual construction started on 3 September and was completed on 29 December.

STATION 1203 - PIPELINE
SITE CHARLIE - USER: UCRL

GENERAL. This Station, used for reaction history, consisted of a group of 12 pipes, or a pipe array, 7437′ - 6″ long supported by wood frames spaced approximately 20 feet apart. Pipes were fabricated of 12-gage steel, spiral wound, shaped and welded to form an 8 5/8″ O. D. pipe. Individual pipes were fabricated in 40-foot lengths and were billet welded together at site to form bents approximately 240 feet long. In each bent a rubber pipe section 24 inches long was inserted to serve as an expansion joint and, a light probe opening was provided

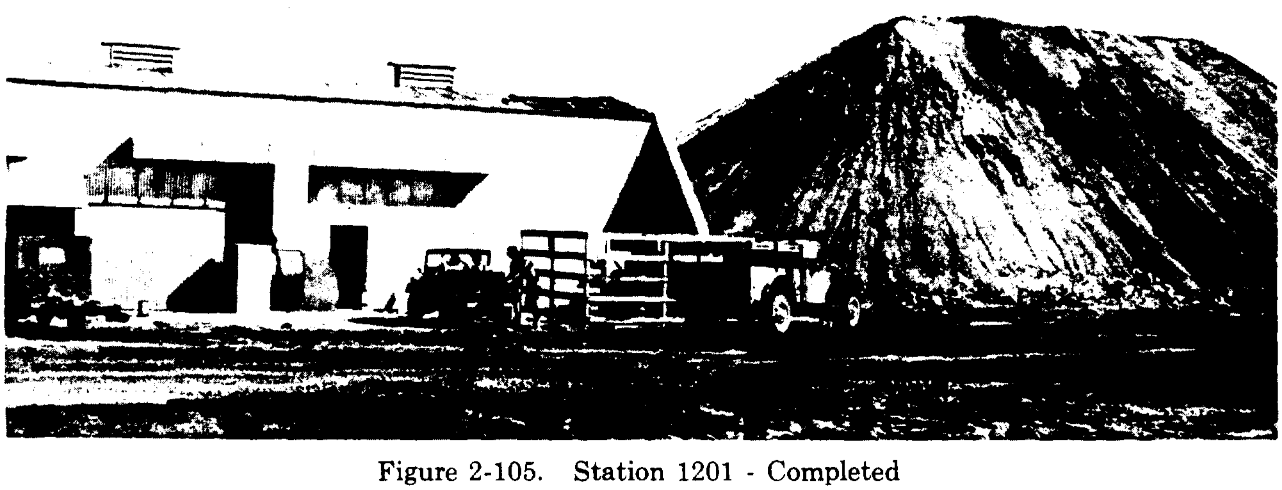


Figure 2-105. Station 1201 - Completed

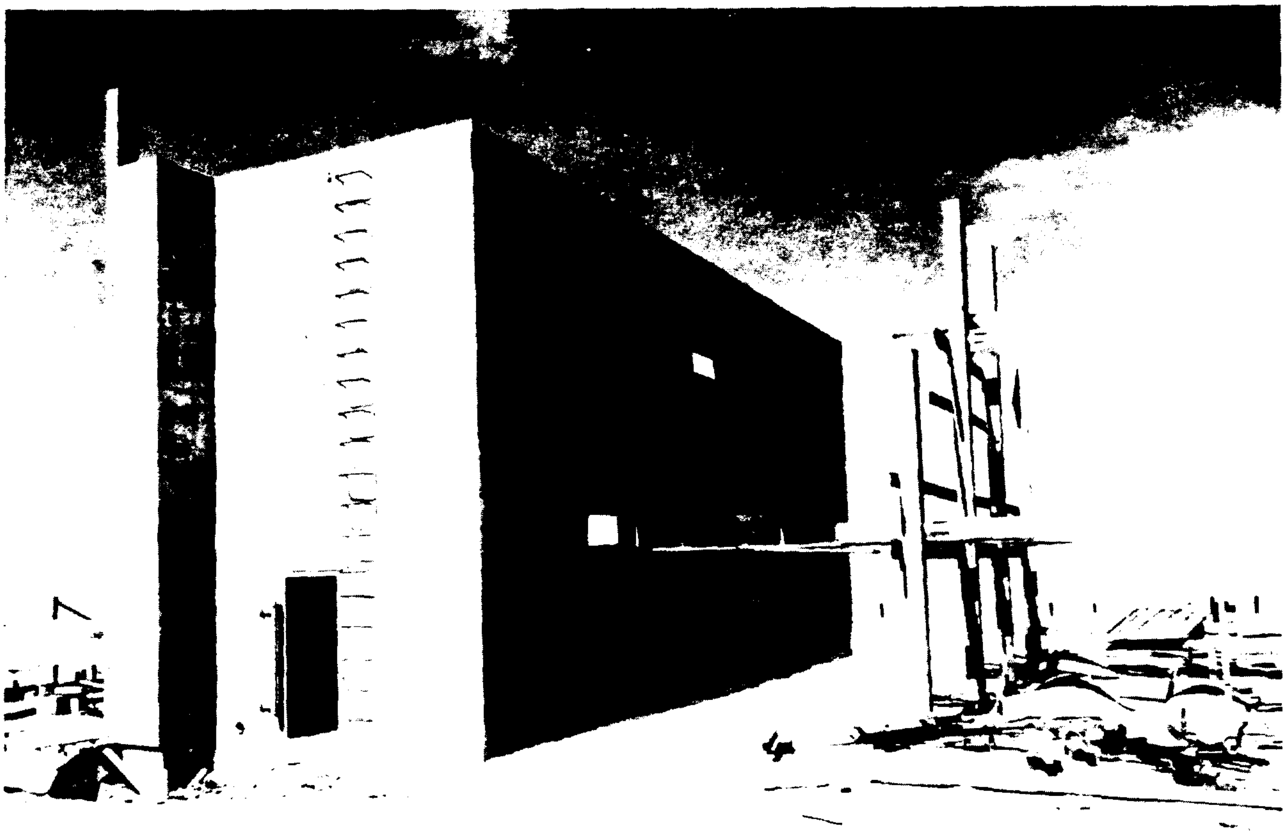


Figure 2-106. Station 1202 - 89% Completed

for alignment purposes. Two insulating pipe sections, 20 feet long, were provided for each pipe; however, during early tests, failure occurred in an insulating section and they were eliminated. Provisions were made in each of the 12 pipes for connecting vacuum pumps for evacuating the pipeline. The vacuum pumps, which were furnished by the User, are described under Station 1204.03.

ENGINEERING. The original design criteria for this Station were received from UCRL in a letter dated 18 December 1952. At that time it was planned to construct a seven-pipe array approximately 9,500 feet long on the Tare-Sugar-Roger group of islands at Bikini. The location was later changed to site Charlie, and the number of pipes was increased to 12. In the original criteria it was established that the alignment of the pipeline, both horizontal and vertical, would have to be held in a straight line from the device to the detector. It was further established that the pipeline should be designed to withstand a wind of 35-mph without movement and a wind of 90-mph with movement, although after a 90-mph wind it would be expected that minor adjustments, repair and realignment would be required.

On 19 December 1952, an alignment procedure was submitted to UCRL which covered the alignment of a continuous pipeline 10,000 feet in length, to a horizontal and vertical tolerance of plus or minus 0.5 inch from a line of sight between working points at the extremities of the line. On 23 January 1953, results of tests conducted at the jobsite were received showing solar radiation did not adversely affect alignment of a section of 8 5/8" O. D. pipe. Investigations were conducted in cooperation with UCRL representatives to obtain suitable expansion and insulating joints. A 4,000-foot trial section of pipeline was constructed at UCRL, Livermore, California, and tested. In the meantime, the specification for the pipe was received from UCRL who had made preliminary arrangements to secure it for the various arrays from Armco Drainage and Metal Products, Inc. The procurement of this material was turned over to H & N by the Field Manager for further processing through Armco Drainage and Metal Products, Inc., and delivery to Jobsite. Preliminary design work undertaken is noted above. Working drawings were started on 8 May and seven drawings and seven sketches were submitted from 14 May to 1 December. Approvals were dated from 3 June to 8 January 1954.

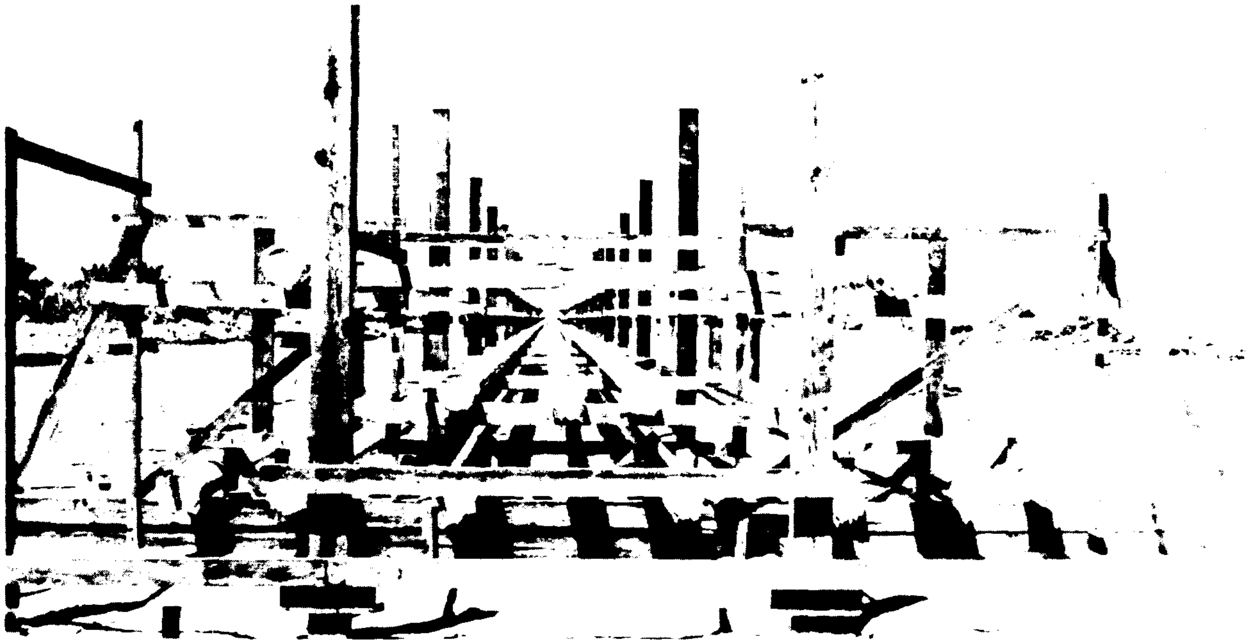


Figure 2-107. Station 1203 - Progress Photograph

CONSTRUCTION. Work was scheduled to commence on 15 June and to be completed by 31 January. Actual work started on 15 June and was completed on 30 November. Figure 2-107 shows status of work on 10 September. Figure 2-108 shows pipe array with horizontal and vertical hardware in place and ready for alignment. Correction to pipeline alignment for curvature of the earth's surface was at first incorrectly applied in the vertical alignment of this Station. The error was detected by telescope and gamma ray source checking, and corrected. Stations 2220 and 2230 were satisfactorily aligned by precise survey methods introduced as a result of the experience with Station 1203. Some trouble was experienced with the wood frames and hardware. With the number of pipes to be supported, the frames were slightly under-designed. The hardware likewise should have been sturdier. With alternating

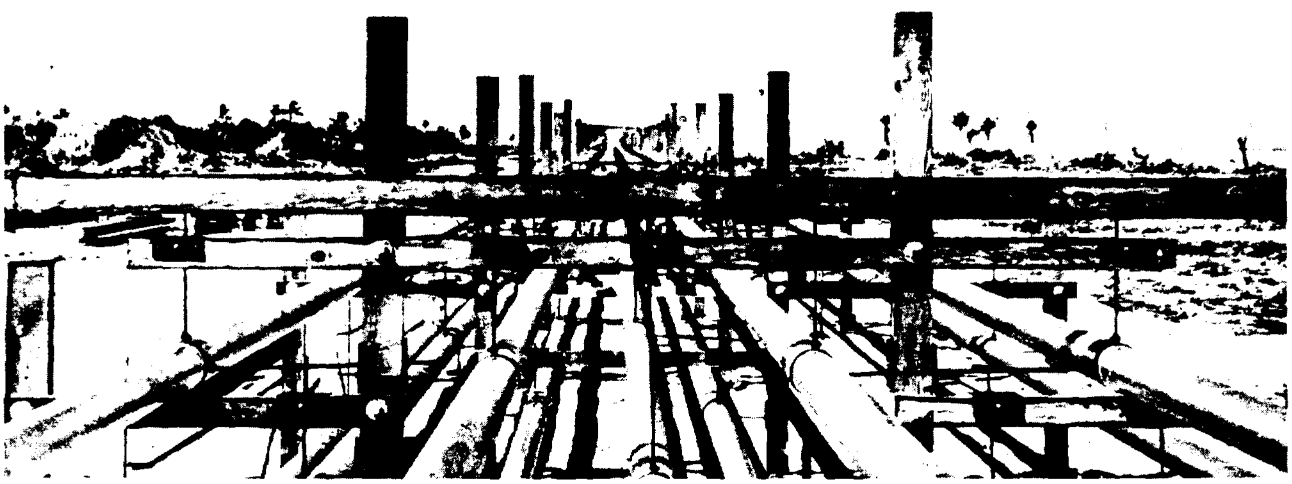


Figure 2-108. Station 1203 - Hardware Installed

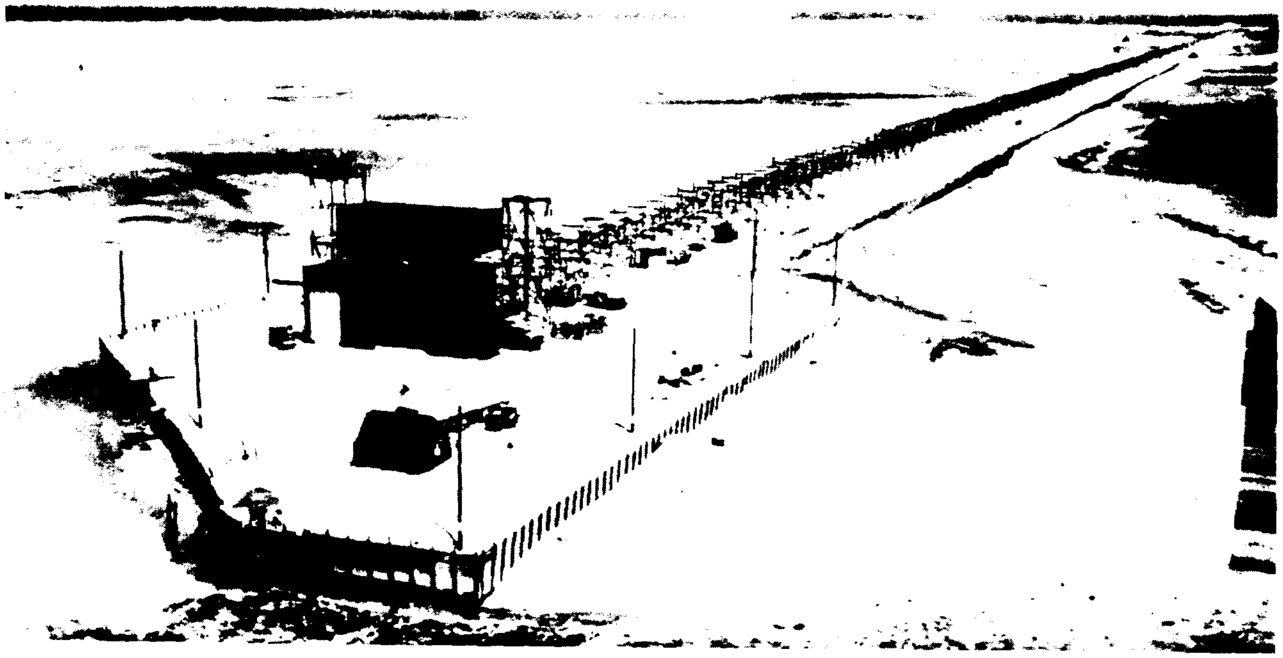


Figure 2-109. Station 1203 - Completed - Aerial View

rains and sunshine, the timbers did warp considerably. This was partially corrected by staggering the clips and increasing the size of some of the horizontal wood frames. To maintain the alignment tolerances required additional checking by the surveyors as noted in Section 1A of this chapter. Figure 2-109 notes Station 1203 completed. This aerial view was taken over the Baker-Charlie Reef looking towards Station 1200. Other details for Station 1203 are shown in figures for Stations 30, 1200, 1201, 1202 and 1204.03.

STATIONS 1204.01 - 1204.03
PUMP STATIONS - SITE CHARLIE
USER: UCRL

GENERAL. These Stations were the permanent pumping Stations for holding the pipe array (Station 1203) under a pressure of 1 cm. Hg. absolute or less. Only one Station (Station 1204.03) was constructed and it contained six 5HP vacuum pumps permanently located on 5′-0″ x 4′ x 0″ x 6″ thick reinforced concrete pads. An auxiliary manifold was provided for connecting an additional four portable vacuum pumps. Salt water was used to cool the vacuum pumps. Figure 2-110 shows the pumps installed and the status of work as 70% completed on 4 December.

ENGINEERING. The criteria were received on 30 April 1953. The mechanical drawing was started on 25 May, was submitted on 24 June and approved on 21 July. The structural work was started on 5 October, submitted on 7 October and approved on 15 October.

CONSTRUCTION. Work was scheduled to commence on 1 October and to be completed by 31 January. Actual construction work was started on 2 November and was completed on 30 November.

STATION 1210 - RECORDING STATION
SITE DOG - USER: LASL

GENERAL. The Station, used for reaction history, was an earth reinforced concrete building containing two main rooms, 12′ - 8″ x 34′ - 8″ and 25′ - 2″ x 28′ - 6″. The entire building was supported on a slab 4′-0″ thick. Three exterior walls and the roof slab were 7′ -0″ thick. The side wall of the larger room, and adjacent to the doors, was 7′ -0″ thick while the remaining two walls of this room and roof slab were 4′ - 0″ thick. There was a reinforced concrete boxed passageway which made two right angle turns before coming out of the earth fill at a point 30 feet from the building side wall. At the exit and at the passageway entrance there was a lead blast type door with a two-ton chain hoist. The entire building was covered with a sloping earth fill to a height of seven feet above the highest building point.

MECHANICAL. The mechanical features included a dehumidification system similar to that

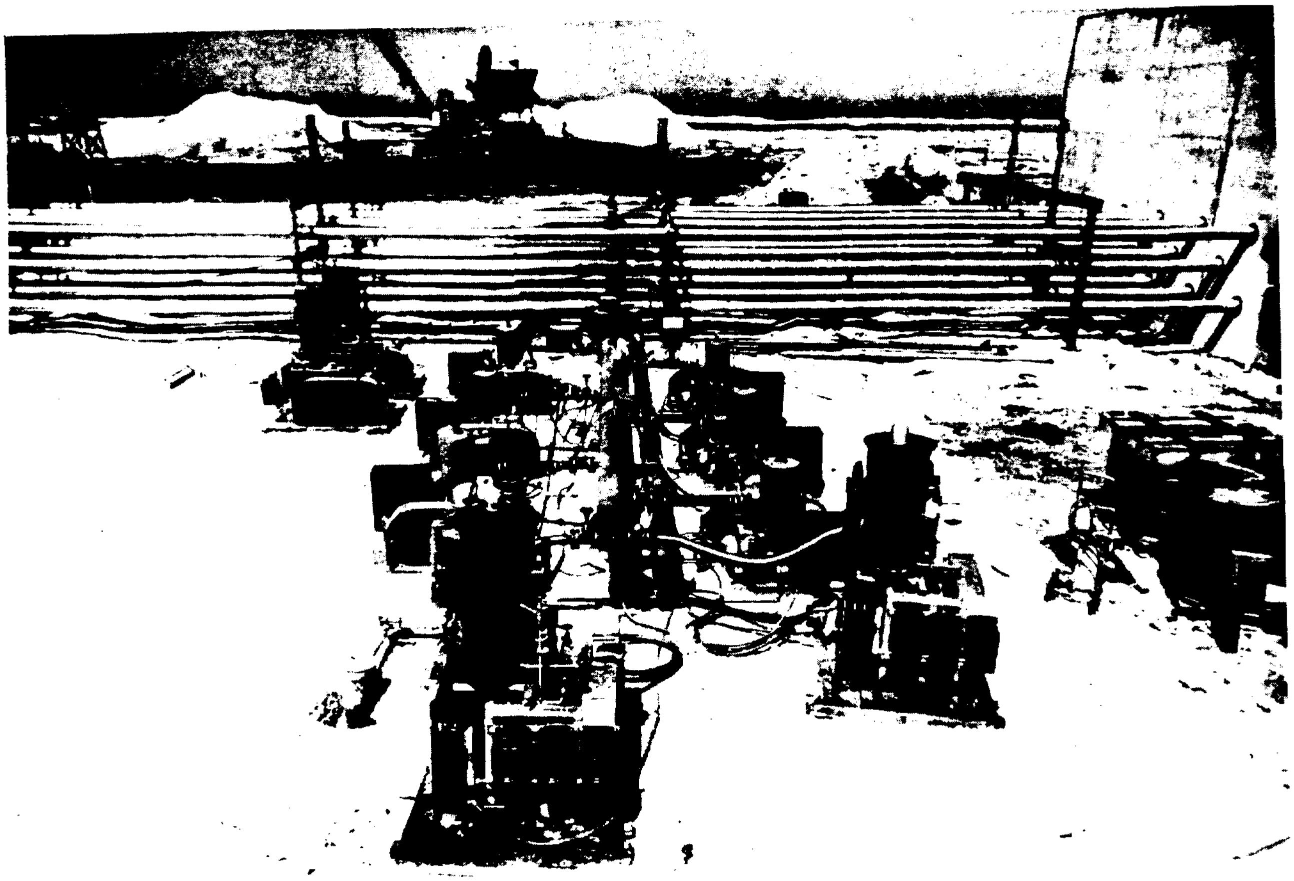


Figure 2-110. Station 1204.03 - 70% Completed

Figure 2-111. Station 1210 - Placing Foundation Forms

installed in Station 1200 and a two-ton hand operated chain hoist with monorail.

ELECTRICAL. A special powerhouse (DO-500) delivered power to the Station's main switchboard, which sub-fed three 30HP motor generator sets. A 10KW gasoline generator was installed to supply limited post-shot power.

ENGINEERING. The original design criteria were received on 7 April. Additional criteria were received on 12 May, 16 June, 6 July, 8 July and 24 July. Extensive changes to electrical criteria were received on 15, 23 and 26 October and 2 December. Design work started on 4 March. Seventeen plans and one sketch were submitted from 22 May to 2 November, and approvals were dated from 9 June to 15 December. Revisions were made as late as 10 December.

CONSTRUCTION. Work was originally scheduled to commence on 15 August and to be completed by 31 January. Actual work started on 9 September and was completed on 15 January 1954. Figure 2-111 shows the foundation forms being placed on 7 October. The progress was estimated as 12% completed. Figure 2-112 shows the structure as 45% completed as of

7 November. The forms have been partially removed and the side walls seven feet thick, are noted. At the left and adjacent to Station 1210, is shown the foundation being prepared for Station 1211. Figure 2-113 shows the Station as 95% completed as of 8 January. The relationship with Stations 1211, 1212 and 1213 is shown by this aerial view. Figure 2-114 shows the south wall and earth fill in place and the use of sand bags for protection.

STATION 1211 - DETECTOR STATION
SITE DOG - USER: LASL

GENERAL. This Station, used for reaction history, was part of Station 1210 and measured 12′ - 6″ x 28′ - 6″ x 11′- 0″ high. The floor was at the same level as the floor of Station 1210 but was 2′ - 6″ thick. Within the Station there were seven 12-inch baffle walls 6′ - 0″ x 4′ - 3″ high at 3′ - 6″ centers. On the exterior wall, between baffles, embedded in openings were 30″ I. D. steel pipes which extended into Station 1212. The exterior wall of Station 1211 was supported on three H-piles, 10′ - 6″ on centers.

MECHANICAL. Cooled and dehumidified air was brought in from Station 1210.

ELECTRICAL. The main electrical feature was a single electro-static screen cage.

ENGINEERING. The original criteria were received on 15 April. On 18 May a revision provided for the inclusion of baffle walls. Engineering drawings and designs are included with Station 1210.

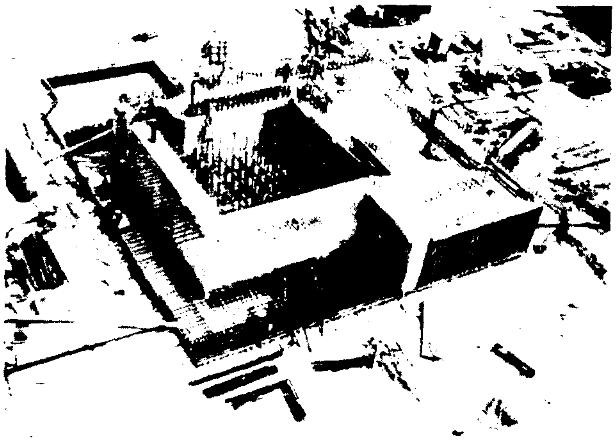


Figure 2-112. Station 1210 - 45% Completed

CONSTRUCTION. Work was scheduled to commence on 15 August and to be completed by 31 January 1954. Actual work started on 9 September and was completed on 25 January. Figure 2-113 shown under Station 1210, shows the exterior wall of Station 1211 with the 30-inch pipes extending into Station 1212.

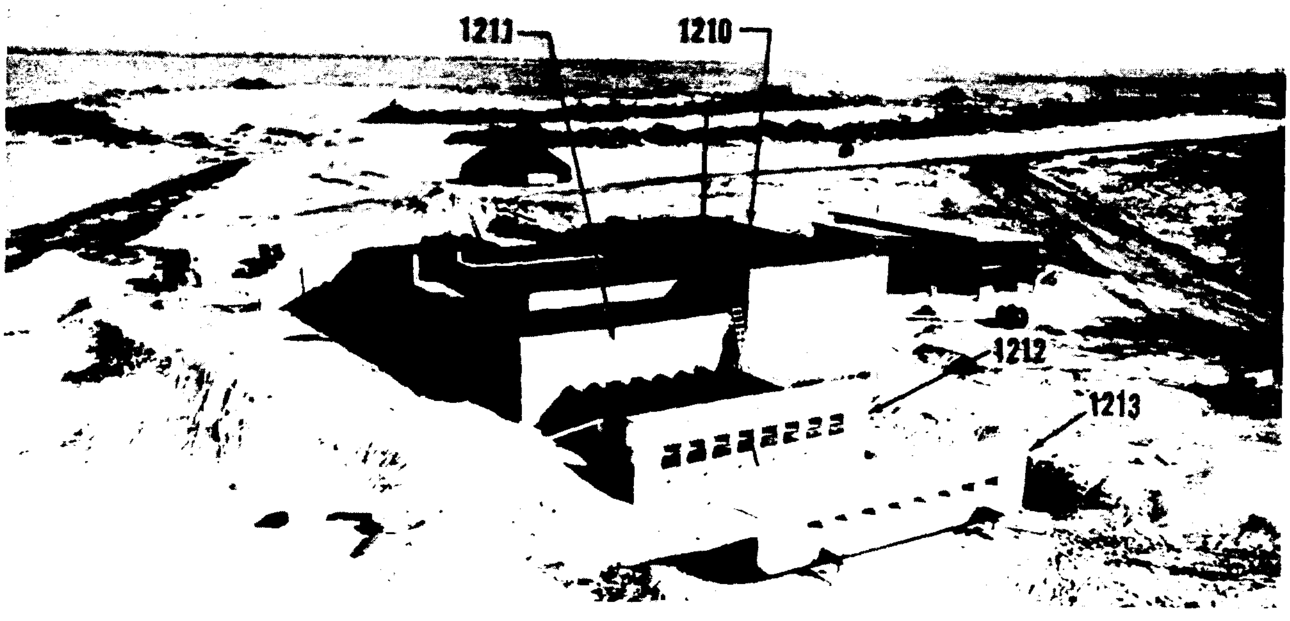


Figure 2-113. Station 1210 - Completed

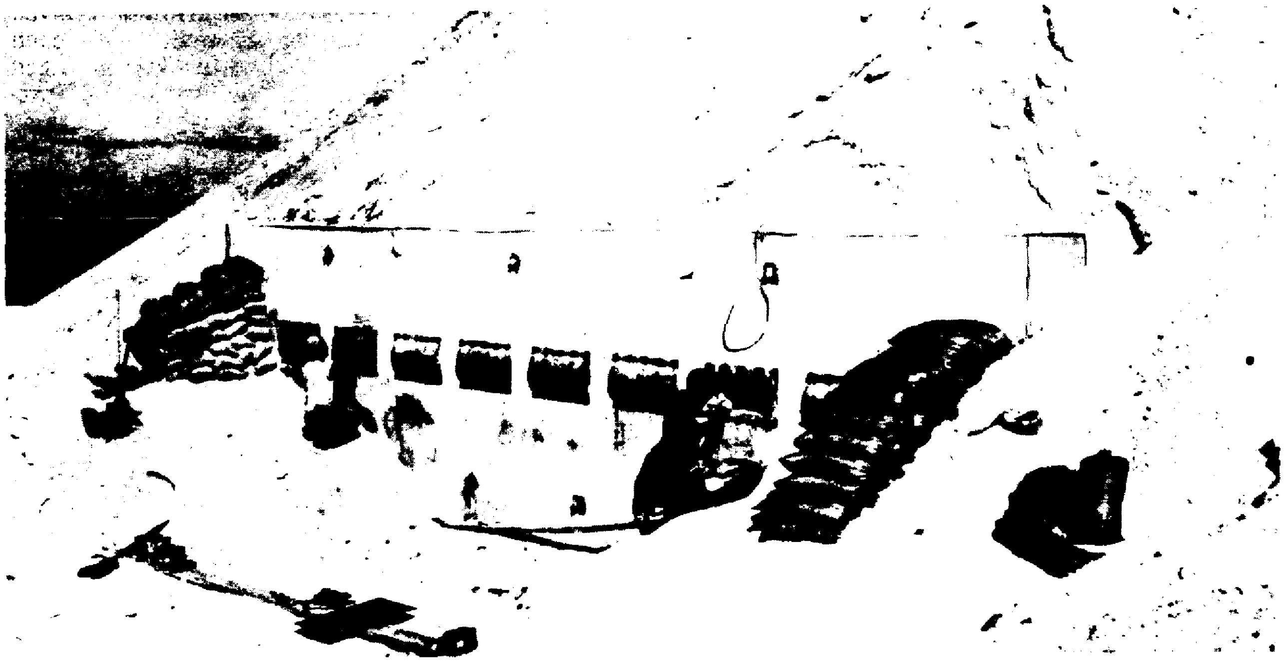


Figure 2-114. Station 1210 with Earth Fill and Sand Bags

STATION 1212 - BAFFLE - SITE DOG
USER: LASL

GENERAL. This station, used for reaction history, was a reinforced concrete retaining wall, 34 - 6″ long, 11′ - 0″ high and 2′ - 0″ thick. The wall was supported on three H-piles and was tied at the top to the exterior wall of Station 1211 with three one-inch tie rods, ten-foot on centers. This wall retained the earth fill covering for Stations 1210 and 1211. The 30-inch round pipes from Station 1210 were embedded three inches into the Station wall. Figure 2-113 shown under Station 1210 shows the relation-

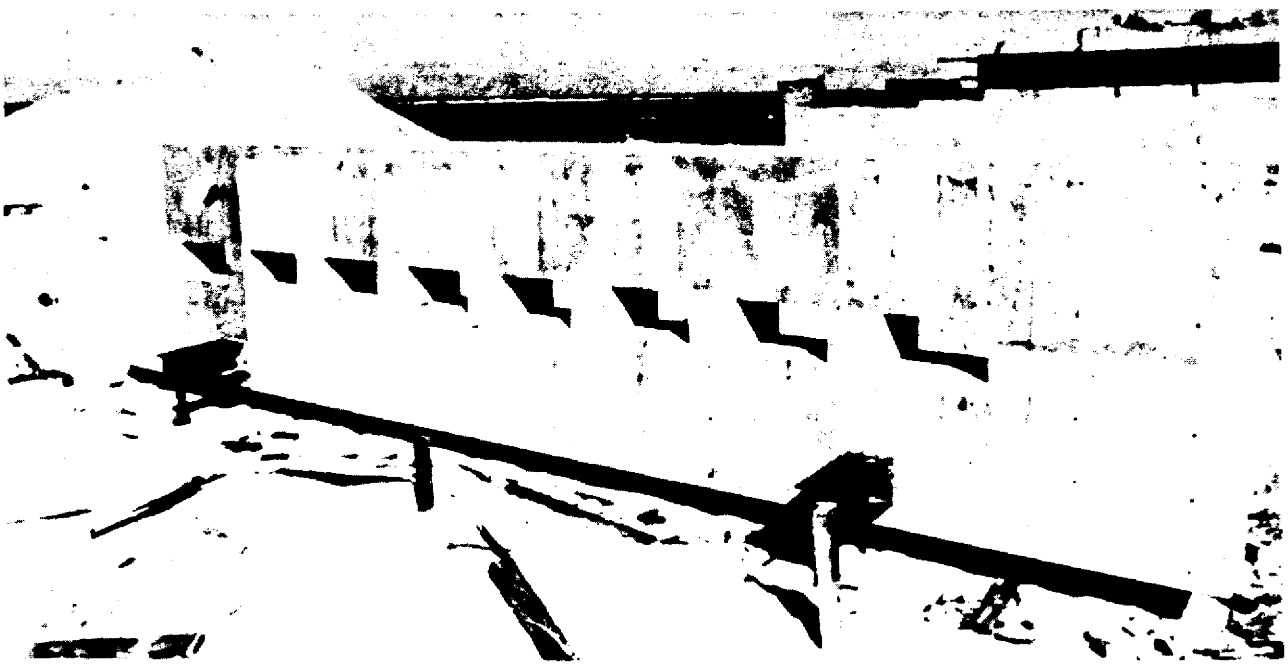


Figure 2-115. Station 1214 - 95% Completed

ship between these various Stations and construction status on 8 January 1954.

ENGINEERING. The original criteria were received on 15 April. Drawings were included with Station 1210.

31 January 1954. Actual construction started on 9 September and was completed on 25 January 1954.

STATIONS 1213, 1214 AND 1215
CONCRETE BAFFLE - SITE DOG
USER: LASL

GENERAL. These Stations, used for reaction history, consisted of a system of reinforced Concrete Baffles two feet thick with openings to match the openings of Station 1211. These Stations were spaced 50 feet, 100 feet and 200 feet from the inside wall of Station 1211.

ENGINEERING. One drawing was prepared and submitted on 22 June 1953. It was approved on 28 July.

CONSTRUCTION. Work started on 20 September and was completed on 22 January 1954. Figure 2-115 is typical and shows the method of alignment using supporting jacks.

STATIONS 1220.01 - 1220.10
HOLE-IN-GROUND - SITES VARIOUS
USER: LASL

GENERAL. These Stations were located from sites Able to Easy. Each Station of this series consisted of a 24″ I. D. pipe, 22 feet long, embedded its entire length in the ground. The top of the pipe was centered in a 6′ - 6″ square by 1′ - 6″ thick reinforced concrete pad with a plywood cover bolted on to a flange welded to the top of the pipe. Figure 2-116 shows Station 1220.04 on site Dog as 95% completed on 5 September. The User installed equipment which measured gamma versus time.

Figure 2-116. Station 1220.04 - Typical of Series

ENGINEERING. The original criteria received on 15 April 1953, was for three Stations, each with two pipes. On 24 July, this was changed to a one pipe Station and the number of Stations increased to six. On 6 August, ten Stations were desired. On 18 August the number was reduced to six. On 1 October the Stations were relocated. One drawing was started on 15 May, was submitted on 21 May and approved on 20 September.

CONSTRUCTION. The construction schedule planned for work to start at varied dates from 10 December to 15 December and to be completed from 31 January to 15 February 1954. Actual construction starting dates varied from 28 October to 24 November and completion dates varied from 5 January to 21 January.

STATIONS 1221.01 AND 1221.02
TWO HOLES-IN-GROUND
SITE CHARLIE - USER: LASL

GENERAL. These Stations were similar to the 1220 series with the exception that two pipes 22 feet long were used. The concrete pad was 6′ - 6″ x 13′ - 0″.

ENGINEERING. The criteria were received on 18 August. The Stations were re-oriented for Station 20 on 23 September and relocated on 1 October. Design details were included with the 1220 series.

CONSTRUCTION. Construction was scheduled to commence on 15 November and to be completed by 31 January. Actual construction started on 28 October and was completed on 21 January 1954.

STATION 1300 - CAB ON 300-FOOT
TOWER - SITE NAN - USER: EG&G

GENERAL. This Station, used for technical photography, was a cab obtained from Jobsite Supply originally intended for installation on a 75-foot photo tower, and it was mounted on top of a modified 300-foot steel tower, also obtained from Jobsite Supply. The cab was 14′ - 0″ x 16′ - 0″ in plan, with roll-up doors at each end of the two short sides, and was supported by special platform framing. Access was provided by a man lift.

MECHANICAL. The tower had a combination freight and passenger elevator. The elevator cab was enclosed on three sides with aluminum sheet and had a folding gate on the entrance side. A broken or slack cable device combined with a down travel overspeed governor would stop the elevator in case of trouble and an interlock was provided on the cab door. Personnel hoists installed on these photo towers were tested for conformance with the rigid safety standards required by the design. Performance of broken cable and overspeed safety devices as well as electrical interlocks was witnessed in satisfactory operation. The same tests were made on Station 1301 and the 1302 series.

ELECTRICAL. This Station was served electrically from the main switchboard in Station 70. The cab was wired with rigid conduit and with standard industrial lighting fixtures. Receptacles, signal cabinet, and phone were located as requested by the User. Lightning rods were provided to protect the cab from tropical storms, and obstruction lights were placed on the tower according to C. A. A. requirements to warn off night flying aircraft.

ENGINEERING. Criteria received on 16 April called for the use of a spare 75-foot tower cab on the top of the 300-foot tower. Additional criteria were received on 17 December 1953. The feasibility of adapting the Jobsite 300-foot tower to the new conditions of loading was investigated. This involved modifying the guying system, designing new tower and guy footings, and revising the tower structure for high horizontal forces. To utilize the existing tower members, and to provide the necessary rigidity against lateral movement at the top of the tower, three sets of guys were required instead of the single set previously used on the unmodified tower. These were located at the top of the tower (elevation approximately 300 feet) and at the 100-foot and 200-foot levels. Guys at each level were anchored at the ground to a common concrete deadman 10′ - 0″ x 19′ - 0″ in plan and 5′ - 6″ deep. Some of the tower diagonals in panels adjacent to each guy level were changed from single angle members to double angle members to meet the heavy shear loads involved. Footings under the tower legs were heavier than those used for the original tower. Drawings were started February 1953. Twelve drawings and two sketches were prepared and submitted from 16 April to 18 December. Approvals were dated from 1 May to 19 January 1954.

CONSTRUCTION. Work was originally scheduled to commence on 1 September and to be substantially completed by 1 December with the exception of installation of safety devices. The entire structure was scheduled to be completed by 15 February. Actual work started on 17 September and all work was completed on 25 January 1954. Figure 2-117 notes 40% completion as of 6 October 1953.

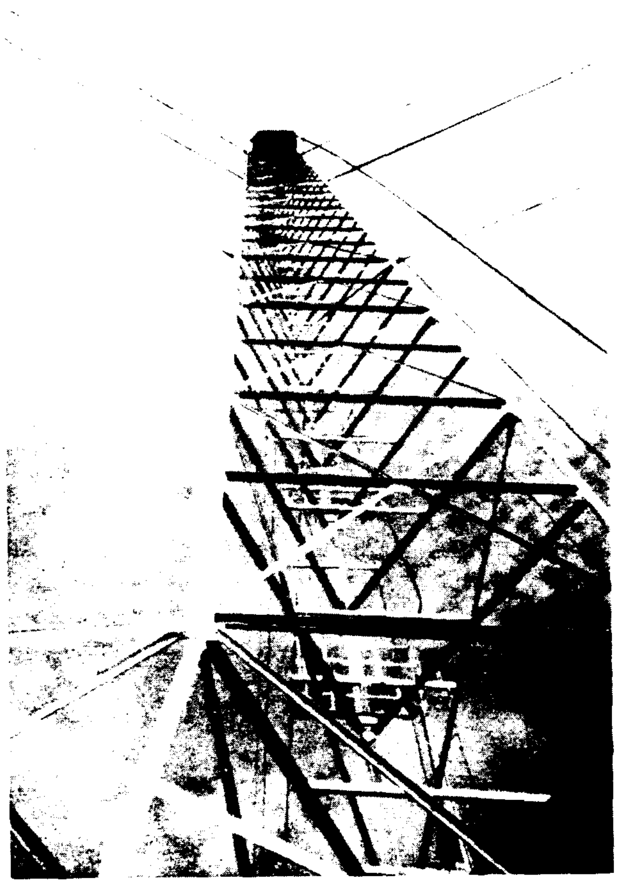


Figure 2-117. Station 1300 - 40% Completed

STATION 1301
CAB ON 125-FOOT TOWER
SITE ELMER - USER: EG&G

GENERAL. A 125-foot high steel tower existing from OPERATION IVY was utilized with minor additions for technical photography. An aluminum ladder was added from the platform to the roof of the cab. Flooring was laid on this roof and a handrail was installed. The electric power hoist was modified by additional controls and safety devices.

ENGINEERING. Preliminary electrical criteria were received on 6 May but adequate information to undertake the complete design work was not received until 17 August. Design work started on 7 August. Three drawings were prepared and submitted from 18 August to 16 November. These plans were approved from 10 September to 4 December.

CONSTRUCTION. Work was scheduled to commence on 15 December and to be completed by 15 February 1954. Actual work started on 10 December and was completed on 16 January.

STATION 1302.02
CAB ON 75-FOOT TOWER
SITE HOW - USER: EG&G

GENERAL. The Station was a 14′ - 3″ square x 75 foot high steel tower with a 14′ - 3″ x 16′ - 3″ x 7′ - 0″ high cab on top used for technical photography. The tower was used in OPERATION GREENHOUSE, dismantled, and then reassembled. On the roof of the cab, 1″ x 6″ flat wood flooring was added. The legs of the tower were extended and embedded in concrete.

MECHANICAL. The electric powered passenger hoist was modified by the addition of hoist controls and safety devices.

ELECTRICAL. Incandescent lighting, as well as receptacle outlets, as required were provided in the tower cab. Power was supplied from a portable generator.

ENGINEERING. Criteria were received on 15 April. Four drawings and one sketch were started on 29 July, submitted from 18 August to 18 September and approved from 10 September to 6 November.

CONSTRUCTION. Work was scheduled to commence on 1 September and to be substantially completed by 31 December with the exception of the installation of safety devices. All work was scheduled to be completed by 15 February 1954. Actual work started on 8 November and all work was completed on 6 February. Figure 2-118 shows Station 1302.03 as 95% completed. This figure is typical of the 1302 series.

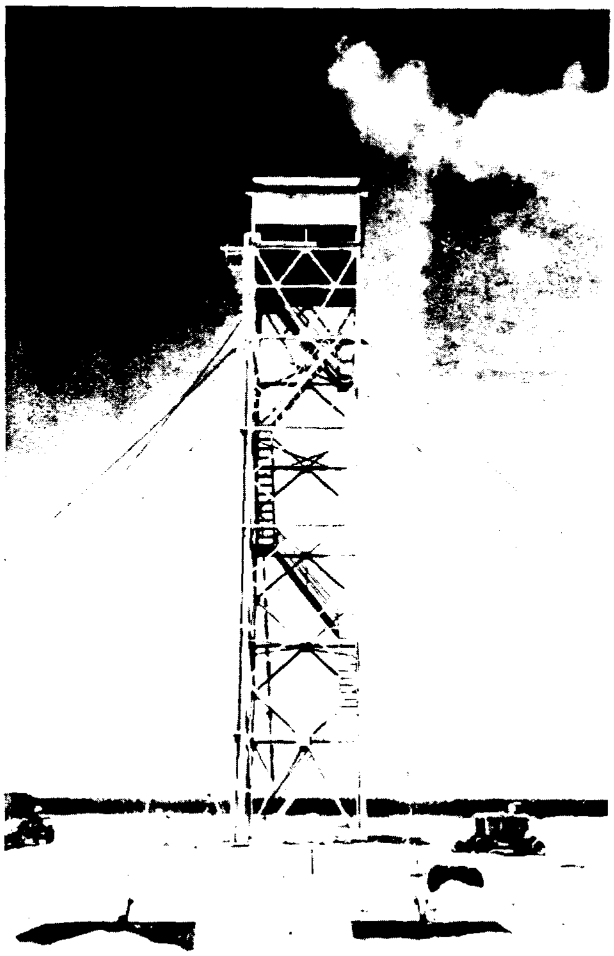


Figure 2-118. Station 1302.03 - Typical of Series

STATION 1302.03
CAB ON 75-FOOT TOWER
SITE TARE - USER: EG&G

GENERAL. Same as Station 1302.02.

ENGINEERING. Criteria were received on 15 August.

CONSTRUCTION. Scheduled the same as Station 1302.02. Actual work started on 10 October and was completed on 5 January 1954.

STATION 1302.04
CAB ON 75-FOOT TOWER
SITE JANET - USER: EG&G

GENERAL. Same as Station 1302.02.

CONSTRUCTION. Scheduled the same as Station 1302.02. Actual work started on 8 September and was completed on 20 January 1954.

STATION 1303
CAMERA PIERS ON STATION 1342
SITE GEORGE - USER: EG&G

GENERAL. This Station, used for technical photography, was located on the roof of Station 1342. The Station consisted of two items: (1) a wood-framed, plywood covered building 6′ - 8″ x 8′ - 8″ x 8′ - 0″ high and (2) a two-foot thick reinforced concrete slab, 15′ - 0″ x 9′ - 6″, and keyed into the roof of Station 1342. Figure 2-5-52 reported under Station 1342 shows the status of work as completed on 5 February.

ENGINEERING. The criteria were received on 13 August. Structural plans were started on 19 August, submitted on 27 August and approved on 17 September. The electrical drawings were included with Station 1342.

CONSTRUCTION. Construction work was scheduled to commence on 1 November and to be completed by 31 December. Actual construction started on 20 December and was completed on 30 January 1954.

STATION 1304
CAMERA PIERS ON STATION 72.03
SITE YVONNE - USER: EG&G

GENERAL. This Station, used for technical photography and similar to Station 1303, was located on the roof of Station 72.03. It was a wood-framed building 13′ - 6″ x 16′ - 0″ x 9′ - 0″ high.

ENGINEERING. Criteria received on 1 June changed Station 1302.05 to 1304. On 1 July, Station 1304 was deleted. On 14 August, criteria changed Station 111 to 1304. The design criteria, due to these changes, were received on 20 August. The electrical drawings were included with those for Station 72.03. Structural design started on 23 September; one drawing was submitted on 29 September and was approved on 28 October.

CONSTRUCTION. Construction work was scheduled to commence on 15 November and to be completed by 31 December. Actual construction started on 31 December and was completed on 6 February.

STATION 1307
CAMERA PIERS AT IVY STATION 303
SIGHT JANET - USER: EG&G

GENERAL. This Station consisted of rehabilitating the existing mounts located on the roof of IVY Station 1001.01 (ex-GREENHOUSE Station 69). IVY Station 303 consisted of two concrete piers, 17 feet high, anchored to the roof and embedded with mounting plates, various 3″ O. D. pipe sleeves and metal cable ducts. The Station was used for technical photography.

ENGINEERING. Engineering work was included with Station 72.01.

CONSTRUCTION. Work was started and completed on 20 January 1954.

STATION 1341 - CAMERA BUNKER
SITE DELTA - USER: LASL

GENERAL. This Station, used for high speed photography, was a complex, massive reinforced concrete bunker planned to be exposed to tremendous blast pressures. The approximate overall dimensions were 33 feet wide by 69 feet long and 33 feet high (above foundation). The structure was three-stories high with exterior wall and roof thicknesses varying from a minimum of three feet to a maximum of six feet six inches. A vertical slot from foundation to the underside of the roof (called the chimney) existed at the rear of the structure. Three rooms were located on the first floor, one room on the second floor, and one room on the third floor. The exterior side walls of this Station extended toward the rear to form a pair of sloping buttresses. The front wall was constructed of limonite concrete.

MECHANICAL. Mechanical features were a dehumidification system, a 500-gallon diesel fuel oil storage tank, and a monorail with trolley and half-ton hoist.

ELECTRICAL. This Station had its own power generation plant which consisted of two 60 KW generator sets. A concealed rigid conduit system was used throughout to provide clear wall surfaces. To obtain maximum head room, special recessed incandescent fixtures were specified.

ENGINEERING. Initial criteria were received on 27 March 1953. Revised criteria were received on 27 April, and on 16 June. Criteria received on 5 October required a closing time

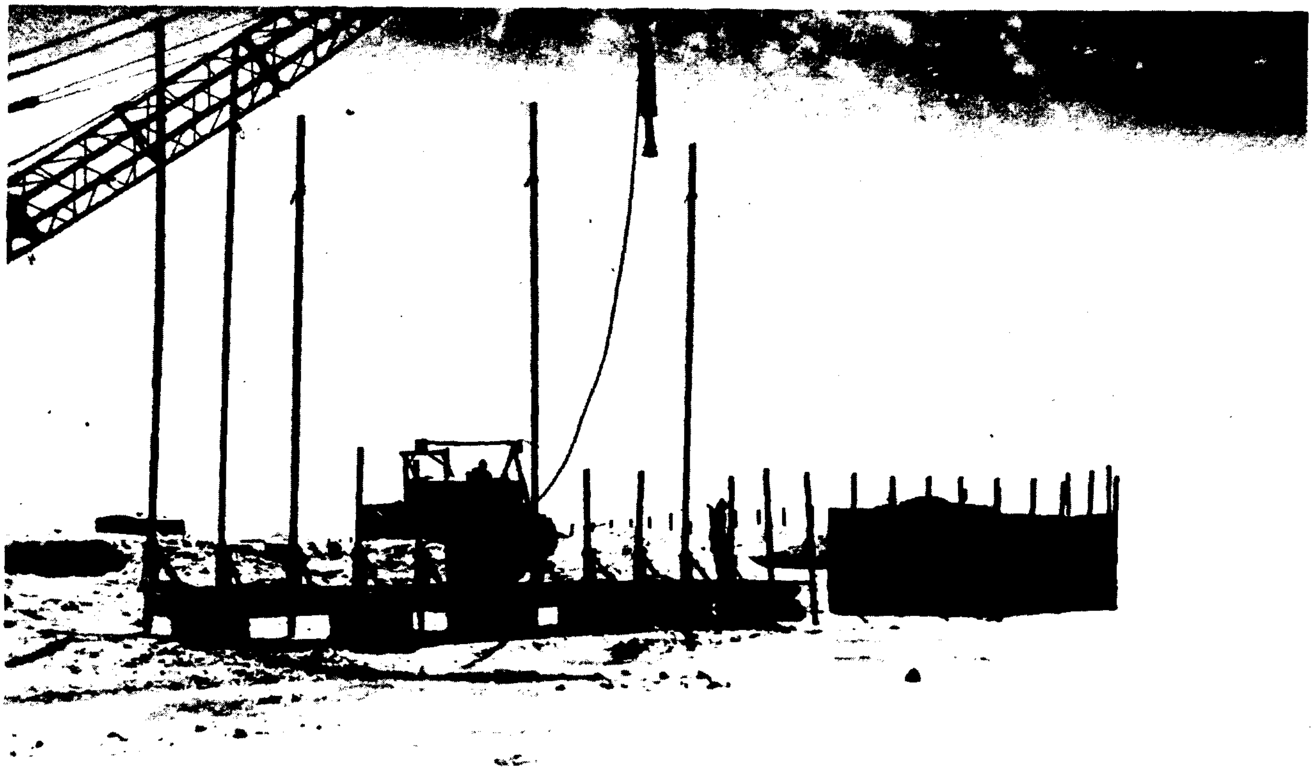


Figure 2-119. Station 1341 - Forming Island "Delta"

Figure 2-120. Station 1341 - Completing Bulkhead and Fill

for the shutters of less than one second. The large, rectangular shutter doors of these camera bunkers were subjected to extensive performance testing to insure that (a) they would close within the allowable 0.5 seconds of time, and (b) they would latch securely without rebound. High-speed cameras, and special timing devices were used. Minor adjustments to latches and springs were necessary, as well as the anticipated replacement of lead sill blocks deformed by repeated performance tests. The shutter doors on Stations 1342, 2300 and 2301 were similarly tested. The high pressures that would occur and the peculiar arrangement of the structure presented several unprecedented structural problems. And because of the large exposed frontal area and its proximity to ground zero, stability and overturning calculations were

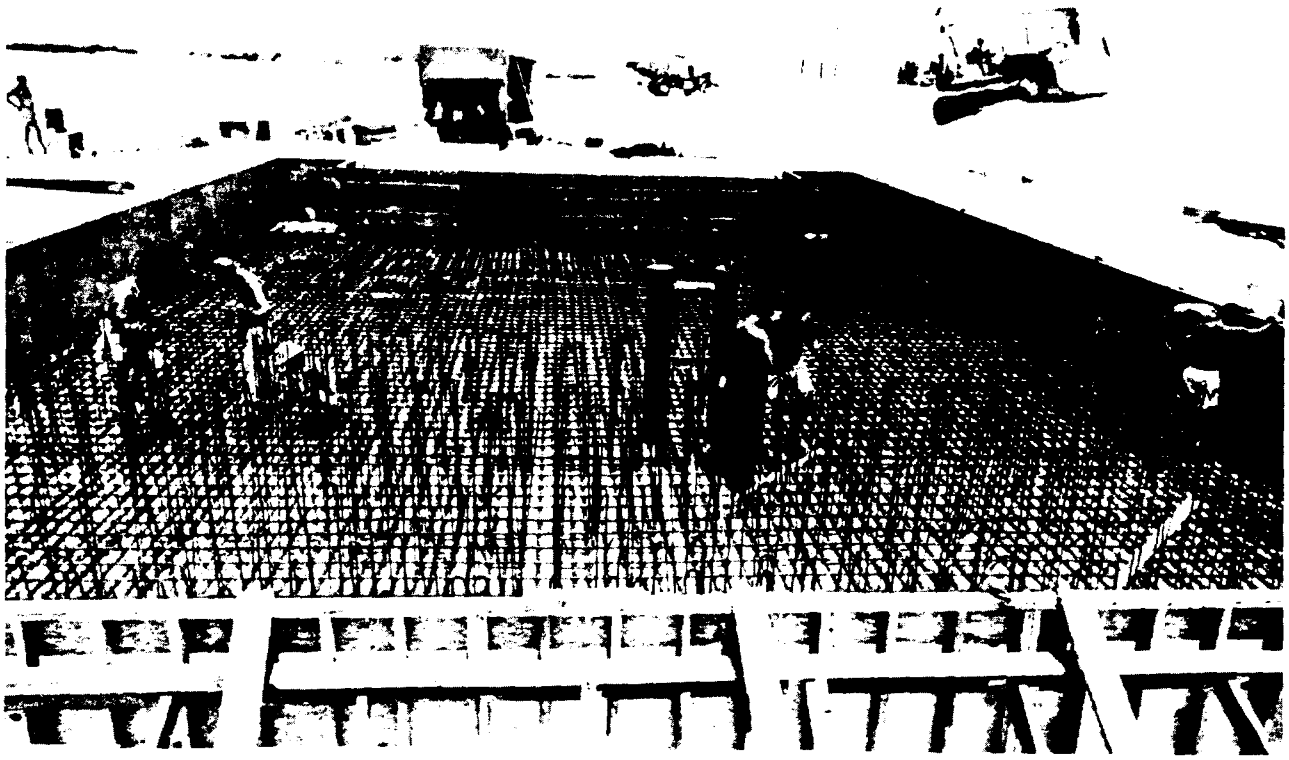


Figure 2-121. Station 1341 - Foundation, Forms for

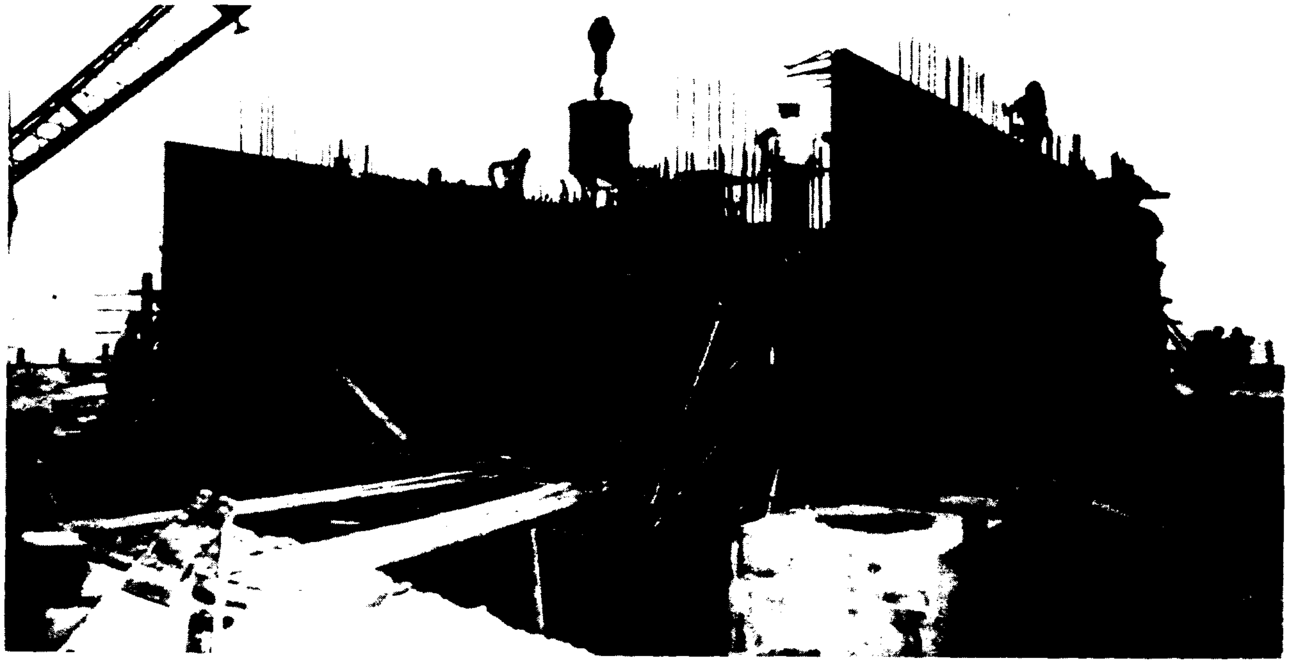


Figure 2-122. Station 1341 - Pouring Side Walls

made, based on dynamic conditions. Designs were started on 4 May; 23 plans and two sketches were submitted from 1 June to 25 September. These drawings were approved from 25 June to 19 November.

CONSTRUCTION. Work was scheduled to commence on 1 September and to be completed by 5 January 1954. Actual work started on 5 September and was completed on 25 January. Figure 2-119 shows driving railroad rails as piles to form bulkhead for site Delta. Delta was a man-made island. This figure notes status of work as of 10 September. Figure 2-120 shows the bulkhead and coral fill nearing completion on 14 September. A 1.3 foot discrepancy was found between the originally designed elevations of Station 1341 and Station 20 on site Charlie (its reference zero). This resulted from a site Charlie datum error introduced by reef current effect on the tide gage. The Charlie datum was adopted for construction of all sub-

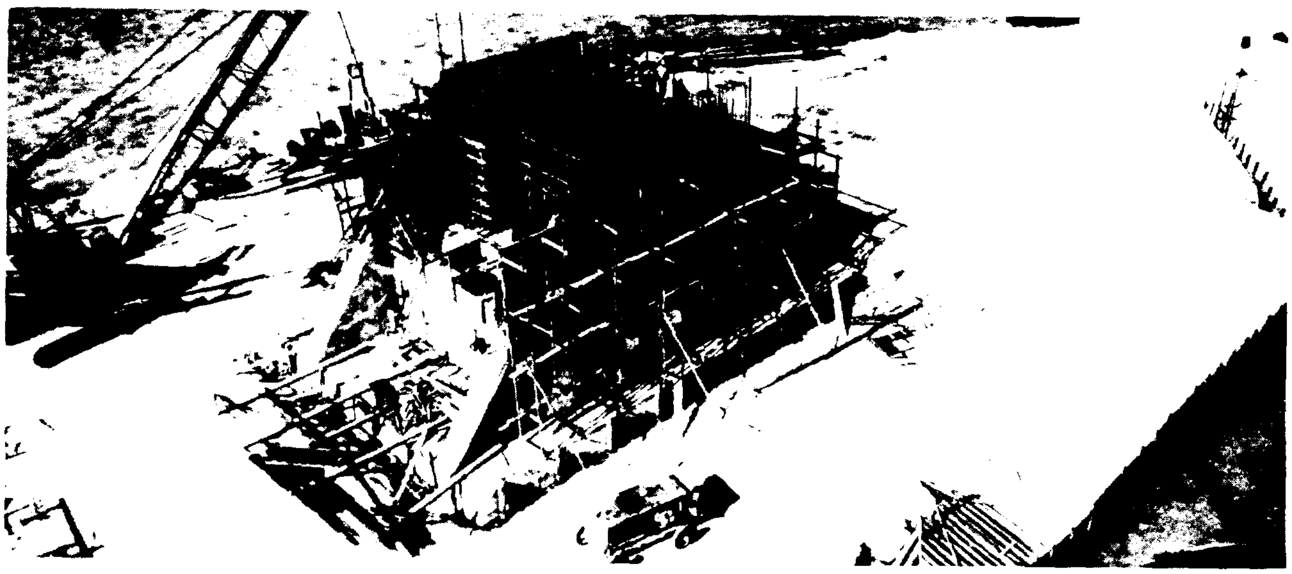


Figure 2-123. Station 1341 - 61% Completed

Figure 2-124. Station 1341 - South and West Walls

sequent structures on Delta and Able. After driving of the sheet piling which enclosed the Station footings, some rotation due to settlement also resulted. Neither the effect of settlement nor the elevation differences were critical to photography in the 7500-foot distance involved. Figure 2-121 shows the foundation wall forms and the massive depth to prevent overturning. The two pipes in the center were the siphon sleeves for the salt water well. Status of work on 5 October was 8% completed. Figure 2-122 shows the pouring of the side walls, and the structure was 31% completed as of 5 November. Figure 2-123 notes erection of forms for the second and third floors. The progress as shown, and as of 5 December, was estimated at 61% completion. Figure 2-124 shows the south and west walls of the Station nearing completion on 8 January. The vertical slot, or chimney, is shown on the rear side. Figure 2-125 shows the Station completed with the User's trailers on Delta as of 5 February. On the third floor, zero side, is shown a continuous horizontal slot, closed by a single heavy steel shutter door pivoting on hinges located above the slot.

STATION 1342 - CAMERA BUNKER
SITE GEORGE - USER: LASL

GENERAL. This Station used for high speed photography was a massive reinforced concrete bunker identical in most respects to Station 1341. The addition of a room on the first floor and the addition of Station 1303 on the roof of Station 1342 constituted the principal differences.

ELECTRICAL. The electrical system was similar to Station 1341 with the following major exceptions: (1) two 30 KW generator sets were provided and (2) two distinct electrical systems were provided, both A-C and D-C.

ENGINEERING. Similar to and reported under Station 1341.

CONSTRUCTION. Work was scheduled to commence on 10 September and to be completed by 15 January 1954. Actual work started on 31 August and was completed on 25 January. Figure 2-127 shows the massive steel rods required for the reinforcement of the ceiling slab. Figure 2-126 notes Station 1303 (camera piers) on the roof of Station 1342 and completed as of 5

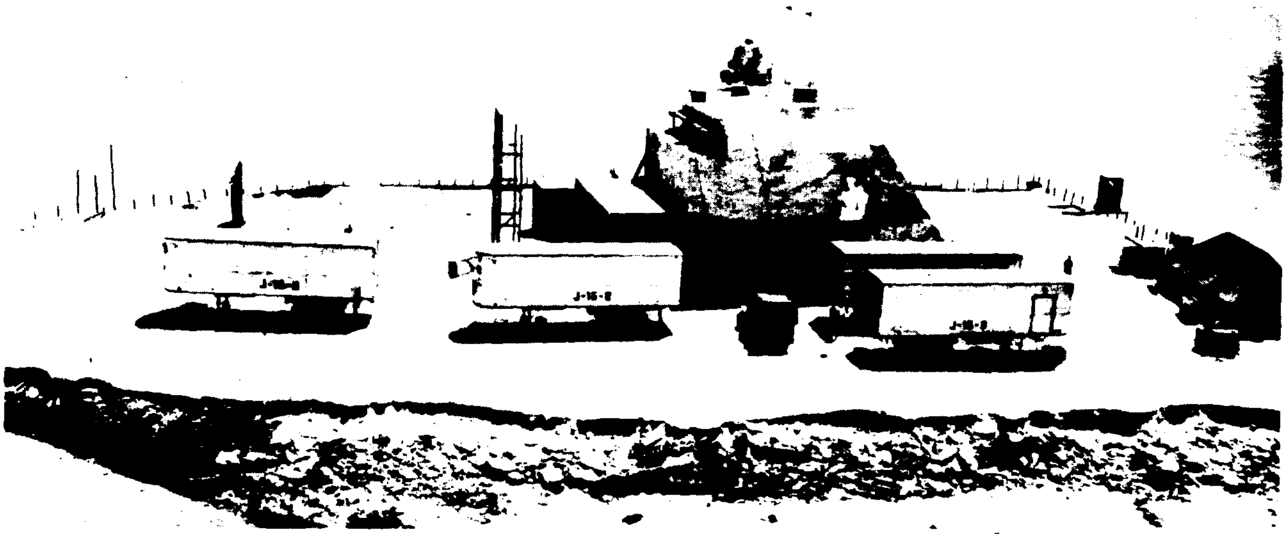


Figure 2-125. Station 1341 - Completed

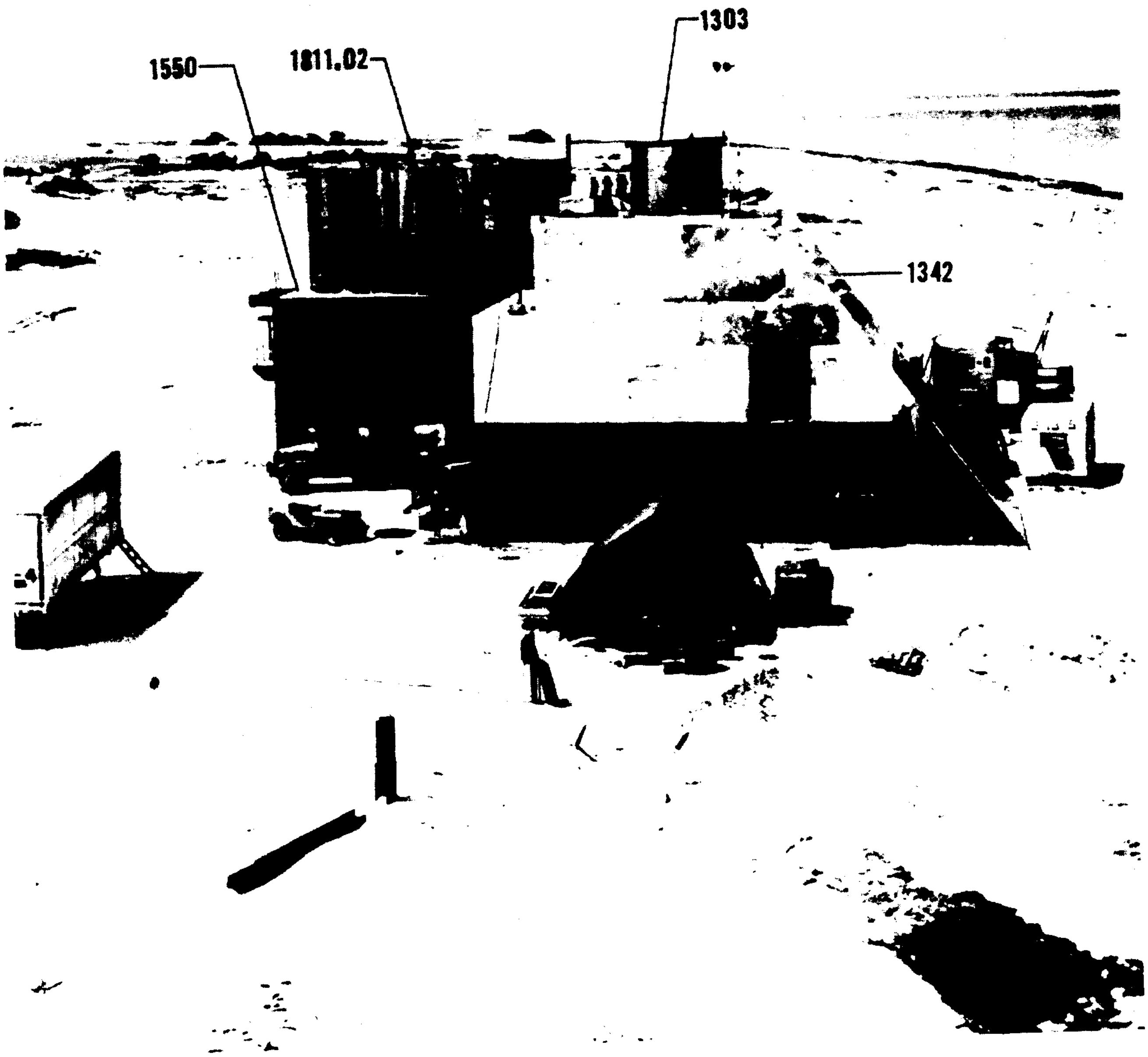


Figure 2-126. Station 1342 - Completed

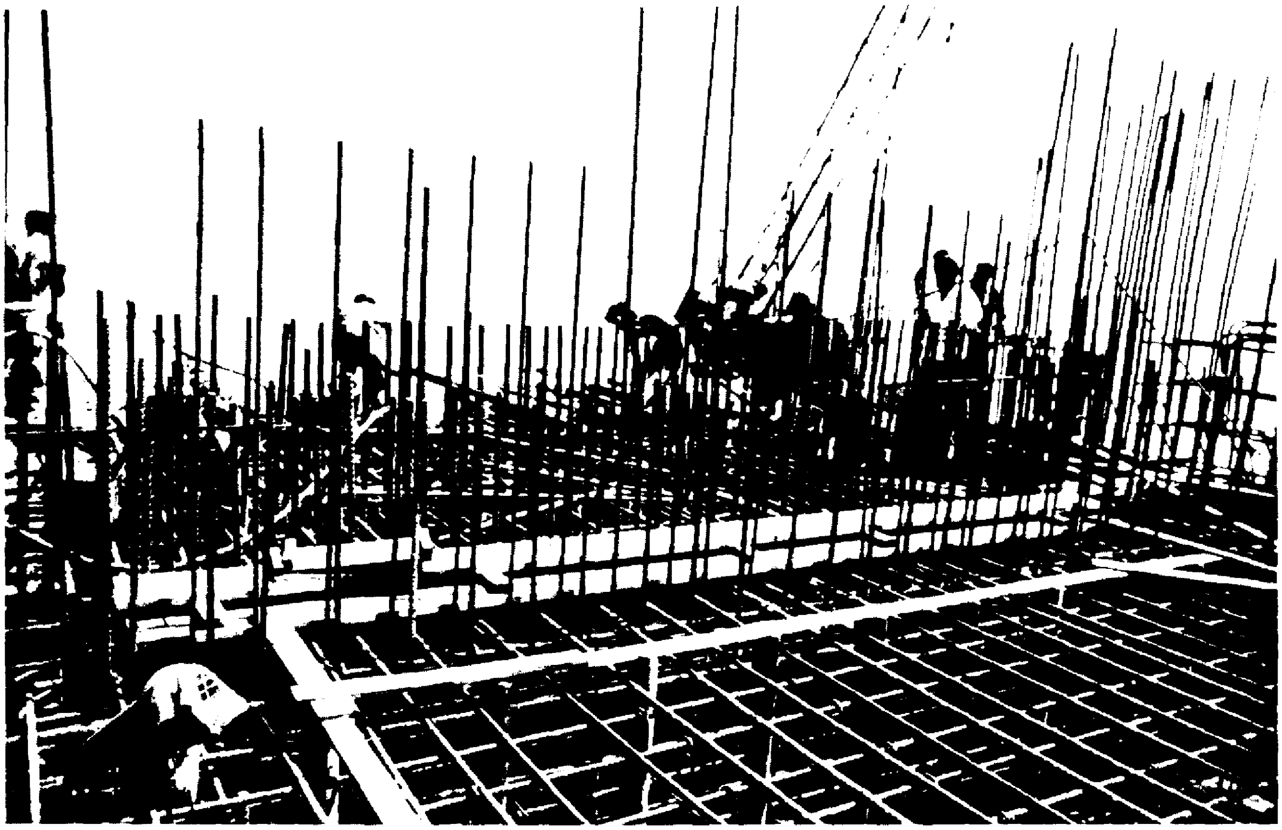


Figure 2-127. Station 1342 - Reinforcement Required

February. Other views of Station 1342 are shown under Station 1550, (Figures 2-138 and 2-139).

STATION 1343 - CAMERA BUNKER
SITE ALICE - USER: LASL

GENERAL. This Camera Bunker Station, used for high speed photography on site Alice, consisted of reactivating an IVY Camera Bunker, IVY Station 300.

ENGINEERING. The criteria were received on 1 September and involved minor rearrangements only. Figure 2-128 shows the camera ports completed as of 10 April 1954.

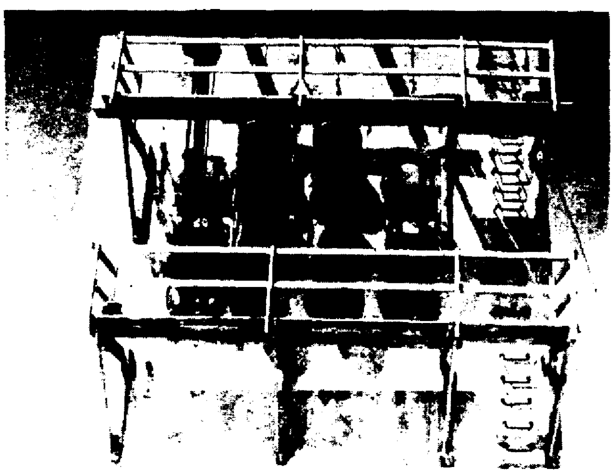


Figure 2-128. Station 1343 - Showing Camera Ports

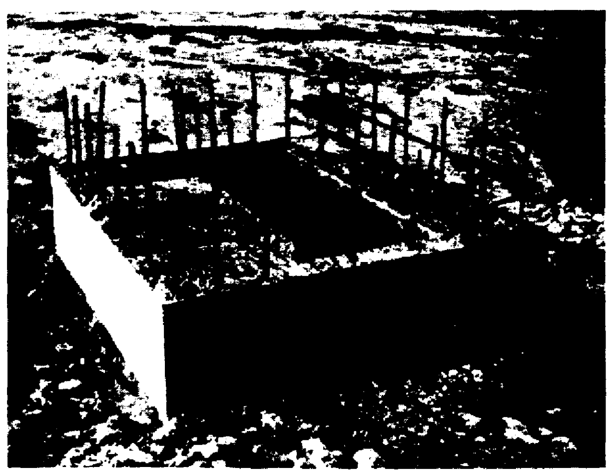


Figure 2-129. Station 1350 Series - Typical Foundation

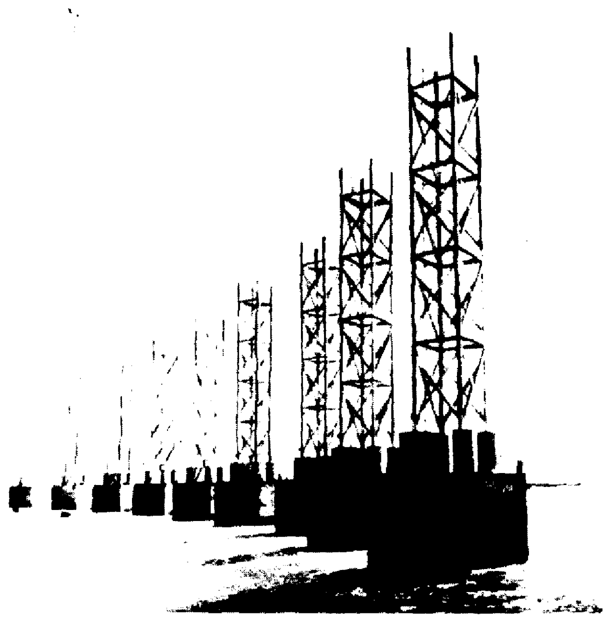


Figure 2-130. Station 1350 Series 65% Completed

a 8′ - 0″ x 8′ - 0″ plywood framed shelter. The steel towers were free standing but the plywood shelters were guyed. The structures were built on a reinforced concrete foundation which rested in water. Figure 2-129 shows a typical foundation at an extreme low tide with the progress of work as 35% completed. The towers were used as mirror supports and each Station had two plywood shutters operated by pulleys.

ENGINEERING. The criteria were received on 13 April 1953. Three drawings were prepared and were started from 17 April to 27 July, were submitted for approval from 7 May to 28 July and were approved from 29 May to 21 August. On 28 July 1953, minor revisions to the criteria were received.

CONSTRUCTION. Construction was scheduled to start on 1 October and to be completed on 31 December. The earlier progress of the work was dependent upon the time available during the extreme low tide periods in September. By 31 October, the concrete foundations were completed and the group was 65% completed. Figure 2-130 notes this condition with foundations completed and steel towers erected. As of 4 December, the progress remained at 65%

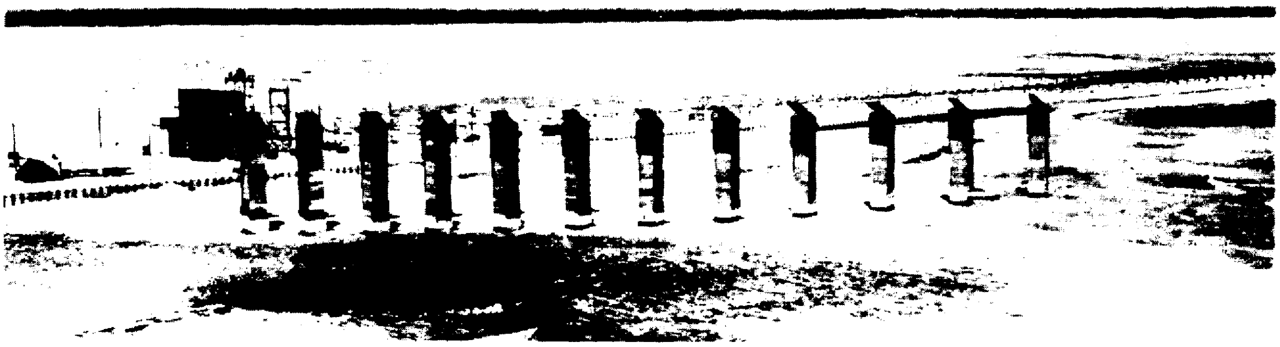


Figure 2-131. Station 1350 Series Completed

CONSTRUCTION. Work was scheduled to commence on 1 November and to be completed on 15 February. Actual construction started on 29 July and was completed on 20 January 1954.

STATIONS 1350.01 - 1350.12
MIRROR TOWERS
SITE BAKER-CHARLIE REEF
USER: LASL

GENERAL. These Stations, used in connection with high speed photography, were located in the Bikini Lagoon a few hundred feet from Station 20. Each Station consisted of a rigid all welded steel tower, 4′ - 0″ x 4′ - 0″ x 26′ - 0″, set within

completed. All Stations were completed on 25 January 1954. Figure 2-131 shows the 1350 series completed. At the rear are Station 20 and the 12 pipe array (Station 1203), and their relationship to the 1350 series may be noted.

STATION 1351 - PENTHOUSE AT ZERO
SITE BAKER-CHARLIE REEF
USER: LASL

GENERAL. This Station, used in connection with high speed photography, was a wood-framed, plywood covered building, 18′ - 7″ x 40′ - 0″ x 9′ - 0″ high and rested above Station 20 and

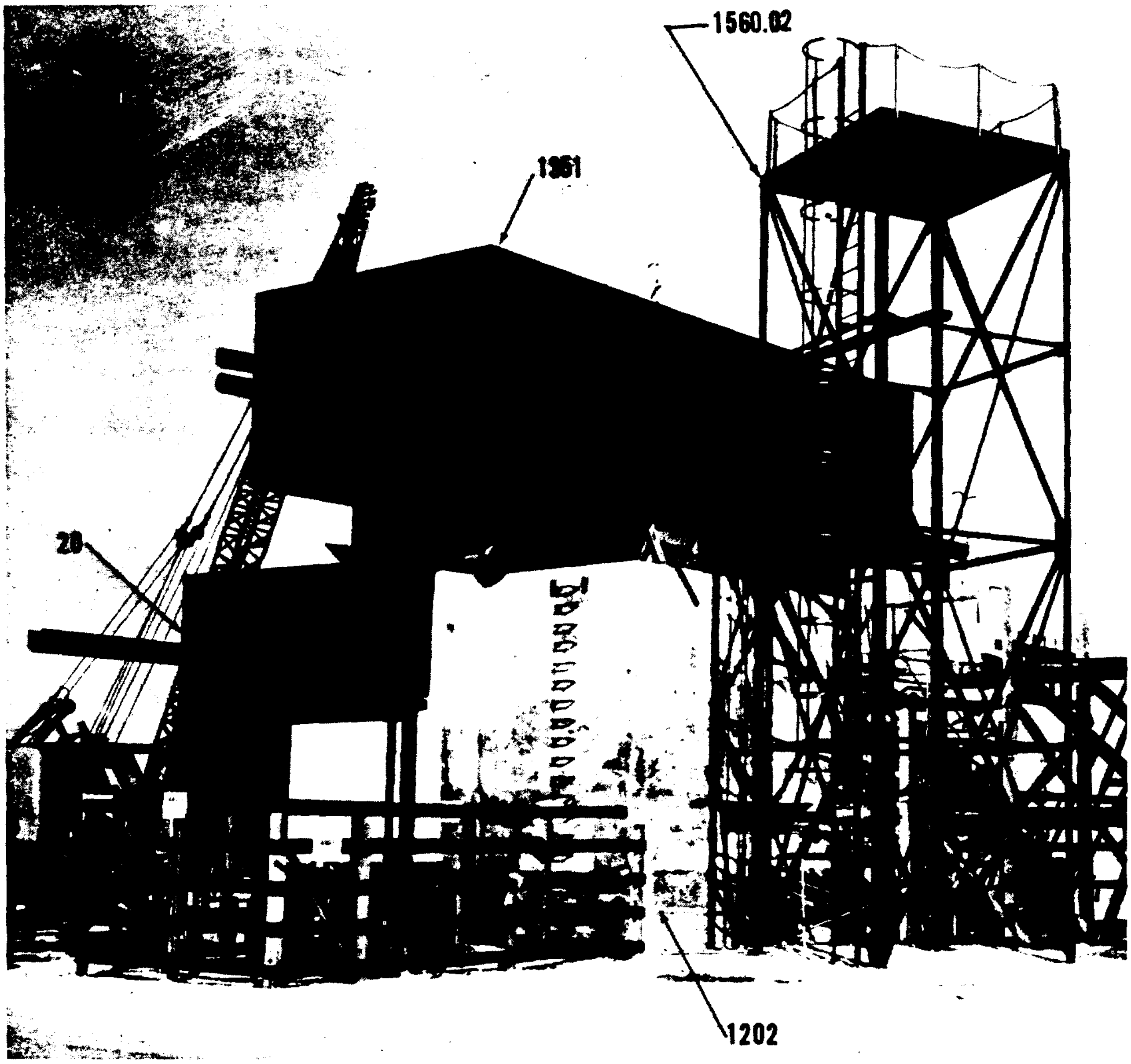


Figure 2-132. Station 1351 - Completed

cantilevered out over Station 1202, as shown in Figure 2-132. This figure shows subject Station completed as of 3 February.

ENGINEERING. The criteria were received on 22 May. Plan data are included with Station 20.

CONSTRUCTION. Work was scheduled to start on 1 November and to be completed by 31 December. Actual construction started on 3 September and was completed on 25 January.

STATION 1352 - OPTICAL BAFFLE
SITE DELTA - USER: LASL

GENERAL. This Station was a plywood baffle, 3′ - 6″ x 10′ - 0″, and mounted 25 feet above the ground with face openings and braced with guy wires. It was used for Project 13.5 (high speed photography).

ENGINEERING. The criteria were received on 5 August. One drawing was required, which was started on 7 August, submitted on 13 August, and approved on 1 October. Two revisions were required.

CONSTRUCTION. The construction schedule was planned for work to commence on 10 October and to be completed by 15 January 1954. Actual construction started on 15 December and was completed on 3 February 1954.

STATION 1353 - OPTICAL BAFFLE
SITE ABLE - USER: LASL

GENERAL. This Station was used for the same purpose and was similar to Station 1352. It measured 15' - 0" x 120' - 0" and was mounted 35

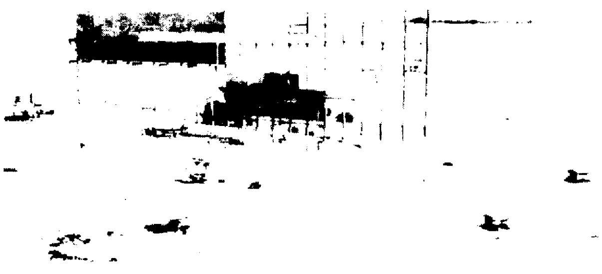


Figure 2-133. Stations 1352 and 1353 Aerial View

feet above the ground. Figure 2-133 shows the structure 61% completed on 8 January. Anchors at the water's edge for securing the guy wires will be noted.

ENGINEERING. The criteria were received on 5 August. One drawing was required, which was started on 7 August, submitted on 13 August, and approved on 1 October. Two revisions were required.

CONSTRUCTION. Work was planned to commence on 10 October and to be completed by 15 January 1954. Actual construction started on 15 December and all work was completed on

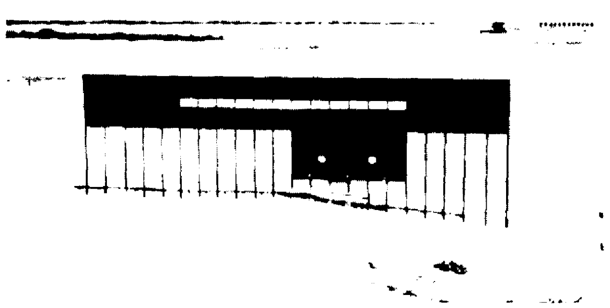


Figure 2-134. Station 1353 - Completed

20 January 1954. Figure 2-134 shows the Station completed as of 5 February. The face openings and their relations to Station 20 may be noted. Station 20 is at rear over the right-hand corner of the baffle.

STATIONS 1354, 1355, 1356, AND 1357
OPTICAL BAFFLES
SITES DELTA AND ABLE - USER: LASL

GENERAL. These four plywood baffles were 12' - 0" x 20' - 0" with two round openings as shown in Figure 2-135.

ENGINEERING. The original design criteria were received on 13 October. One drawing was required which was started on 14 October, submitted on 22 October, and approved on 6 November.

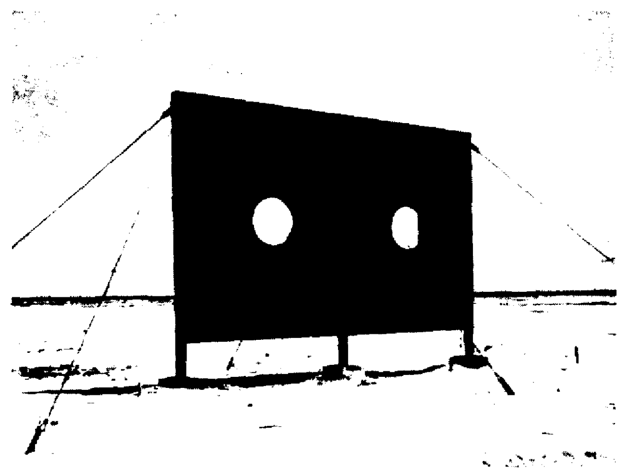


Figure 2-135. Station 1354 - Typical Optical Baffle

CONSTRUCTION. Work was planned to commence on 10 October and to be completed by 15 January 1954. Actual construction on Stations 1354, 1355, and 1356 started on 15 December and was completed by 6 February 1954. Station 1357 was started on 31 December and was completed on 25 January 1954.

STATION 1401 - INSERT ON STATION 1341
SITE DELTA - USER: LASL

GENERAL. This Station was located in the middle of the front face of the lower exterior wall of Station 1341. The work involved consisted of mounting User Neutron Detector equipment using bolts cast vertically in the exterior wall.

ENGINEERING. Design criteria were received on 14 May and on 5 August 1953. On 30 September additional criteria were received, changing the position of the Station. On 21 October, additional items were added. The design work is included with Station 1341.

CONSTRUCTION. Work was scheduled to commence on 1 November and to be completed on 15 February 1954. Actual work started on 17 July and was completed on 25 January 1954.

STATION 1402 - NEUTRON DETECTORS
SITE DELTA - USER: LASL

GENERAL. This Station was identical with the 1403 series reported below.

ENGINEERING. The design criteria, design work and drawings are also the same as reported in the 1403 series.

CONSTRUCTION. Work was scheduled to commence on 1 November and to be completed on 15 February 1954. Actual construction work started on 15 December and was completed on 25 January 1954.

STATION 1403.01 - 1403.16
NEUTRON DETECTORS - SITES VARIOUS
USER: LASL

GENERAL. These Stations were located on islands and reefs from site Able to Easy, and at site Gene. Each Station consisted of a reinforced concrete slab, 5' - 4" x 7' - 0" x 2' - 6" with a raised triangular cross section embedded on one face with eight two-inch diameter bolts. Figure 2-136 shows Station 1403.08, which is typical for the series and 90% completed as of 5 December. Two holes were located between the bolts: one of 12-inch diameter and six-inches deep, the other of nine-inch diameter and four and one-half inches deep.

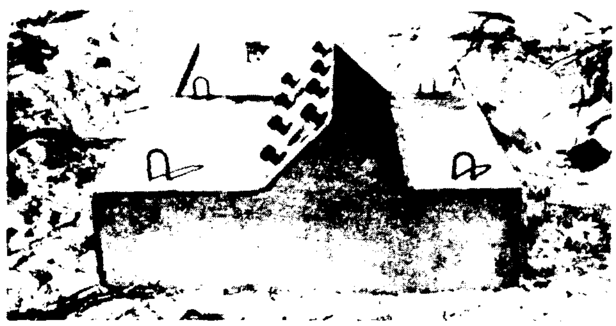


Figure 2-136. Station 1403.08 - Typical

ENGINEERING. The design criteria were received on 14 May 1953 for Stations 1403.01 thru 1403.16. Design work started on 24 July, and one drawing and one sketch were submitted on 29 July, approved and issued on 7 August. On 13 July, Station 1403.17 was added. On 23 October, Stations 1403.15, 1403.16 and 1403.17 were deleted. With the re-scheduling of tests and Stations after shot Bravo, Stations 1403.15 and 1403.16 were added at Gene.

CONSTRUCTION. Work was scheduled to commence on 1 October and to be completed on 15 January 1954. Actual construction starting

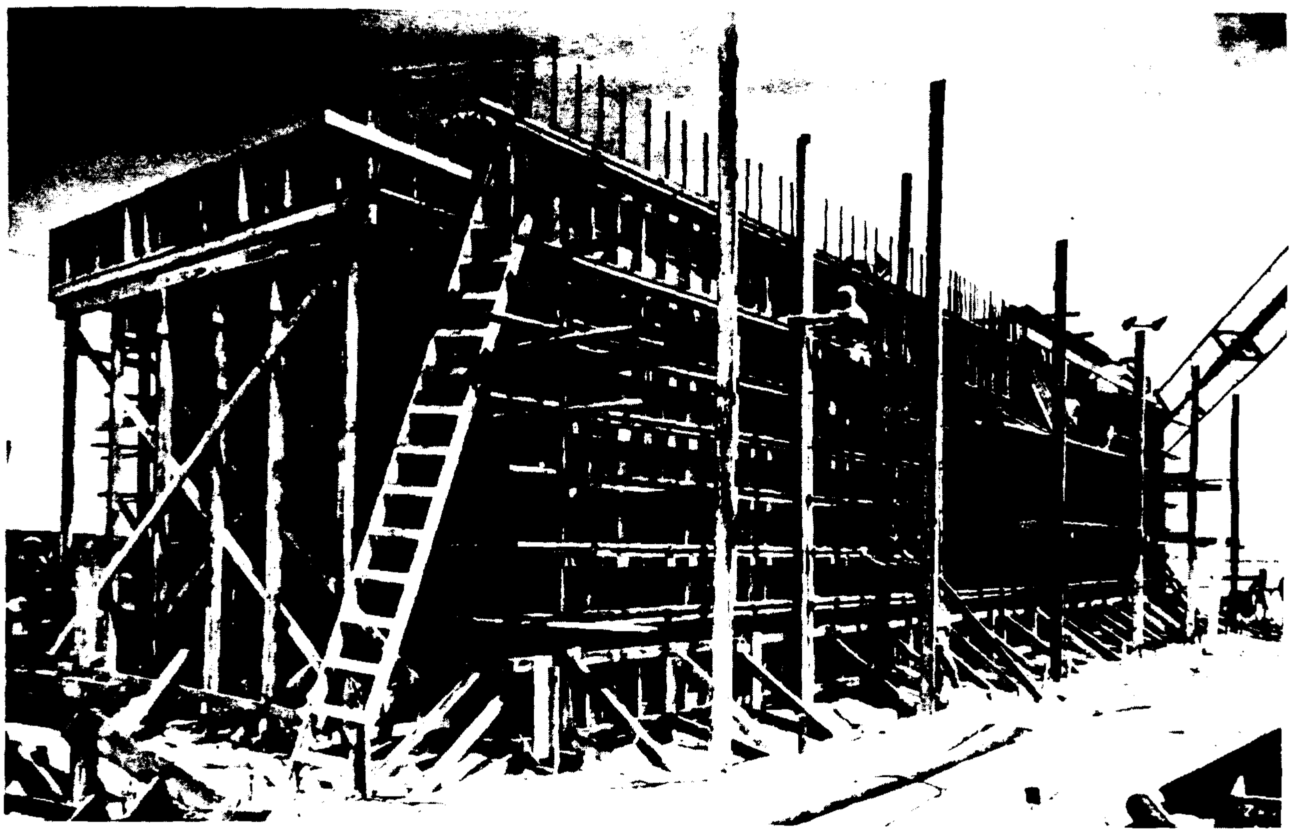


Figure 2-137. Station 1550 - Construction of Wall Forms

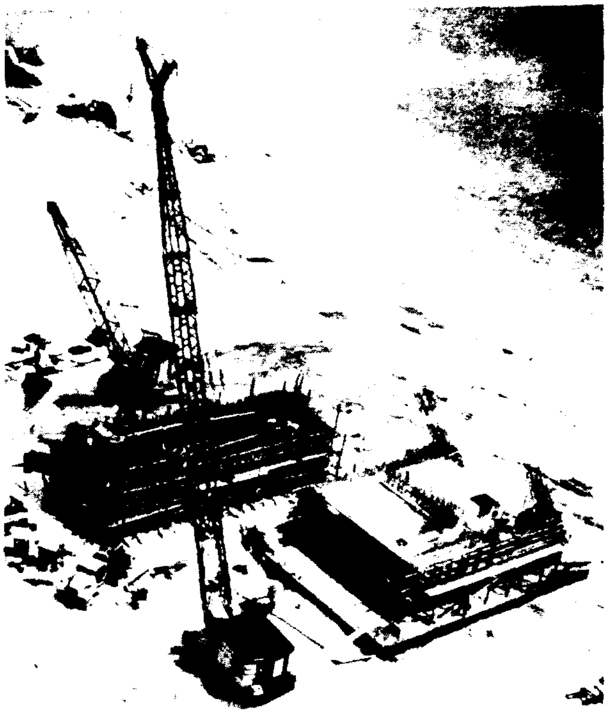


Figure 2-138. Station 1550 - Aerial View

dates varied from 1 October to 20 November and completion dates varied from 5 January to 23 January 1954. Stations 1403.15 and 1403.16 on Gene were started on 29 March and were completed on 3 April 1954.

STATION 1550 - BLOCK HOUSE
SITE GEORGE - USER: LASL

GENERAL. The Station used for Project 15.1 (Optical Alpha) was a reinforced concrete two-story structure 18′ - 0″ x 60′ - 0″ x 24′ - 2″ high with a penthouse on the roof. The roof was two feet thick, and the room below it had a ceiling height of 6′ - 6″. One end wall was 2′ - 6″ thick and remaining walls were 2′ - 0″ thick. The first floor consisted of two rooms and an entry. One room, 10′ - 0″ x 22′ - 0″, had four-foot thick exterior walls. The other room, 14′ - 0″ x 22′ - 0″, had two-foot thick exterior walls. This room had a rung ladder leading to the hatch at the second floor. The entry was a room, 6′ - 0″ x 14′ - 0″ with two-foot thick external walls. The building rested on a two-foot eight-inch continuous pad which extended out five feet at the entry, and which was embedded two feet six-inches into the ground. The penthouse, a 10′ - 0″ x 33′ - 0″ x 17′ - 0″ high steel angle framed building with plywood covering, rested on a skew with the concrete structure.

MECHANICAL. This Station had a dehumidification system. A half-ton capacity chain hoist was installed on the second floor. A 2,000 gallon underground tank for diesel fuel oil was installed outside and adjacent to the Station.

ELECTRICAL. The Station was served by two 30KW diesel engine generator sets. The lighting fixtures were of the standard industrial type and receptacles were located as desired by the Users.

ENGINEERING. The original criteria were received on 28 July. Additional criteria were received on 6 August, 10 August, 24 September and 12 October. Design work started on 12 August. Sixteen drawings and two sketches were prepared and submitted from 19 August to 14 September. Approvals were dated from 10 September to 9 October

CONSTRUCTION. Work was scheduled to commence on 10 October and to be completed

Figure 2-139. Station 1550 - Second Floor Interior

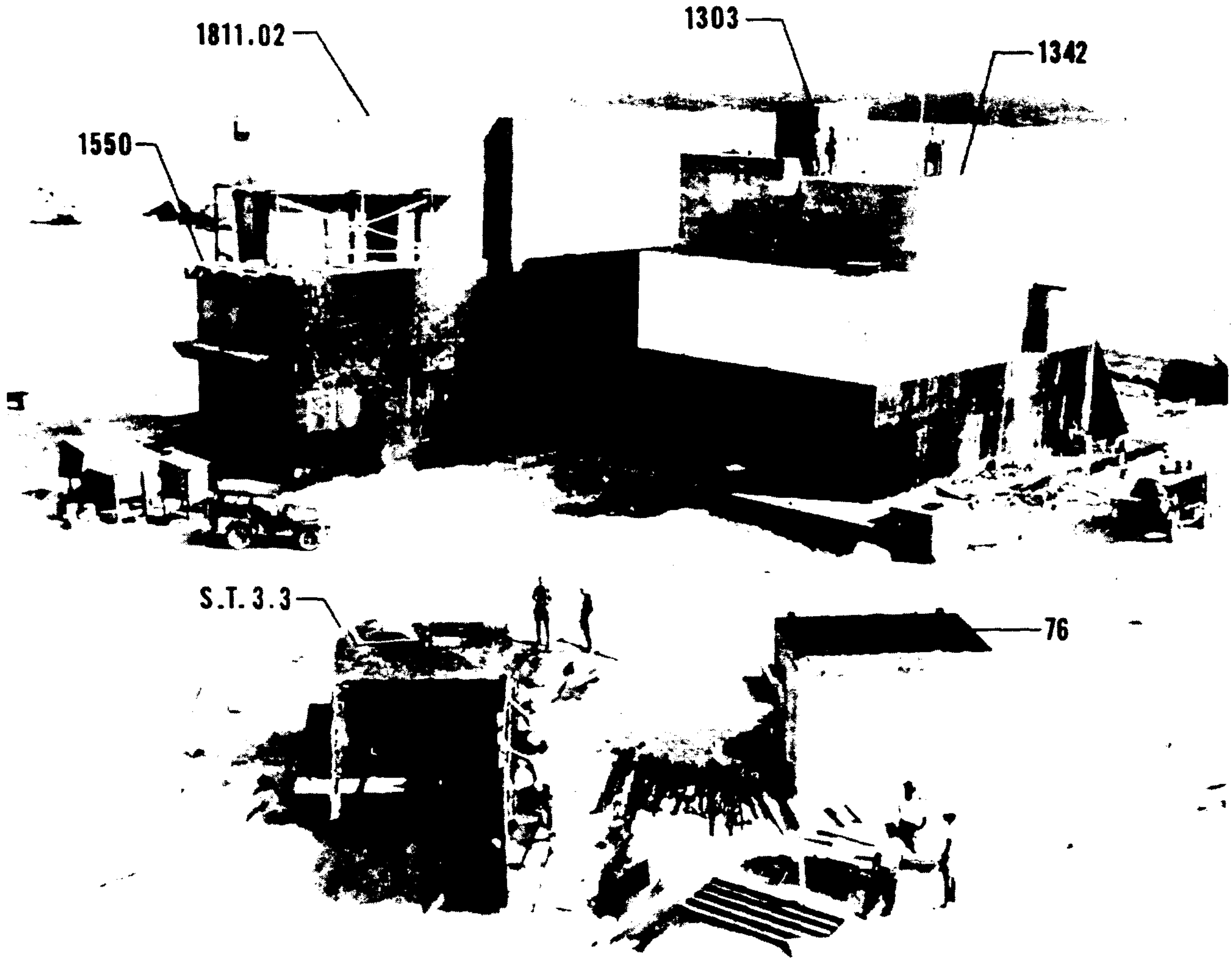


Figure 2-140. Station 1550 - 84% Completed

by 31 January 1954. Actual work st:rted on 6 October and was completed on 3 February. Figure 2-137 shows construction of wall forms. The estimated progress was 30% completed as shown on 6 November. Figure 2-138 shows progress of work in conjunction with Station 1342. Figure 2-140 is looking northwest at Station 1550. The transmission for Station 1342 (Station 1811.02) is noted on top of the penthouse. The camera piers (Station 1303) are noted on top of the camera bunkers (Station 1342). In the foreground is a submarine cable terminating Station (ST 3.3) and a timing shack (Station 76). Figure 2-139 shows interior of the second floor.

STATION 1552 - BLOCKHOUSE
SITE JANET - USER: LASL

GENERAL. This Station was a concrete structure reactivated from IVY Station 800 in March 1954 due to the rescheduling of the Test Program. IVY Station 800 was a reactivation of GREENHOUSE Station 6A. The work consisted of installing a temporary lighting system, some additional concrete, and sandbag protection. It was used in Project 15.1.

ENGINEERING. Field Engineering prepared field sketches as required.

CONSTRUCTION. Work commenced on 30 March 1954 and was completed on 10 April.

STATIONS 1560.01 - 1560.05
PHOSPHOR AND LIGHT ARRAY
SITES VARIOUS - USER: LASL

GENERAL. Station 1560.02, a Phosphor and Light Array Station, was located on the Baker-Charlie Reef. The Station consisted of a 10′ - 0″ x 10′ - 0″ x 37′ - 0″ high steel tower with a platform on top. The platform had a hand rail on all four sides and a caged ladder to the ground.

ENGINEERING. Stations 1560.01 thru 1560.05 were designated on the Instrumentation Chart for Project 15.1 (Optical Alpha). On 14 September, criteria were received solely for Station 1560.02. All work on the other four Stations was therefore held in abeyance. Design work for Station 1560.02 was started on 15 September; one drawing was submitted on 17 September and approved on 2 October. Stations 1560.01 and 1560.03 thru 1560.05 were included with the Test Barges.

CONSTRUCTION. Work was scheduled to start on 15 December and to be completed on 31 January 1954. Actual construction started on 1 December and was completed on 15 January 1954. Figures 2-74, 2-75 under Station 20, and Figure 2-132 under Station 1351 notes Station 1560.02 as completed.

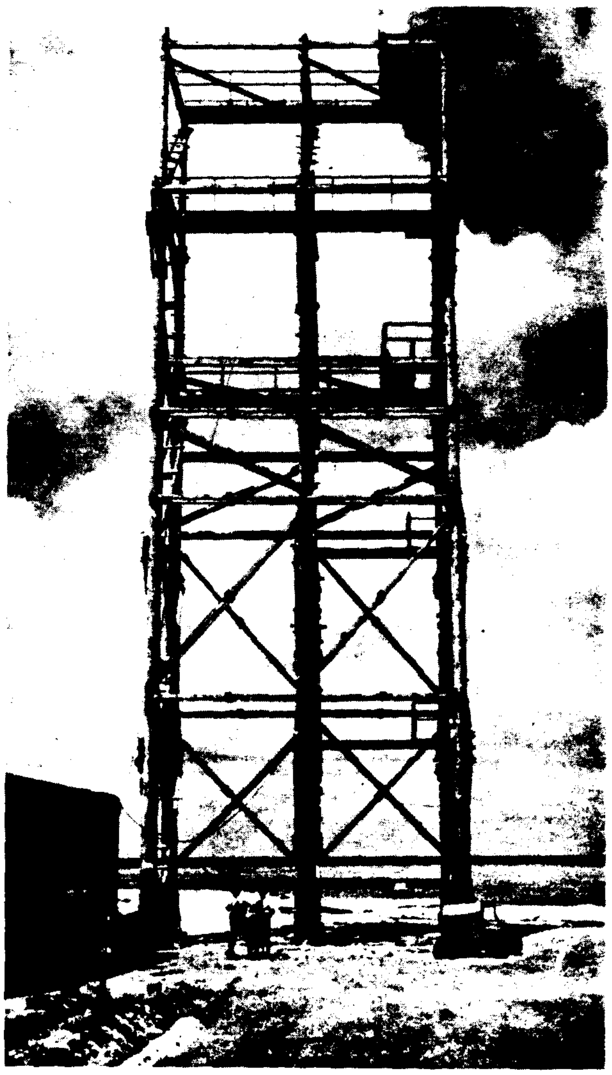


Figure 2-141. Station 1580.01 - Completed

STATION 1580.01
ANTENNA AND TRAILER - SITE NAN
USER: LASL

GENERAL. This Station, used to determine Electromagnetic Effects, consisted of two antennas and a trailer. The antennas were fastened to a non-metallic framework of six power poles arranged to form a tower. This tower was 16' - 0" x 30' - 0" x 95' - 0" high with three narrow working platforms. Figure 2-141 shows the Station completed with trailer as of 4 February 1954.

ENGINEERING. The original design criteria were received on 18 September 1953. Design work started on 22 September and two drawings were submitted on 14 October and approved and issued on 23 October.

CONSTRUCTION. Work was scheduled to commence on 1 November and to be completed on 31 January. Actual construction started on 15 December and was completed on 26 January 1954.

STATION 1581 - ANTENNA - SITE DAVID
USER: LASL

GENERAL. This Station was added in March 1954 due to the rescheduling of the Test Program. The work involved consisted of setting a 70-foot pole in a ten-foot concrete lined hole. Two generators and telephone service were installed. The Station was used to determine electromagnetic effects.

ENGINEERING. Field Engineering prepared field sketches as required.

CONSTRUCTION. Work commenced on 9 March 1954 and was completed on 13 March.

STATION 1801 - PLATFORMS - 200 FT. and 275 FT. LEVELS ON 300 FT. TOWER
USER: NRLS

GENERAL. This Station, used for thermal measurements, consisted of a pair of roofed-over platforms with canvas covered sides mounted at the 200-foot and 275-foot levels of the 300-foot steel tower which comprised Station 1300. A pipe framework was provided for mounting equipment. This consisted of a horizontal pipe about 20 feet long carried on pipe outriggers attached to the tower framework.

ELECTRICAL. This Station was served electrically from Station 70 by panel "PK" located on the 275-foot level. Both the 200-foot and 275-foot levels were wired in rigid conduit with standard industrial lighting fixtures. Receptacles, signal cabinet, and a telephone outlet were located as requested by the User.

ENGINEERING. Initial criteria were received on 12 May. Additional criteria were received on 12 June. The design work is reported under Station 1300.

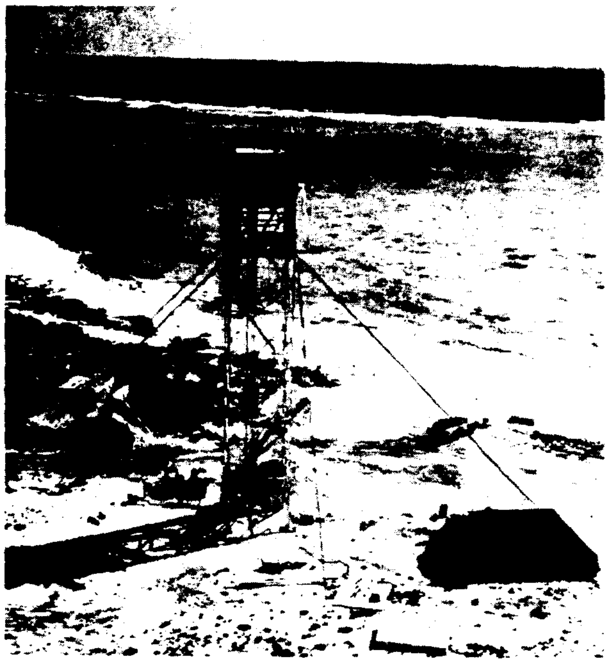


Figure 2-142. Station 1810.04 - Aerial View

CONSTRUCTION. Work was scheduled to commence on 1 September and to be complete by 30 November. Actual work started on 10 September and was completed on 25 January 1954.

STATION 1802 - EXISTING IVY 805
SITE ELMER - USER: NRLS

GENERAL. This Station consisted of reactivating a steel platform located at the 100-foot level of the 125-foot tower shaft of Station 301. Station 1802 was used for thermal measurements.

ENGINEERING. Two drawings were prepared and submitted on 14 October and 10 November. Approvals were dated 2 November and 4 December.

CONSTRUCTION. Work was completed on 24 February 1954.

STATIONS 1810.01 - 1810.05
TWO PLATFORMS IN 75-FT. TOWER
SITES VARIOUS - USER: NRLS

GENERAL. Each Station was used for thermal measurements and consisted of an enclosed platform 14′ - 3″ square at each of two levels of Station 1302.02, 1302.03 and 1302.04. One platform was at the 50-foot level and the other platform was at the 62′ - 6″ level. The sides of the tower between the 50-foot and 62′ - 6″ levels and between the 62′ - 6″ and 75-foot levels were enclosed by means of fold-up canvas sides.

ELECTRICAL. Incandescent lighting was provided at each platform level. A signal cable terminal cabinet and a telephone outlet were provided at the 50-foot level. Receptacle outlets were provided as requested by the User.

ENGINEERING. Criteria were received on 30 April. Station 1810.01 was cancelled on 14 September. Station 1810.05 was added at Clara in March 1954 due to the rescheduling of the Test Program. This Station was reactivated from IVY Station 520. Figure 2-142 is an aerial view of Station 1810.04 looking northeast. Station 72.01 is likewise shown. Figure 2-143 shows the off-loading of a generator for Station 1810.05 for Program 18.

CONSTRUCTION. Work on Stations 1810.02 and 1810.03 was scheduled to commence on 1 October and to be completed by 30 November. Station 1810.04 was scheduled to commence on 1 September and to be completed by 31 January 1954. Actual construction was as follows: Station 1810.02 site How was started on 8 November and completed by 6 February 1954. Station 1810.03 site Tare was started on 10 October and completed by 26 December. Station 1810.04 site Janet was started on 26 August and completed by 20 January 1954. Station 1810.05 site Clara was started on 5 April 1954 and completed by 9 April 1954.

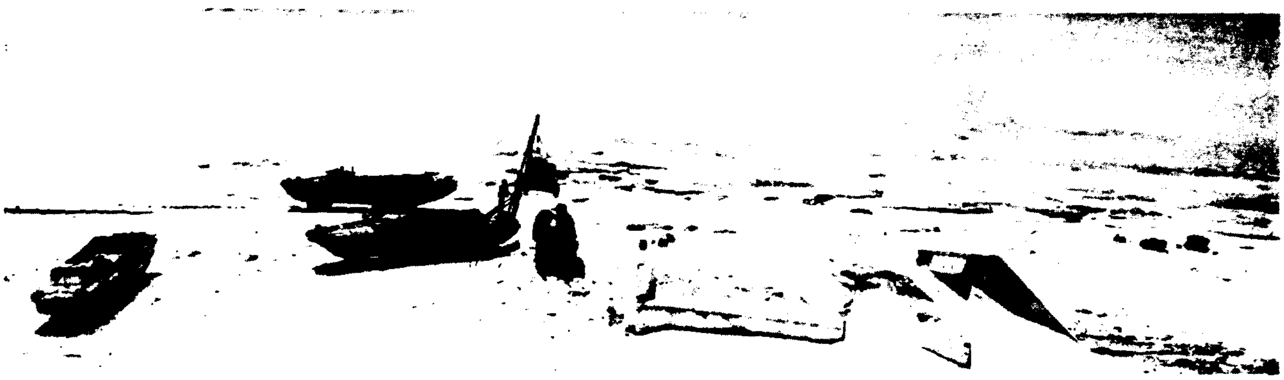


Figure 2-143. Station 1810.05 - Off Loading Generator

STATIONS 1811.01 AND 1811.02
TRANSMISSION
SITES DELTA AND GEORGE
USER: NRLS

GENERAL. Station 1811.01 consisted of an electrical outlet on the roof of Station 1341. Station 1811.02 consisted of a 10′ - 0″ x 32′ - 3″ x 17′ - 0″ high penthouse located on the roof of Station 1550. These Stations were used in Project 18.1 (light transmission).

ENGINEERING. Eleven plans were prepared and submitted from 19 August to 3 September. These plans were approved from 10 September to 9 October.

CONSTRUCTION. Work on Station 1811.01 started on 1 January 1954 and was completed on 23 January. Station 1811.02 was started on 19 December 1953 and was completed on 20 January 1954.

Figure 2-144. Station 1812.07 - Typical

STATIONS 1812.01 - 1812.08
MODULATED LIGHT SOURCE
SITES VARIOUS - USER: NRLS

GENERAL. These Stations were located on islands or reefs of both atolls. Station 1812.01 was a steel tower similar to Station 1560.02 and is shown in Figure 2-82 with its relation to Station 20. Stations 1812.04, 1812.05 and 1812.07 consisted of 12′ - 0″ x 12′ - 0″ wood-framed platforms on top of 8′ - 0″ x 8′ - 0″ x 15′ - 0″ high wood-framed towers. Power was supplied to all four Stations. The three wooden towers had portable generators for this purpose. The User furnished the equipment to measure light transmission.

ENGINEERING. Criteria were received on 31 August. Station 1812.07 was relocated on 2 September. The Instrumentation Chart designated seven Stations. As criteria were not received for Stations 1812.02, 1812.03, 1812.06 and 1812.08, the work on these four Stations was held in abeyance. Design drawings were started on 15 September and three plans were submitted on 25 September; they were approved on 15 October. Figure 2-144, Station 1812.07, is typical of the series.

CONSTRUCTION. Work was scheduled to commence on 10 October and to be completed on 31 December. Actual starting dates varied from 10 November to 15 January. Completion dates varied from 15 to 18 January 1954.

STATIONS 1820.02 - 1820.05
DOUBLE TRAILER PIER LOCATION AT 75 FT. TOWER BASE
SITES VARIOUS - USER: NRLS

GENERAL. These trailer Pedestal Stations, 1820.02, 1820.03 and 1820.04, were used for thermal measurements and were located on sites How, Tare and Elmer respectively. Station 1820.05, at Yvonne, was added in March 1954 due to the rescheduling of the Test Program. These pedestals or supports consisted of three parallel steel members, the tops being six feet above the ground. The support covered an area of 12′ - 0″ x 30′ - 0″ x 30′ - 0″ and the tops of the trailers were guyed to concrete anchors. Figure 2-145, Station 1820.05, is typical of this series.

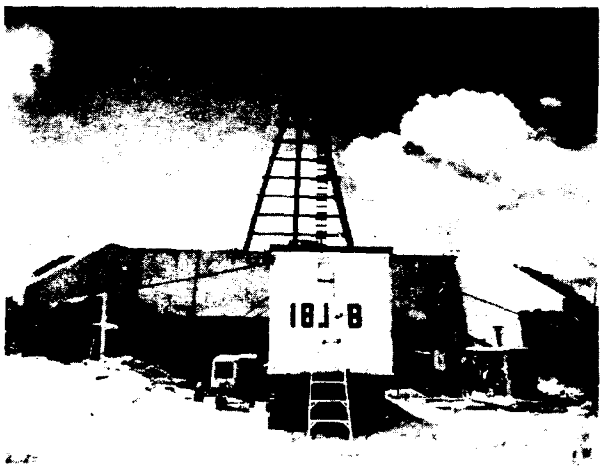


Figure 2-145. Station 1820.05 - Typical

ENGINEERING. The original design criteria were received on 13 July 1953. One drawing was required and it was started on 20 August, submitted on 18 September, approved and issued on 6 November. GREENHOUSE Station 100 was reactivated and the work consisted of installation of blowers, generators and transformers. Additional concrete slabs, tower and a mirror platform were required.

CONSTRUCTION. Work was scheduled to commence on 15 October and to be completed on 31 December. Actual construction started on 27 October and completion dates varied from 16 January to 1 February 1954. Station 1820.05 was started on 30 March 1954 and completed on 10 April.

STATION 1840.01 - TRAILER ON BARGE SITE HOW - USER: NRL

GENERAL. This Station was added in March 1954 due to the rescheduling of the Test Program. The work involved consisted of loading User's equipment on a barge, installing generators, erecting a pipe frame over trailers and providing living accomodations for six men. Deadmen, anchors, cable and winch for mooring were provided.

ENGINEERING. Jobsite Engineering prepared field sketches as required.

CONSTRUCTION. Work commenced on 11 March 1954 and was completed on 18 March.

STATION 1841 - INSTRUMENT SHELTER SITE JANET - USER: NRL

GENERAL. This Station was reactivated from IVY Station 801 in March 1954 due to the rescheduling of the Test Program. IVY Station 801 was a reactivated concrete structure from GREENHOUSE, Station 6B. Work consisted of installing a generator and blower, electrical and signal circuits and additional earth fill and sandbag protection.

ENGINEERING. Jobsite Engineering prepared field sketches as required.

CONSTRUCTION. Work commenced on 30 March 1954 and was completed on 10 April.

STATION 2200 - RECORDING STATION SITE SUGAR - USER: UCRL

GENERAL. Station 2200, used for reaction history, was practically identical with Station

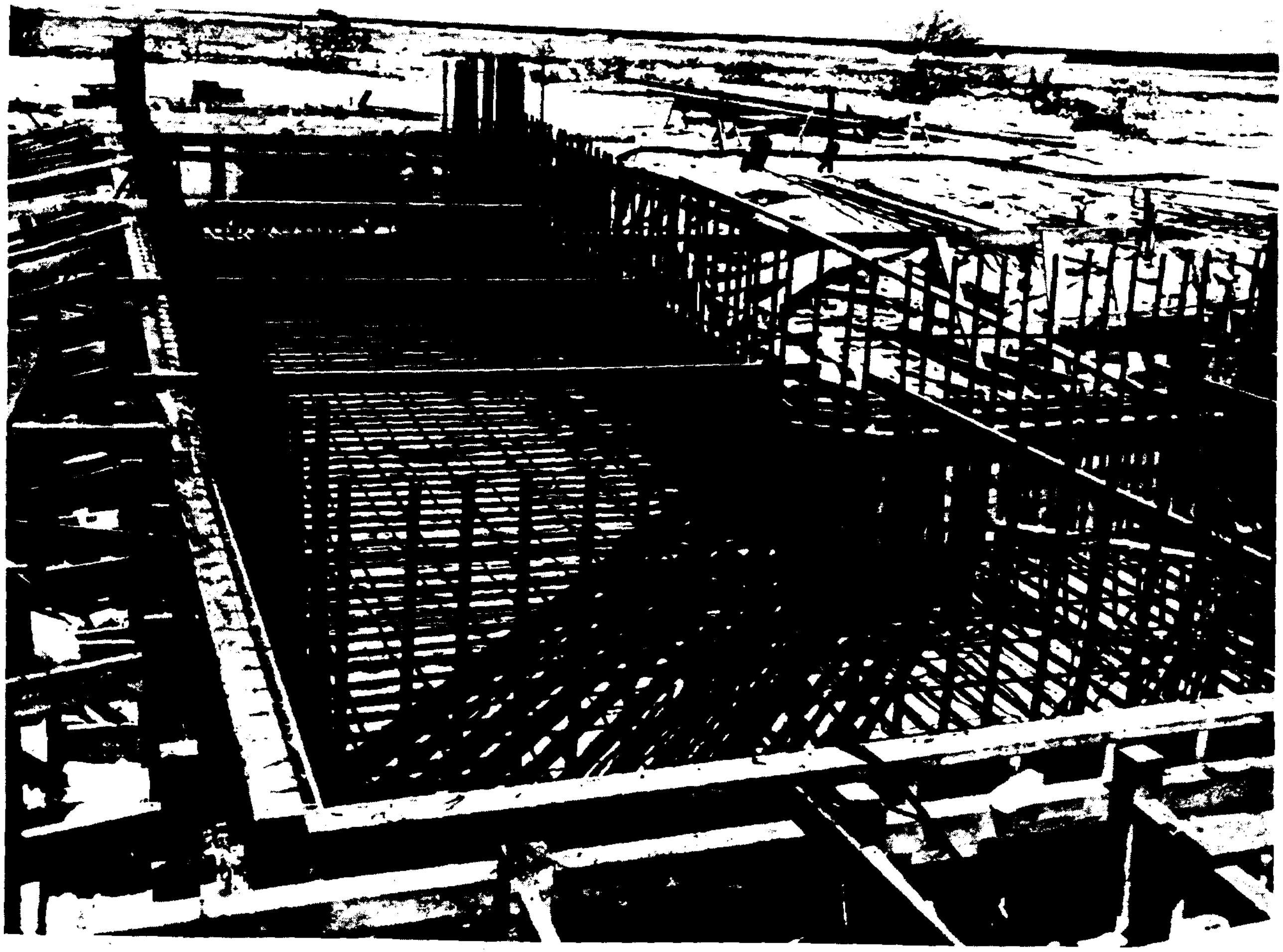


Figure 2-146. Station 2200 - Corner Reinforcement

1200 with the one exception being that the main rectangular structure was six feet shorter in length.

ENGINEERING. The design criteria were included and reported under Station 1200.

CONSTRUCTION. Work was scheduled to commence on 1 July and to be completed on 31 December. Actual construction started on 1 July and was completed on 6 February 1954. Figure 2-146 shows the massive diagonal reinforcing steel required for corner bracing. Figure 2-147 likewise notes the massive vertical reinforcements required for the side walls. The progress was estimated as 46% completed as shown on 11 September. Figure 2-148 shows the divisions for the three rooms in the main structure with connecting corridor, tunnel and utility room. Progress of work was estimated as 65% completed as shown and on 7 October.

STATION 2201 - RECORDING STATION SITE SALLY - USER: UCRL

GENERAL. This Station, used for reaction history, was a one-story reinforced concrete addition to existing GREENHOUSE Station 132A and B. The thickness of walls, roof and floor of this Station varied from 2′ - 10″ to 4′ - 6″. It consisted of the existing Station, 34′ - 0″ x 30′ - 0″ in plan, divided by a 34-foot long interior wall, into two instrument rooms of equal size. Each room was connected by a 4′ - 2″ x 7′ - 9″ opening to a utility room 14′ - 0″ x 26′ -0″ in plan, with nine-foot ceiling height, extending across the ends of the existing pair of rooms. One end of this room extended into a tunnel having a clear width and height of four feet and nine feet respectively. The entrance consisted of two openings, each enclosed by a steel blast resistant door. A 5′ - 0″ x 7′ - 0″ protected area outside the opening was completely housed by a small reinforced concrete box-like structure called the vestibule. The main entrance opened onto a reinforced concrete loading platform about 16′ - 0″ x 20′ - 0″ in plan. Steps led down to a 20′ - 0″ wide by 68′ - 0″ loading ramp. The Station was covered with a 15-foot deep earth fill.

CONSTRUCTION. Work was scheduled to commence on 1 July and to be completed by 15 January. Actual work started on 6 July and was completed on 20 January 1954. Figure 2-149 noted method of securing a bond between the old structure and the new addition. The method

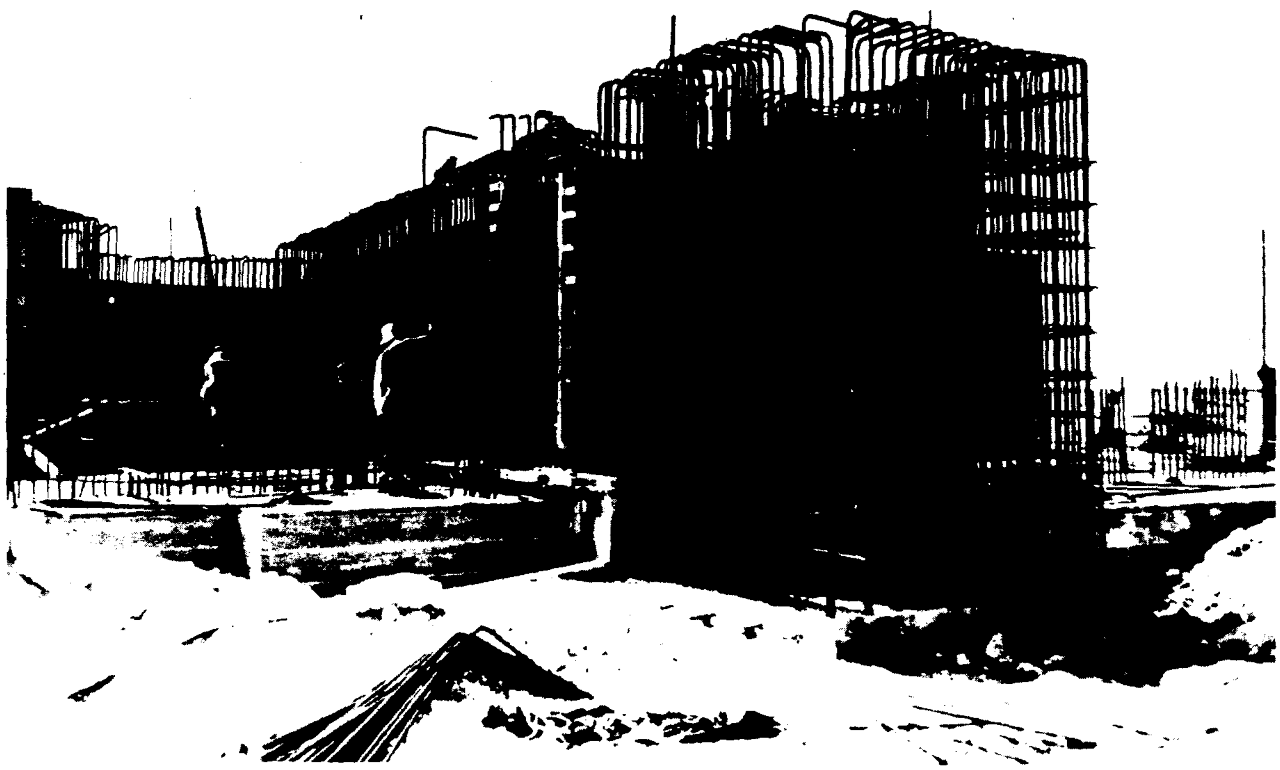


Figure 2-147. Station 2200 - 46% Completed

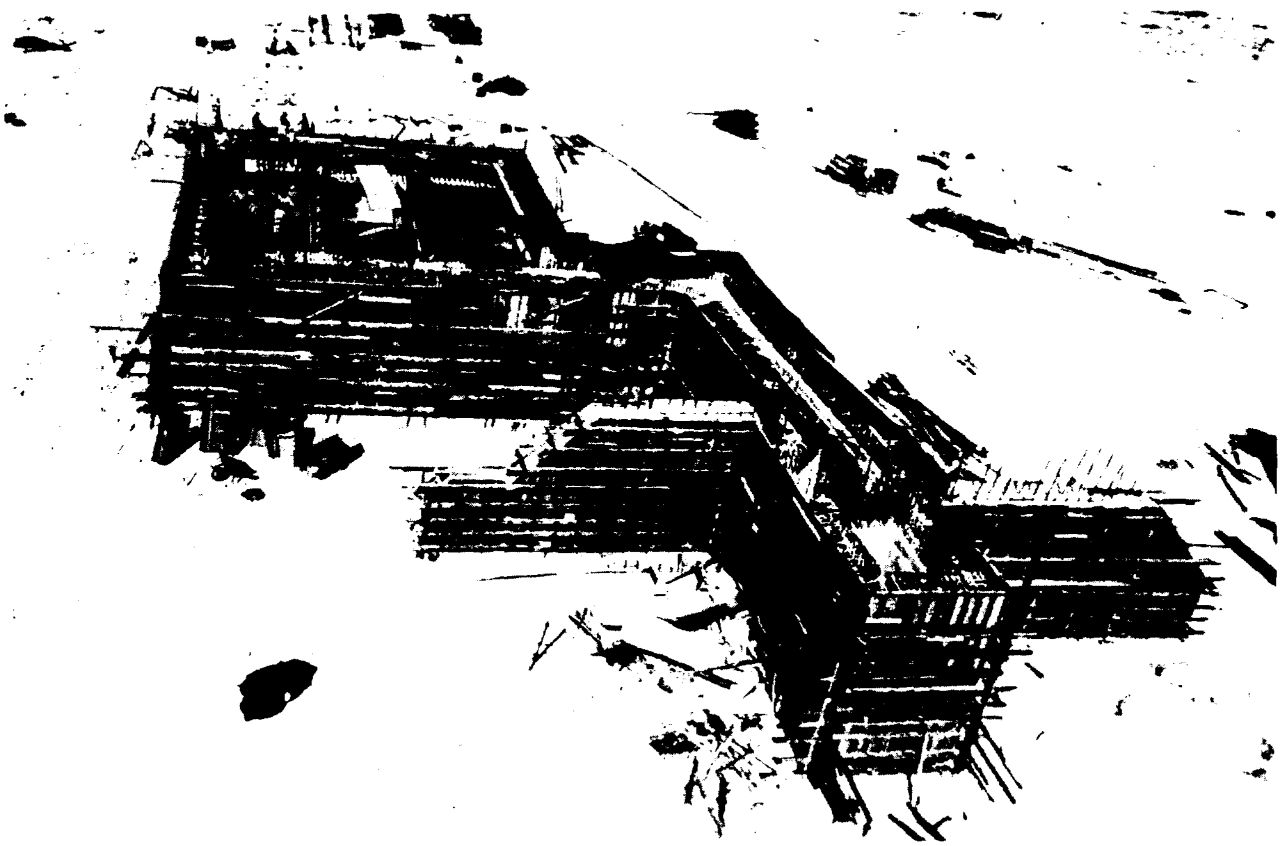


Figure 2-148. Station 2200 - Aerial View

consisted of chipping away old concrete and tying into old reinforcements. When the pour was made, tying into the old concrete and reinforcements, a yardage of approximately 290 cubic yards was involved. In the middle of this pour a severe rainstorm of over an hours duration was experienced. The concrete in place was salvaged. All large subsequent pours were carefully scheduled on weather predictions. Figure 2-150 notes an estimated 55% completion as of 15 October. Figure 2-151 shows Station completed with User's trailers in operation as of 10 April 1954.

STATION 2210 - DETECTOR STATION SITE SUGAR - USER: UCRL

GENERAL. The Station, used for reaction history, was a steel framed building 55' - 0" x 19'- 0" x 15' - 6" high with corrugated aluminum roofing and siding. Along the ridge was a two-foot high continuous metal air ventilator. From the underside of the roof beams, crane girders were hung for a two-ton bridge crane moving from end to end of the building. The floor of the building was a reinforced concrete slab poured on grade.

MECHANICAL. The mechanical features included a two-ton bridge crane and forced air ventilation.

ELECTRICAL. The electrical system was subfed from Station 2200. Standard industrial lighting fixtures were used with a rigid conduit wiring system. Power was supplied to receptacles as desired by the Users.

ENGINEERING. The original design criteria were received on 20 April 1953. Alterations and additional criteria were received on 12 June, 6 July, 13 July, 31 July and 7 August. Design work was started on 18 June. Seven plans were prepared and submited from 24 June to 16 December. Approval dates varied from 15 July to 8 January 1954.

CONSTRUCTION. Work was scheduled to commence on 1 September and to be completed on 31 December. Actual construction started on 16 September and was completed on 1 February 1954.

STATION 2211 - DETECTOR STATION SITE SALLY - USER: UCRL

GENERAL. Same as for Station 2210, with minor exceptions.

ENGINEERING. Same as for Station 2210.

CONSTRUCTION. Work was scheduled to commence on 15 September and to be completed on 15 January 1954. Actual construction work

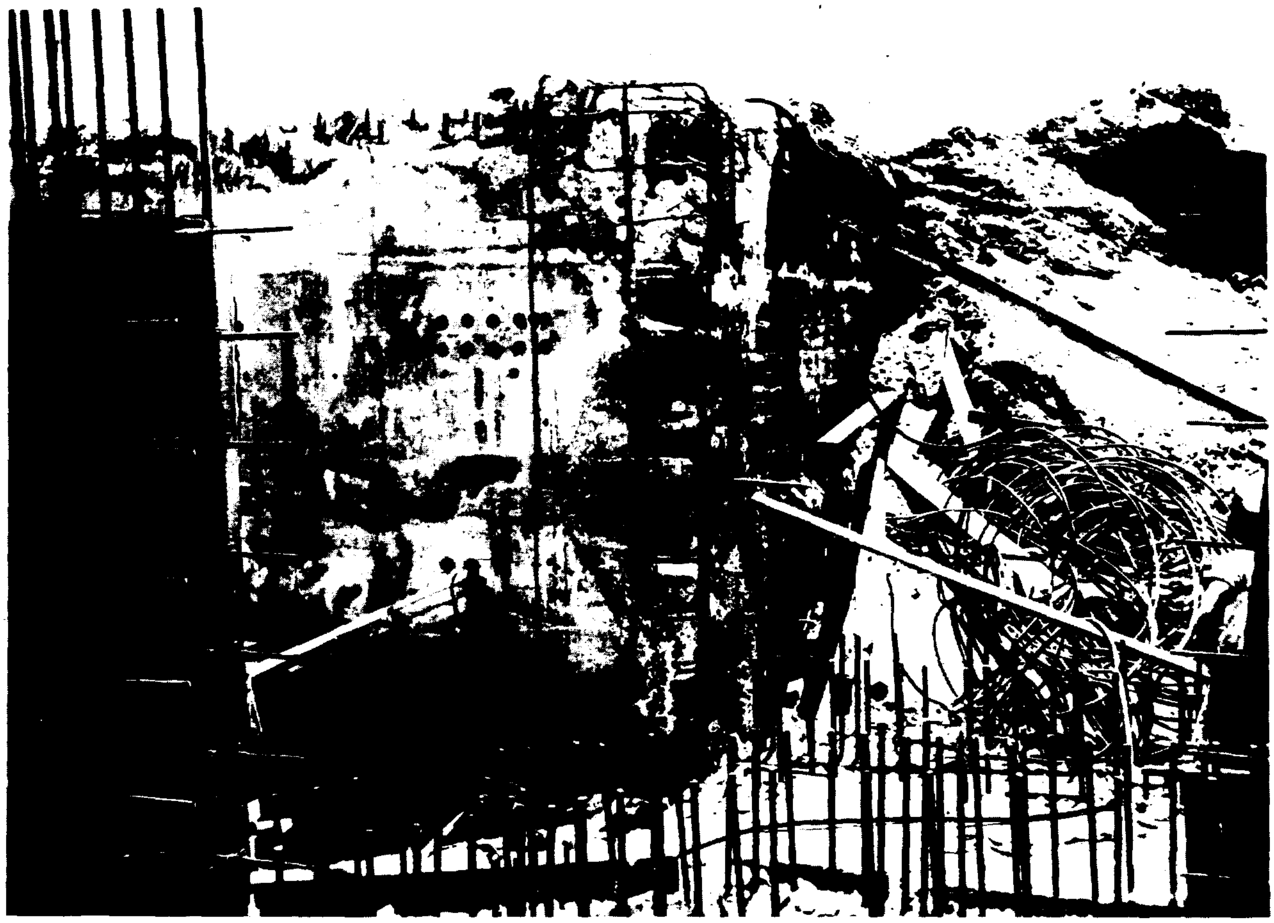


Figure 2-149. Station 2201 - Bonding to Old Structure

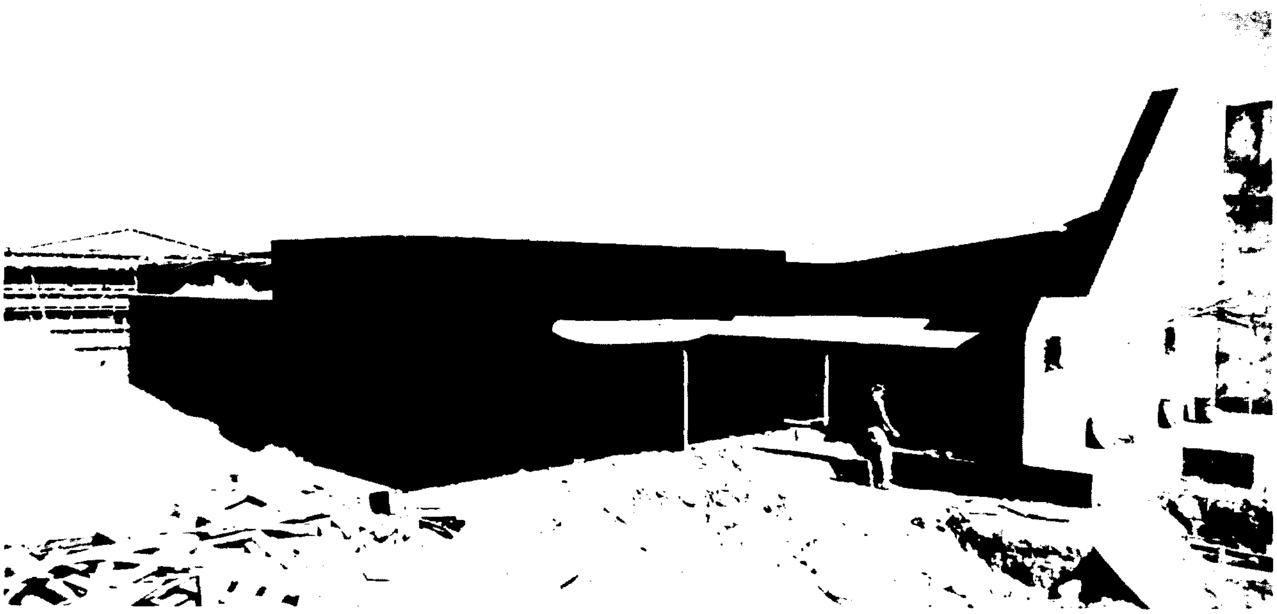


Figure 2-150. Station 2201 - 55% Completed

Figure 2-151. Station 2201 - Aerial View - Completed

started on 28 September and was completed on 20 January. Figure 2-152 shows blast wall foundations poured and rear wall forms in place. Figure 2-153 shows Station as 84% completed on 30 December. At left is shown Station 2231 (vacuum Station) and Station 2230 (2-pipe array). Figure 2-154 notes interior of Station nearing completion.

STATION 2220 - PIPELINE
SITE SUGAR-TARE - USER: UCRL

GENERAL. This Station consisted of a pair of pipes, or two-pipe array, 5544′ - 0″ long supported by wood frames spaced approximately 20 feet apart. Pipes were fabricated and installed as reported for Station 1203. The vacuum

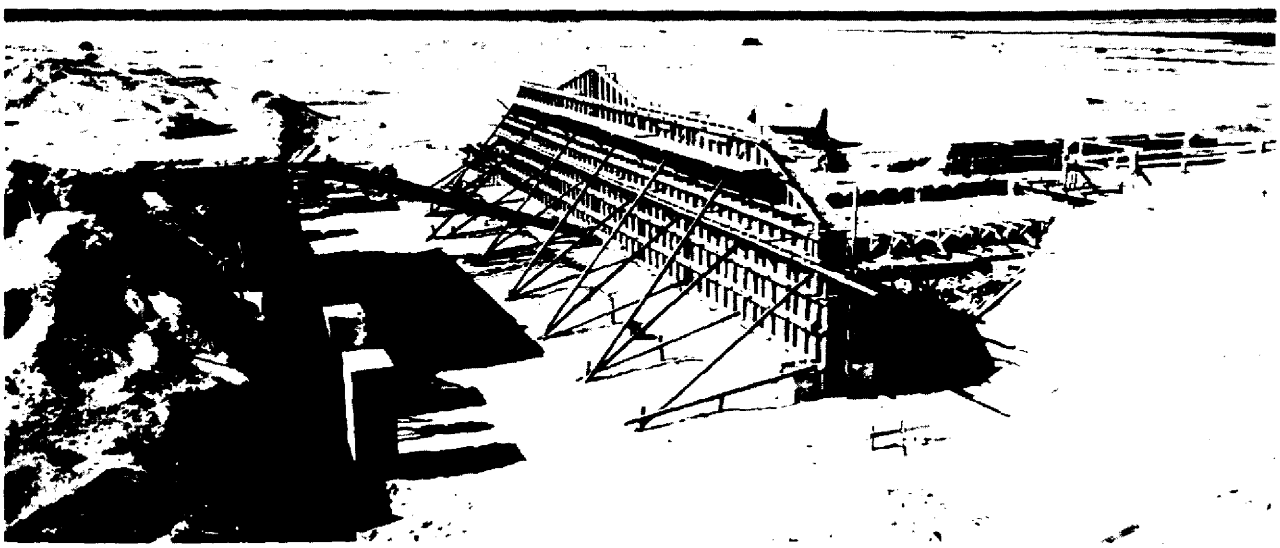


Figure 2-152. Station 2211 - 25% Completed

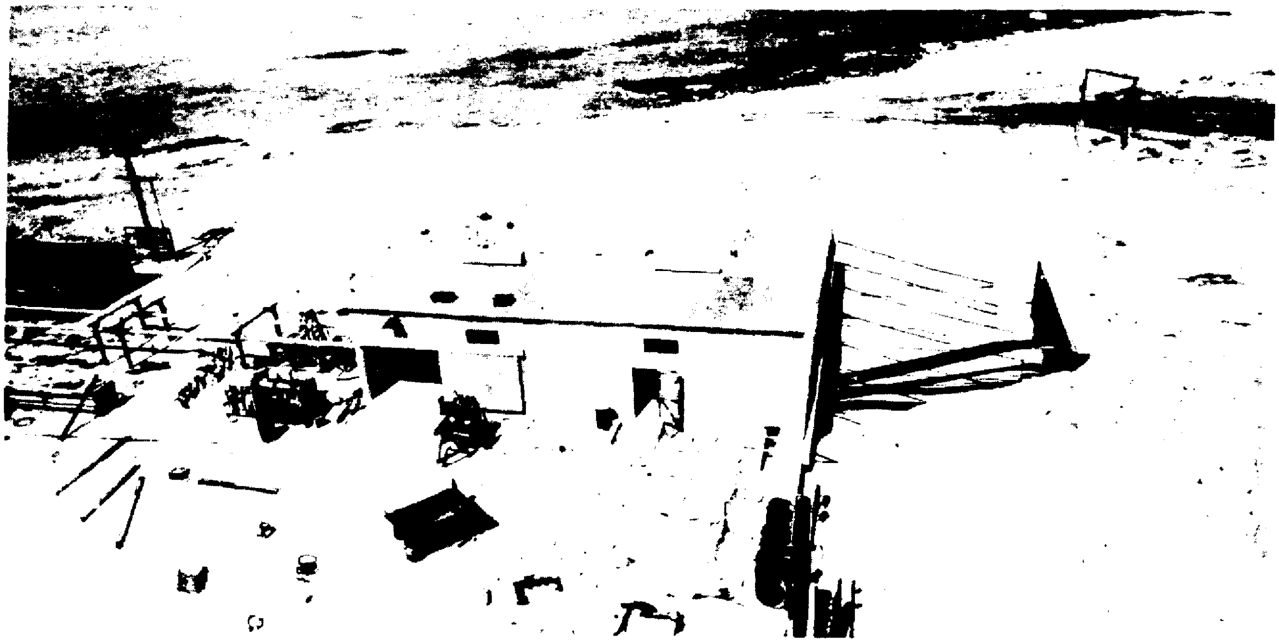


Figure 2-153. Station 2211 - 84% Completed

pumps were furnished by the User and the pump Station is described under Station 2221.02.

ENGINEERING. Reported under Station 1203.

CONSTRUCTION. Work was scheduled to commence on 1 June and to be completed by 31 December. Actual work started on 20 July and was completed on 2 January 1954. Figure

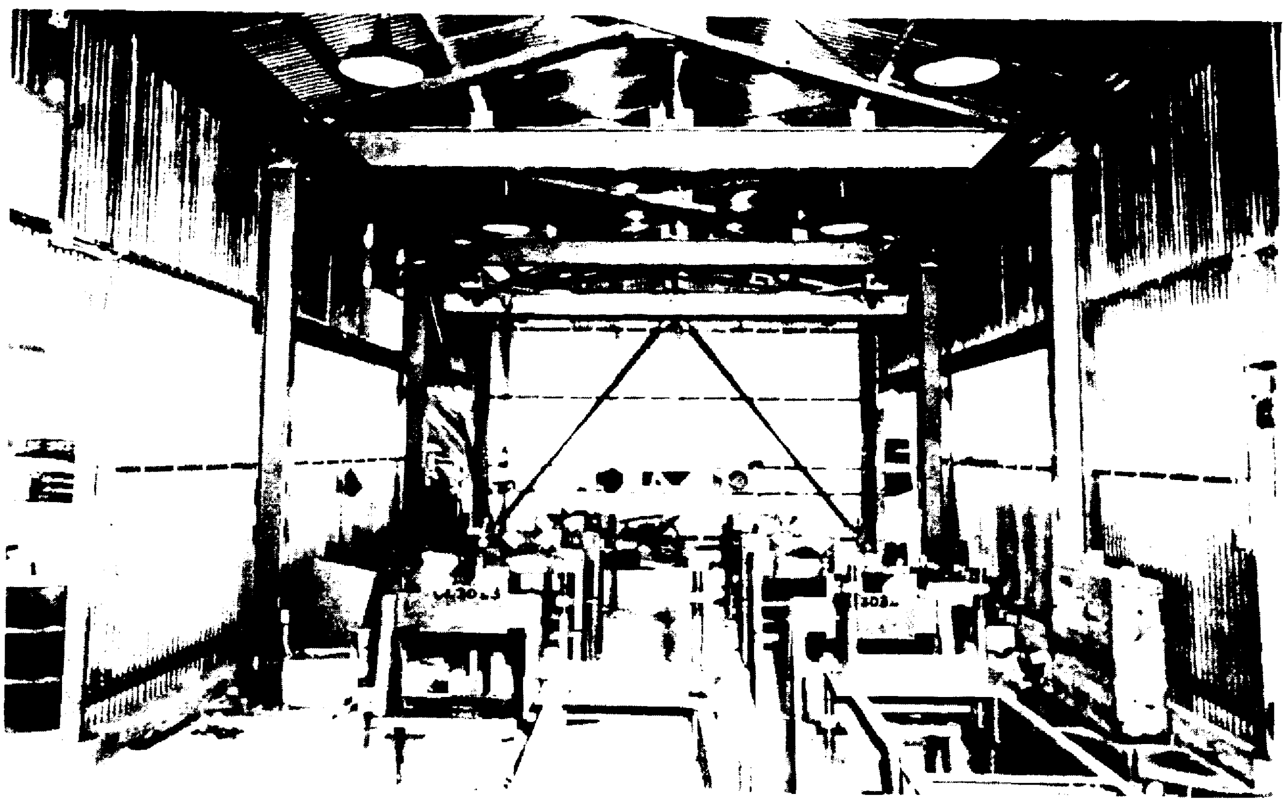


Figure 2-154. Station 2211 - Interior

Figure 2-155. Station 2220 - Supports for Pipes

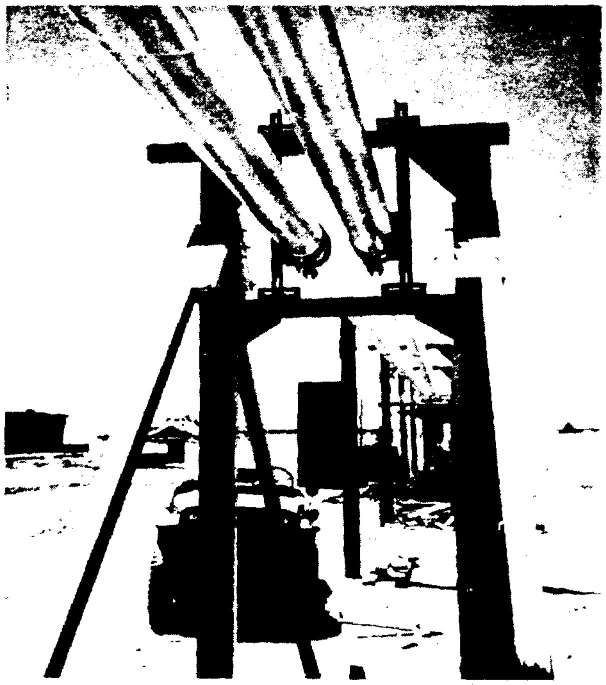


Figure 2-156. Station 2220 - Hardware Installed

2-155 shows the supports and distance between pipes near Station 2200. Figure 2-156 notes the supports and hardware installed near Station 50. Difficulties arose when the fiber glass pipe joints and neoprene expansion joints collapsed under the applied vacuum. Fibre glass pipe was replaced with steel pipe, and new neoprene expansion joints with a greater wall thickness were installed. Figure 2-157 shows pipes entering Station 2210. At the rear of Station 2210 is shown Station 2200. The earthfill has been completed and is being covered with sand bags. The sheet metal siding has been removed from Station 2210.

STATION 2221.01 AND 2221.02
PUMP STATION - SITE TARE-SUGAR
USER: UCRL

GENERAL. Station 2221.02 consisted of vacuum pumps mounted on 4′ - 0″ x 5′ - 0″ x 0′ - 6″ thick reinforced concrete pads which were embedded three inches in the ground. This was the permanent pumping Station for holding Station 2200 pipeline under a pressure of 1 cm Hg. absolute or less. The Station consisted of two 5HP vacuum pumps connected into the pipelines through sediment separators and flexible hose connections. Salt water was pumped from a well and used as a medium for cooling the vacuum pumps. Valved stub-outs were included in the piping for the possible connection of two portable vacuum pumps.

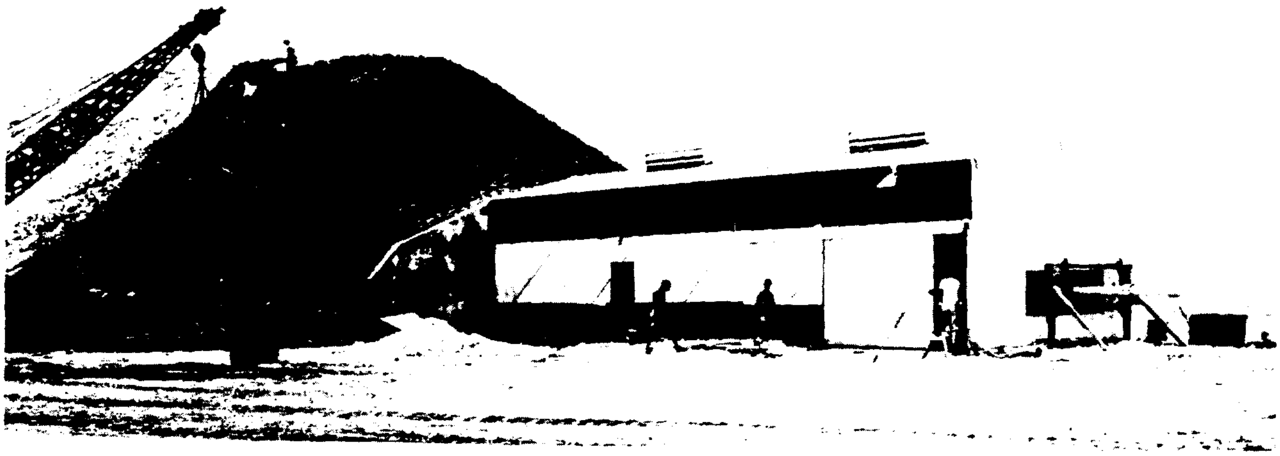


Figure 2-157. Station 2220 - With Earth Fill

Figure 2-158. Station 2221.02 - Completed

ENGINEERING. The design criteria were received on 23 April 1953. Minor desired changes were received on 15 October. Design work started on 4 May. Three plans were prepared and submitted from 3 July to 7 October. Approvals were dated from 7 September to 15 October. Station 2221.01 was not required.

CONSTRUCTION. Work was scheduled to commence on 1 September and to be completed by 31 December. Actual work started on 21 October and was completed on 5 December. Figure 2-158 shows the Station as completed.

STATIONS 2223.01 AND 2223.02
COAX CONNECTION PIT
SITES TARE AND RUBY - USER: UCRL

GENERAL. The work involved consisted of building a pit, 5′ - 2″ square by 6′ - 0″ deep, framed with wood and with a wooden plank cover.

ENGINEERING. The design criteria were received on 6 May 1953. A drawing was started on 12 May, submitted on 21 May, approved and issued on 24 June.

CONSTRUCTION. Work was scheduled to commence on 1 September and to be completed on 15 January 1954. Both Stations were started

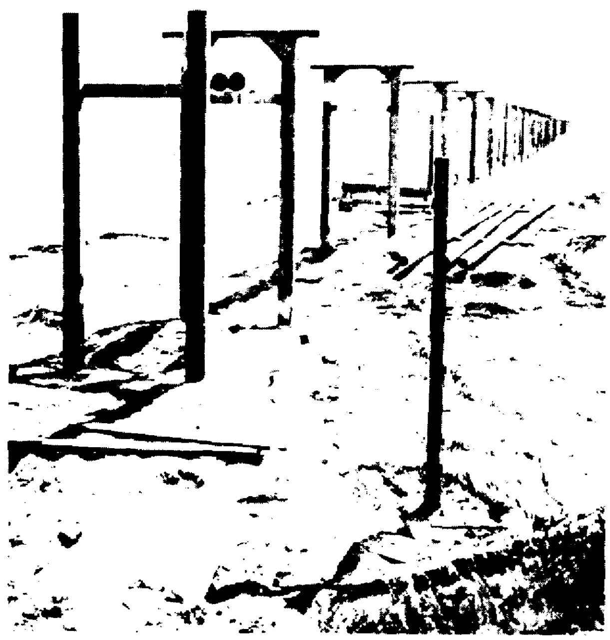


Figure 2-159. Station 2230 - 57% Completed

on 1 September. Station 2223.02 was completed on 20 November and Station 2223.01 was completed on 11 December.

STATION 2230 - PIPELINE
SITE RUBY-SALLY - USER: UCRL

GENERAL. This Station consisted of a pair of pipes, or two-pipe array, 2773' - 0" long supported by wood frames spaced approximately 20 feet apart. Pipes were fabricated and installed as reported for Station 1203.

ENGINEERING. The experiment originally contemplated for the Ruby-Sally group of islands consisted of a tower shot without a pipeline. This was later changed to a land shot with a pipeline. The design criteria is reported under Station 1203.

CONSTRUCTION. Work was scheduled to commence on 15 July and to be completed by 31 December. Actual construction started on 28 July and was completed on 27 February 1954. Figure 2-159 notes 57% estimated completion as of 15 October. Figure 2-160 shows a section of the pipe array with earth covering. At the rear, and earth covered, was Station 2201.

STATION 2231.01 - PUMP STATION
SITE SALLY - USER: UCRL

GENERAL. Same as for Station 2221.02.

ENGINEERING. Same as for Station 2221.02.

CONSTRUCTION. Work was scheduled to commence on 1 September and to be completed by 15 January 1954. Actual work started on 1 September and was completed on 16 January.

STATION 2300 - PHOTO BUNKER
SITE PETER - USER: UCRL

GENERAL. This Station, used for high speed photography, was a massive reinforced concrete bunker similar to Station 1341. The deletion of sloping buttresses, the substitution of a wood equipment lean-to for the reinforced concrete equipment room at the first floor level, the addition of a projecting platform at the door leading into the Station, and a change in thickness of the rear wall constituted the major differences between this Station and Station 1341.

ENGINEERING. Design problems were similar to those applying to Station 1341. While the pressures were much smaller than those encountered on Station 1341, permitting deletion of buttresses, the need for radiation protection required thick walls; consequently wall thicknesses were, in general, maintained the same as those for Station 1341 in accordance with criteria received on 10 July 1953. Drawings required are reported under Station 1341.

CONSTRUCTION. Work was originally scheduled to commence on 1 August and to be completed by 15 January 1954. Actual work started on 7 September and was completed on 25 January. Figure 2-161 shows forms stripped after pouring limonite wall. The Station was 30% completed as of 8 November. Figure 2-162 shows Station nearing completion on 5 January 1954. This view notes the projecting platform and door leading into the Station and the wood lean-to equipment room. The 500-gallon vertical tank shown was used for diesel oil storage.

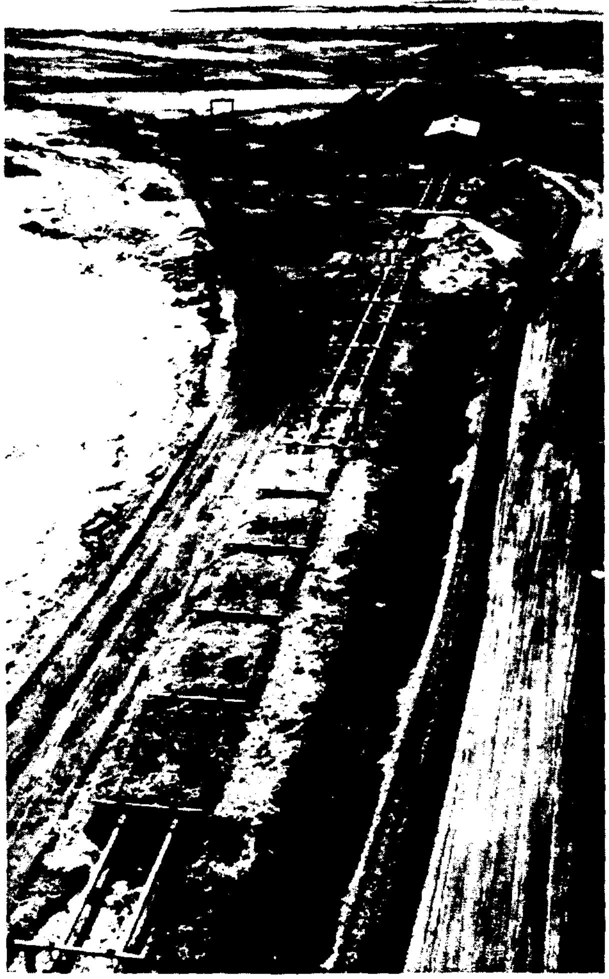


Figure 2-160. Station 2230 - Section with Earth Covering

STATION 2301 - PHOTO BUNKER
SITE TILDA - USER: UCRL

GENERAL. Similar to Station 2300.

ENGINEERING. Similar to Station 2300.

CONSTRUCTION. Work was originally scheduled to commence on 1 September and to be com-

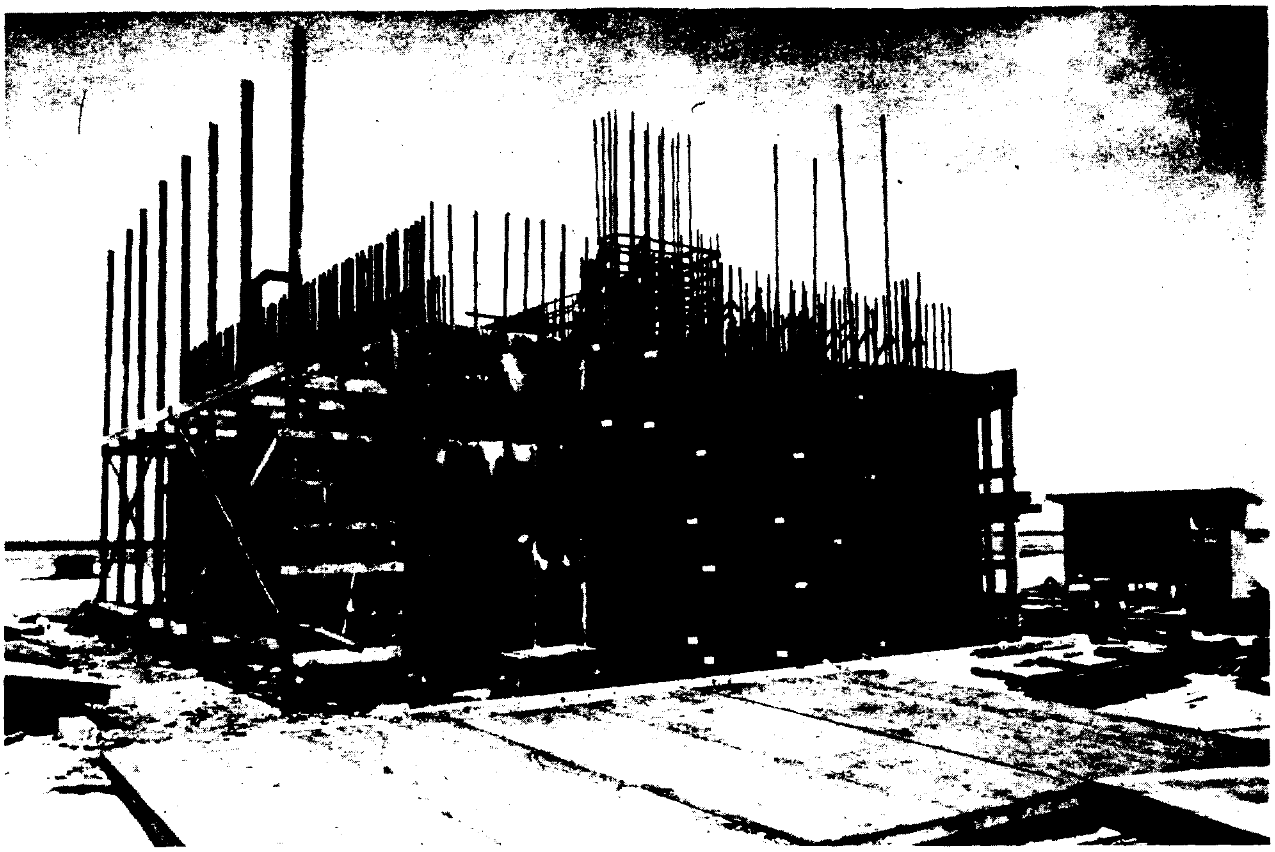


Figure 2-161. Station 2300 - Limonite Wall

Figure 2-162. Station 2300 - 91% Completed

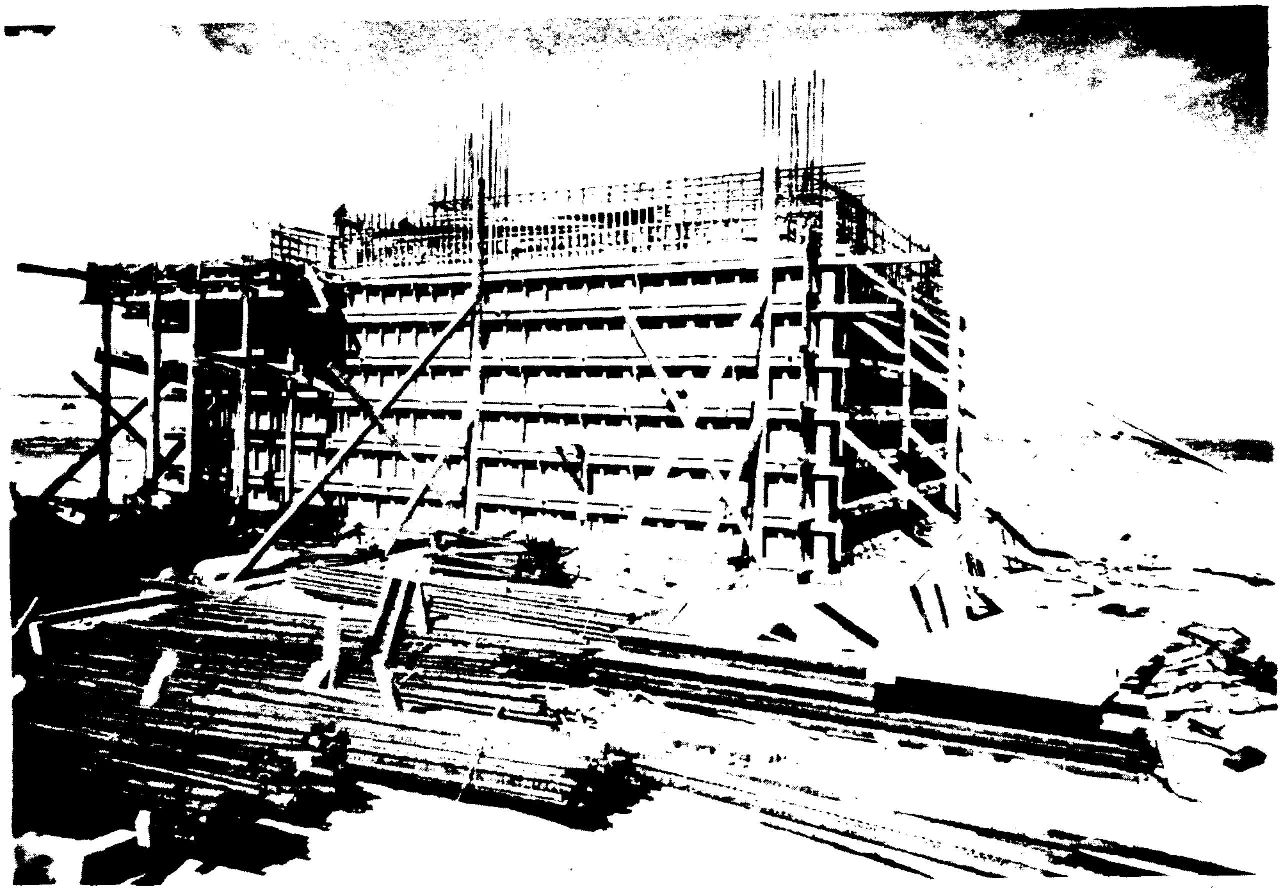


Figure 2-163. Station 2300 - 55% Completed

pleted by 15 February 1954. Actual work started on 25 August and was completed on 20 January. Figure 2-163 shows an estimated completion of 55% as of 15 October. The reinforcing steel in the foreground represents only a part of the steel required to be worked into the upper side walls and roof slab. Figure 2-164 shows the east or rear wall of the Station as completed. The platform and light at the left of the Station was Station 1812.07. Difficulty was experienced in pouring the heavily reinforced limonite concrete key monolithic with the coral concrete foundation of this Station. On the similar pour for Station 2300, this was remedied by providing reverse forms for the limonite pour, which was made after the surrounding coral cement had set.

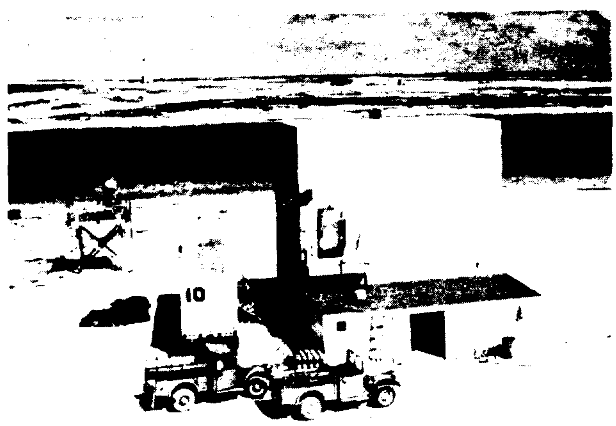


Figure 2-164. Station 2300 - Completed

STATION 2310 - MIRROR SHED
SITE TARE - USER: UCRL

GENERAL. Station 2310 was a 12′-0″ x 68′-0″ x 8′ - 0″ high wood building resting on a series of steel trestles ten feet high. The structure had a wood floor, plywood and stud walls, and plywood and joist roof. The floor of the Station had two exposed steel I-beams for the purpose of mounting optical instruments. The design required that a 1000-pound load applied anywhere along the I-beams, or a 20-mph wind would not cause a slope of the I-beams of more than two minutes of arc. For this reason a riveted trestle-type support, braced continuously in both directions, was used in the design of the Station. Electric power was supplied from Station 50. The Station was used for Project 23.1 (high speed photography).

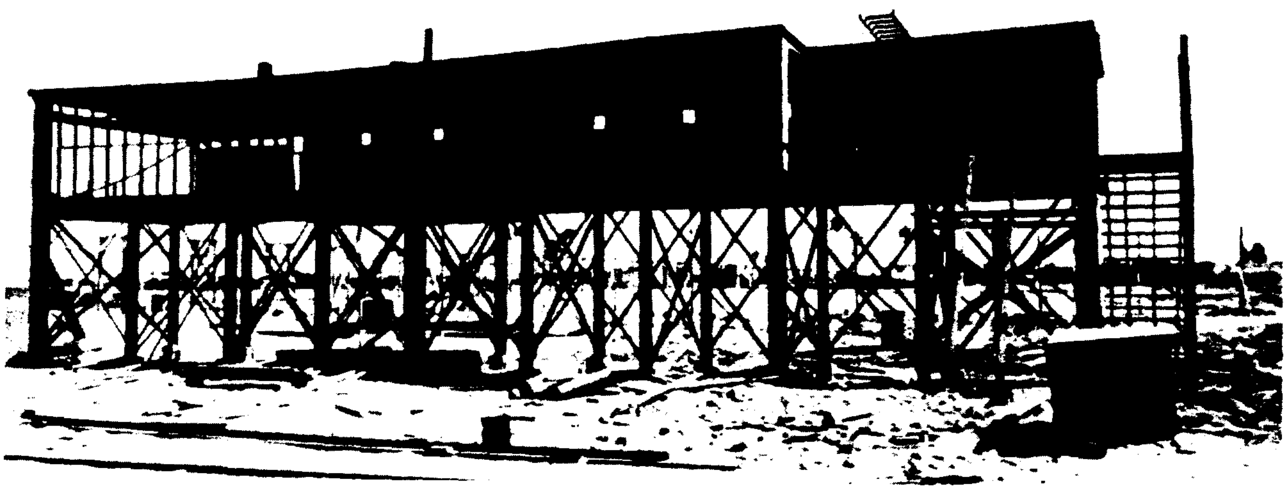


Figure 2-165. Station 2310 - 88% Completed

ENGINEERING. Design criteria were received on 4 June. On 2 December, the User requested that part of the walls be removable. Figure 2-165 shows the Station with the portable walls removed. The construction progress as shown, was estimated at 88% completed. Design work began on 22 June. Six drawings were prepared and submitted from 17 July thru 6 August. These drawings were approved from 31 July thru 27 August.

CONSTRUCTION. Construction was scheduled to commence on 1 November and to be completed on 15 January. Actual work started on 8 September and was completed on 16 January 1954.

STATION 2311 - MIRROR SHED
SITE RUBY - USER: UCRL

GENERAL. This Station was similar to Station 2310. 12' - 0" x 53' - 0" x 18' - 0" high, and only one end wall was removable.

ENGINEERING. Reported under Station 2310.

CONSTRUCTION. Work was scheduled to commence on 1 November and to be completed

Figure 2-166. Station 2400.01 - 98% Completed

by 31 January 1954. Actual work started on 28 August and was completed on 18 January 1954.

STATION 2400.01
LIMONITE COLLIMATOR ON UCRL PIPE SITE SUGAR - USER: UCRL

GENERAL. This Station was a reinforced limonite concrete structure used in Project 24 (Phonex). The upper portion was wedge-shaped with an opening in the top that tapered down in steps to an opening in the bottom. The block rested on a 23' - 0" x 20' - 0" x 4' - 0" deep reinforced concrete slab. A six-inch slab extended beyond the structure at the rear and at the front. The front of the structure was provided with a dirt fill, and a three-foot high wall was provided in the front to hold this fill. In addition, there was a two-foot thick limonite concrete wall along the side at the front which acted as a shield and a retaining wall for the earth fill. A number of pipe sleeves were provided, some of which were located horizontally while others were located vertically.

ENGINEERING. A portion of the basic design criteria was received on 6 May 1953. In this criteria it was stated that the engineering would be done by UCRL, and that the Contractor would supply the materials and cast the concrete. All of the basic design criteria were received on 8 July 1953, at which time the steel design for the structure was checked, and it was found that the design was inadequate. After consultation with the User, the Station was re-designed. On 12 July 1953, the size of the slab was changed and minor revisions were received on 27 July which were incorporated on the drawings. On 17 August, criteria were received requesting that the wall at the side of the structure be limonite concrete and, in addition, the vertical holes in the limonite block were re-spaced. The design work proper was started on 29 July. The criteria required that this structure's settlement could not exceed 1-inch maximum. As a result, a heavy foundation was designed which embedded the base four feet in the ground and which was supported by eight steel 12-inch H-piles. Two drawings were submitted on 3 August and on 8 September respectively. They were approved on 20 August and on 25 September.

CONSTRUCTION. Work was scheduled to commence on 1 September and to be completed by 31 December. Actual construction started on 17 September and was completed on 2 January 1954. The piling foundations for these Stations could not be driven because of the hard coral ledges underlying the Stations. After verifying the thickness and extent of the coral, an alternate design of a concrete foundation, doweled and grouted into the rock, was employed.

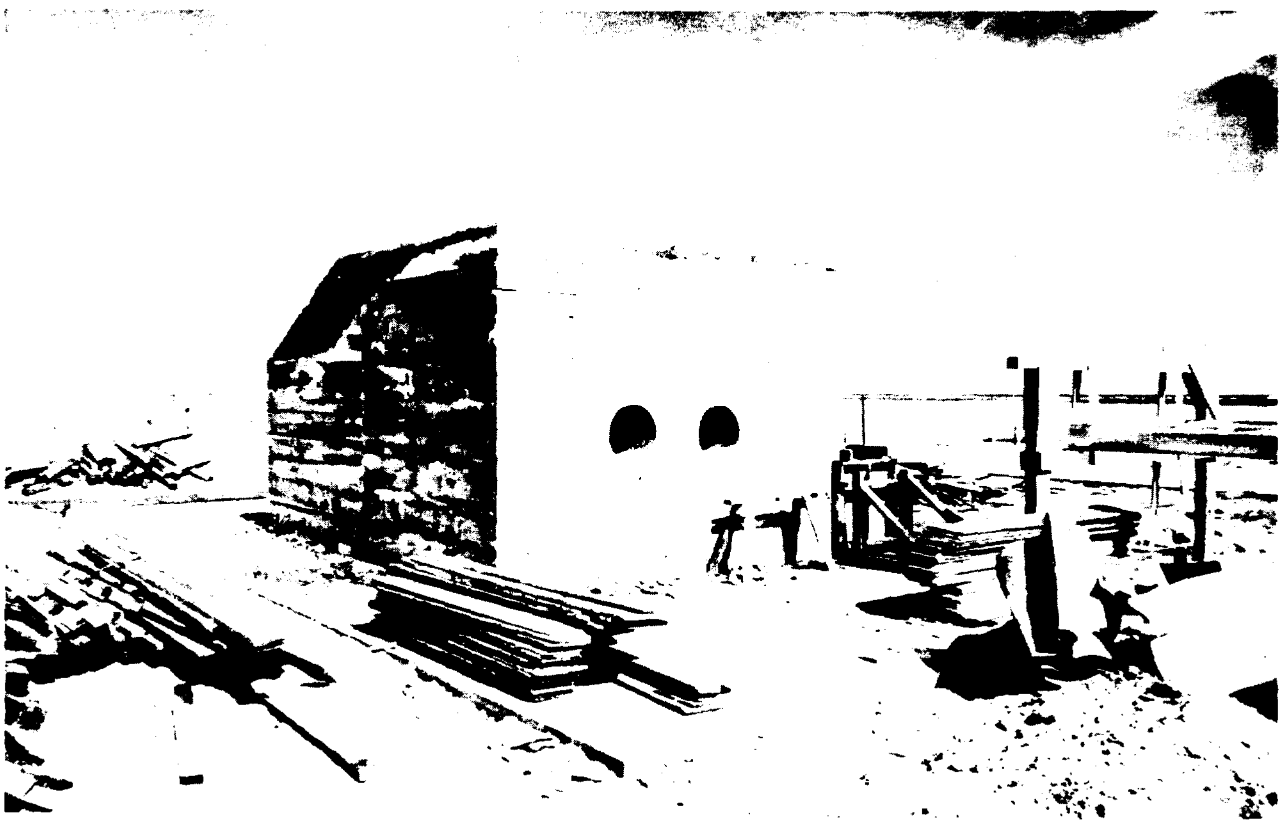


Figure 2-167. Station 2400.02 - 85% Completed

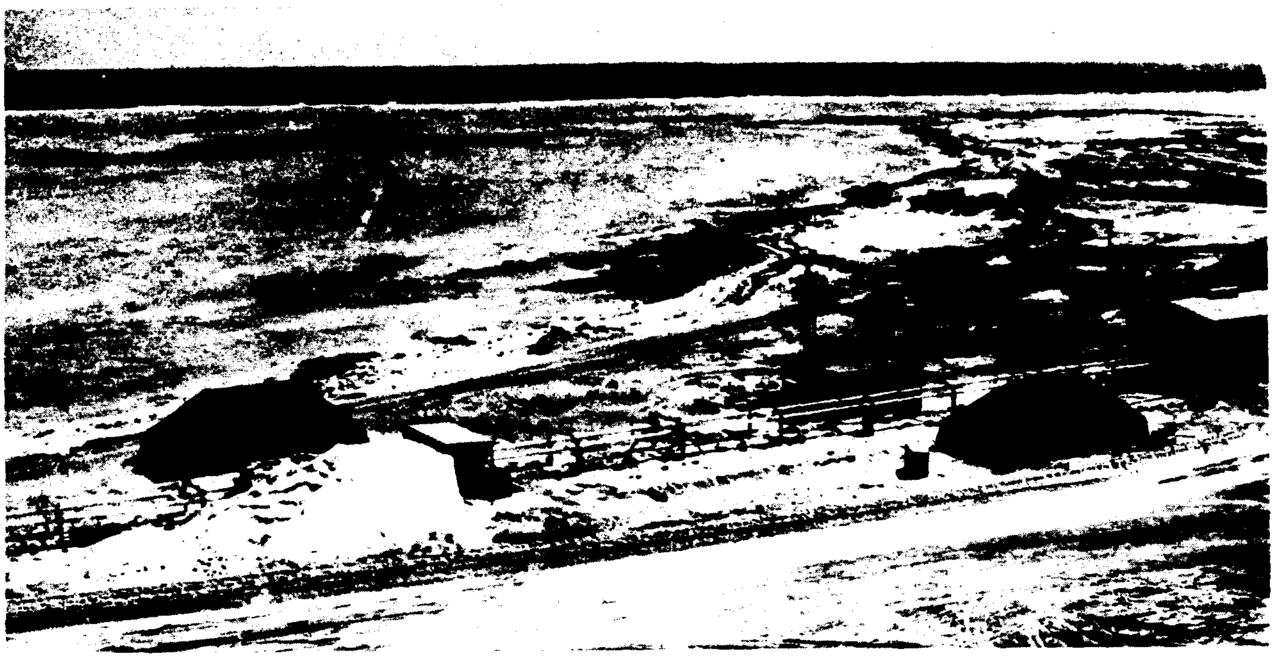


Figure 2-168. Station 2400.02 - Aerial View of Completed Structure

Figure 2-166 shows the Station as 98% completed on 19 December. This figure shows the relation between Stations 2400.01, 2210 and the pipe array.

STATION 2400.02
LIMONITE COLLIMATOR STATION ON UCRL PIPE
SITE SALLY - USER: UCRL

GENERAL. Similar to Station 2400.01 with minor exceptions.

ENGINEERING. Reported under Station 2400.01.

CONSTRUCTION. Work was scheduled to start on 15 September and to be completed by 15 January. Actual work started on 17 September and was completed on 2 January 1954. Figure 2-167 shows the Station as 85% completed on 15 October. Figure 2-168 shows Station completed with earth fill as of 10 April 1954.

STATION 7400
RADIO BEACON SHELTER AND ANTENNA
SITE NAN - USER: TG 7.4

GENERAL. The Station consisted of 11' - 0" x 13' - 0" x 9' - 0" high wood-framed, plywood covered building. Normal lighting and receptacle outlets were provided. An emergency power source was provided with an automatic transfer switch.

ENGINEERING. Criteria were received on 25 November. Design work was started on 25 November. Two drawings were prepared and submitted on 7 and 11 December. Approvals were received on 17 and on 29 December.

CONSTRUCTION. Work was scheduled to commence on 1 December and to be completed by 20 January. Actual construction started on 6 January and was completed on 26 January.

CONTRACT ITEM A-27
SUPPORT FACILITIES FOR SCIENTIFIC STATIONS

Under expendable items on Contract Item No. A-27 were included items other than Scientific Stations. Among these items were the Assembly Area and its structures and facilities on site Elmer, a small temporary camp on site Able, general site work and temporary power at all sites, Scientific Power Plants, modifications to structures and facilities in the CMR Area site Elmer, clearance of CROSSROADS structures as required at sites George and Nan, pylon range markers and electrical Sub-stations for Scientific Stations.

The more important of these items are reported on pages numbered 2-198 to 2-206 inclusive.

Pages 2-142 through 2-188 note the geographic location of all Scientific Stations constructed for OPERATION CASTLE on both atolls.

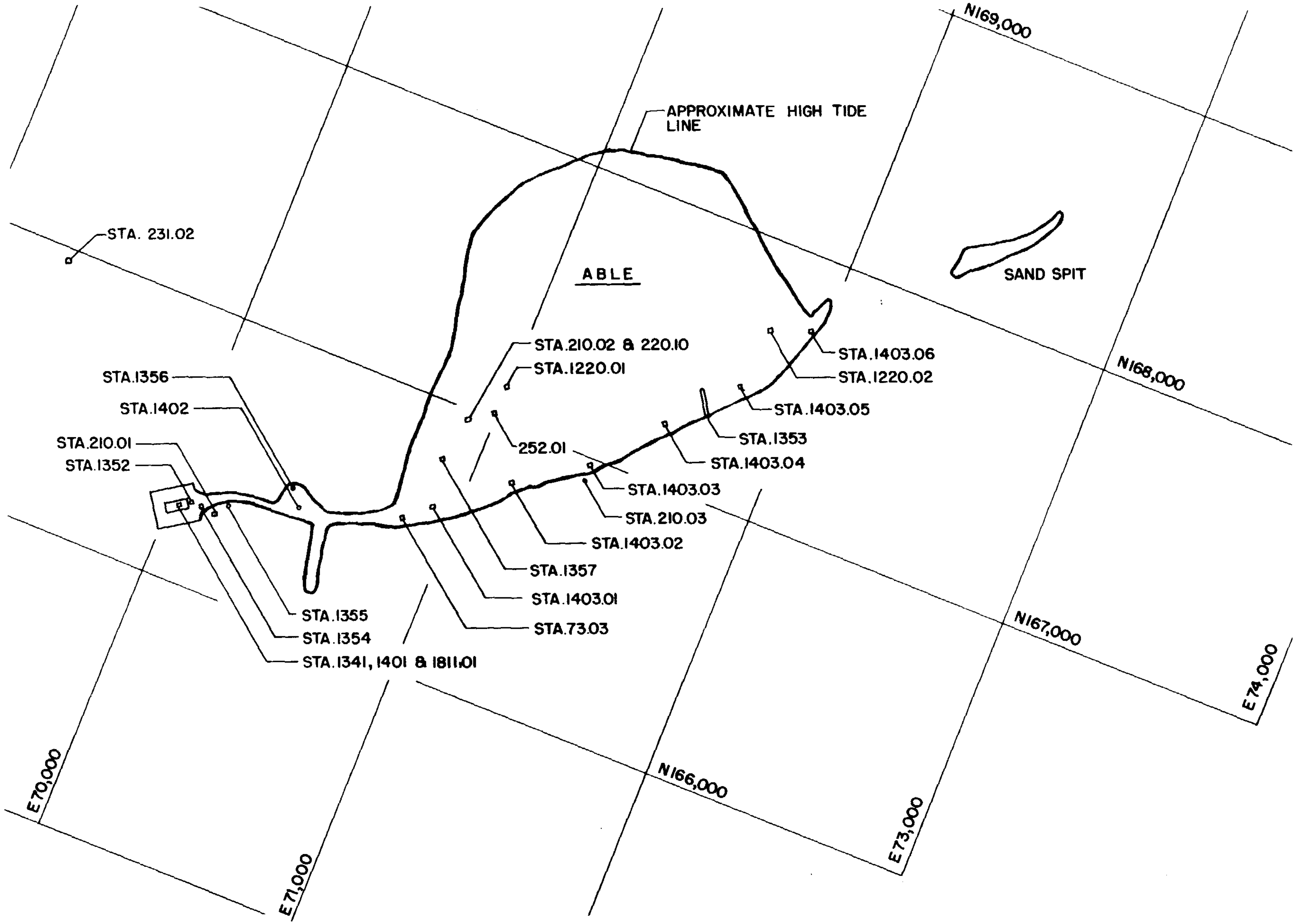


Figure 2-169. Scientific Station Sites - Able and Delta

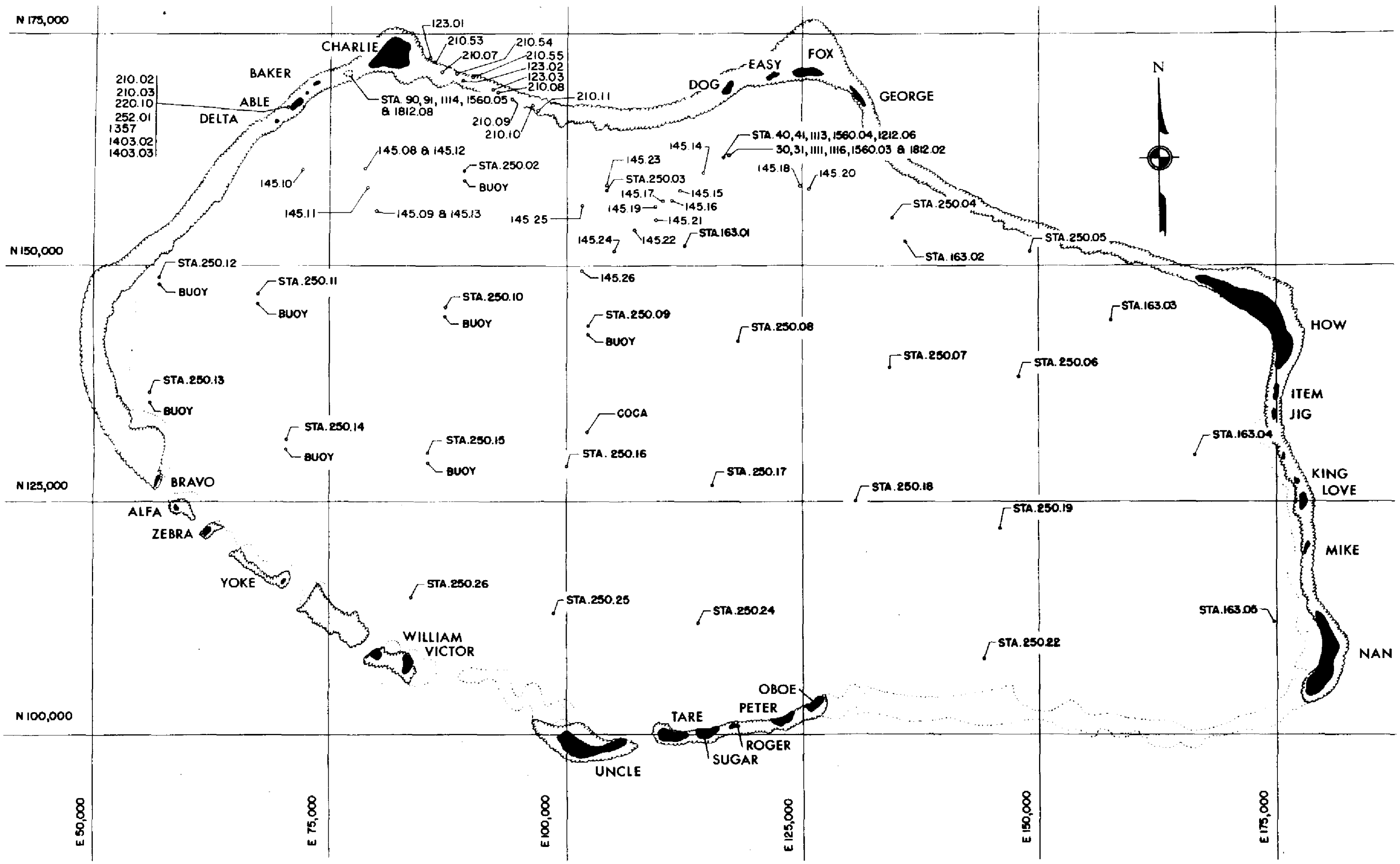


Figure 2-170. Scientific Station Sites - Bikini Lagoon and Reefs

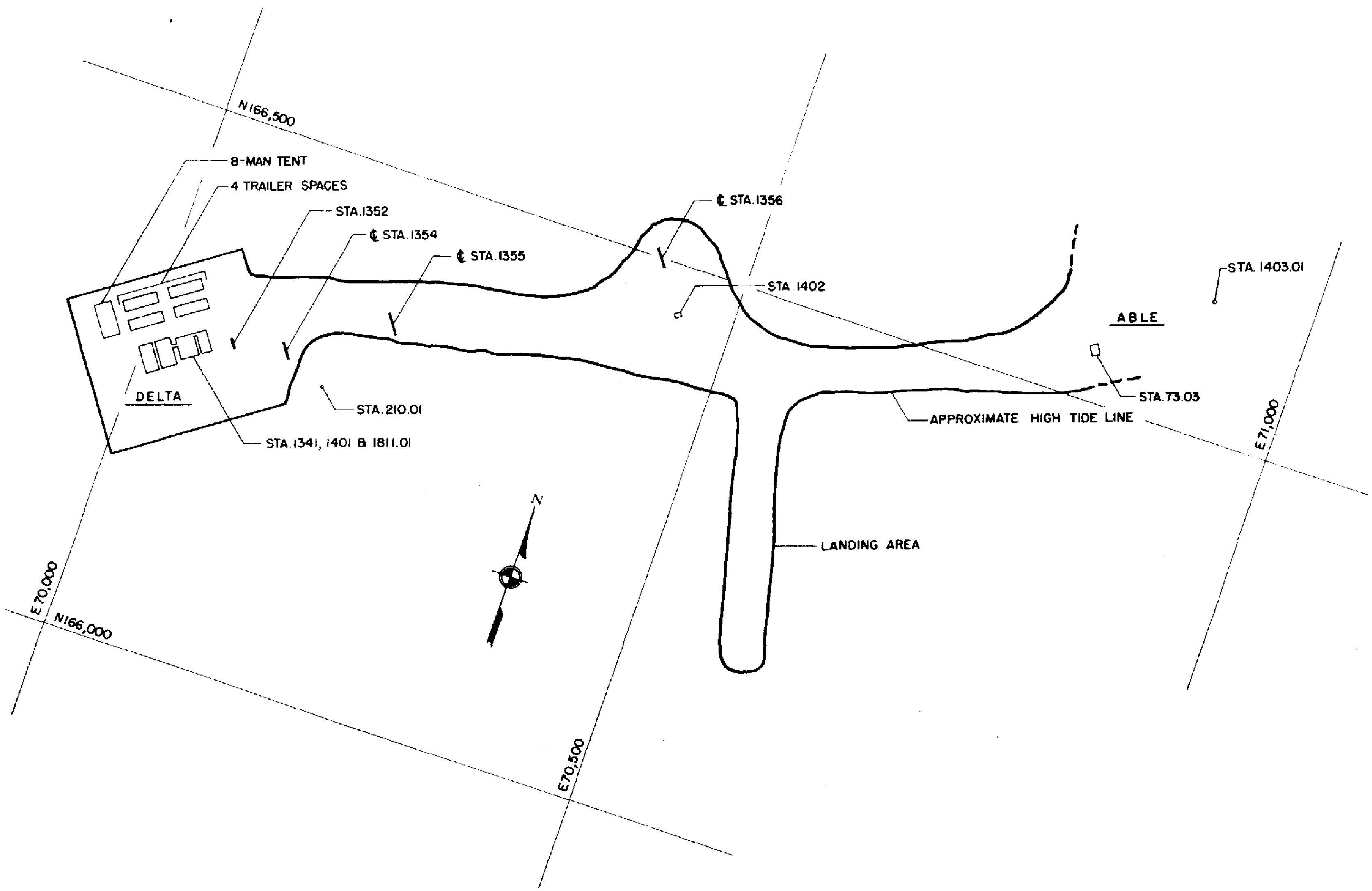


Figure 2-170A. Scientific Station Sites - Able to Delta Details

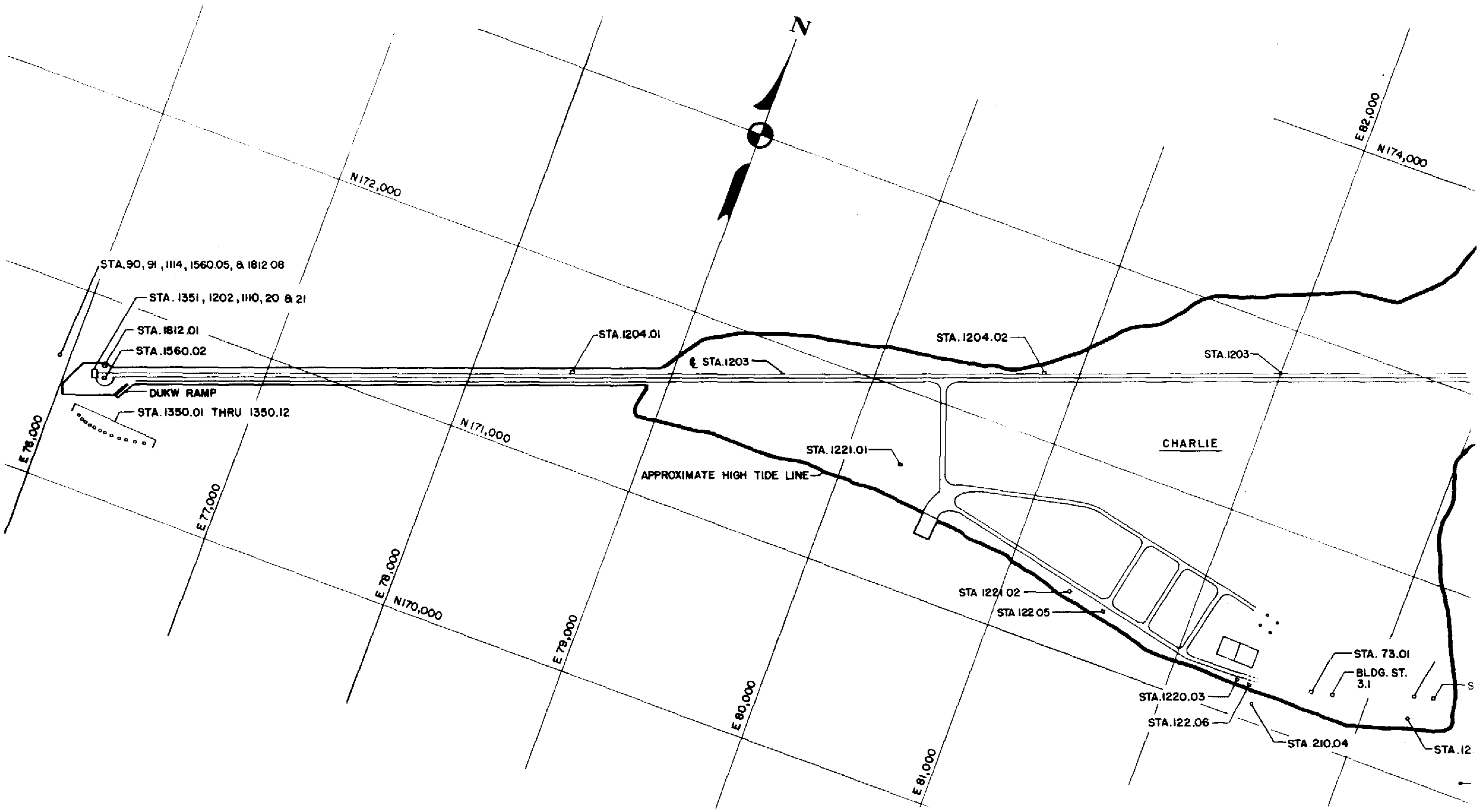


Figure 2-171. Scientific Station Sites - Charlie

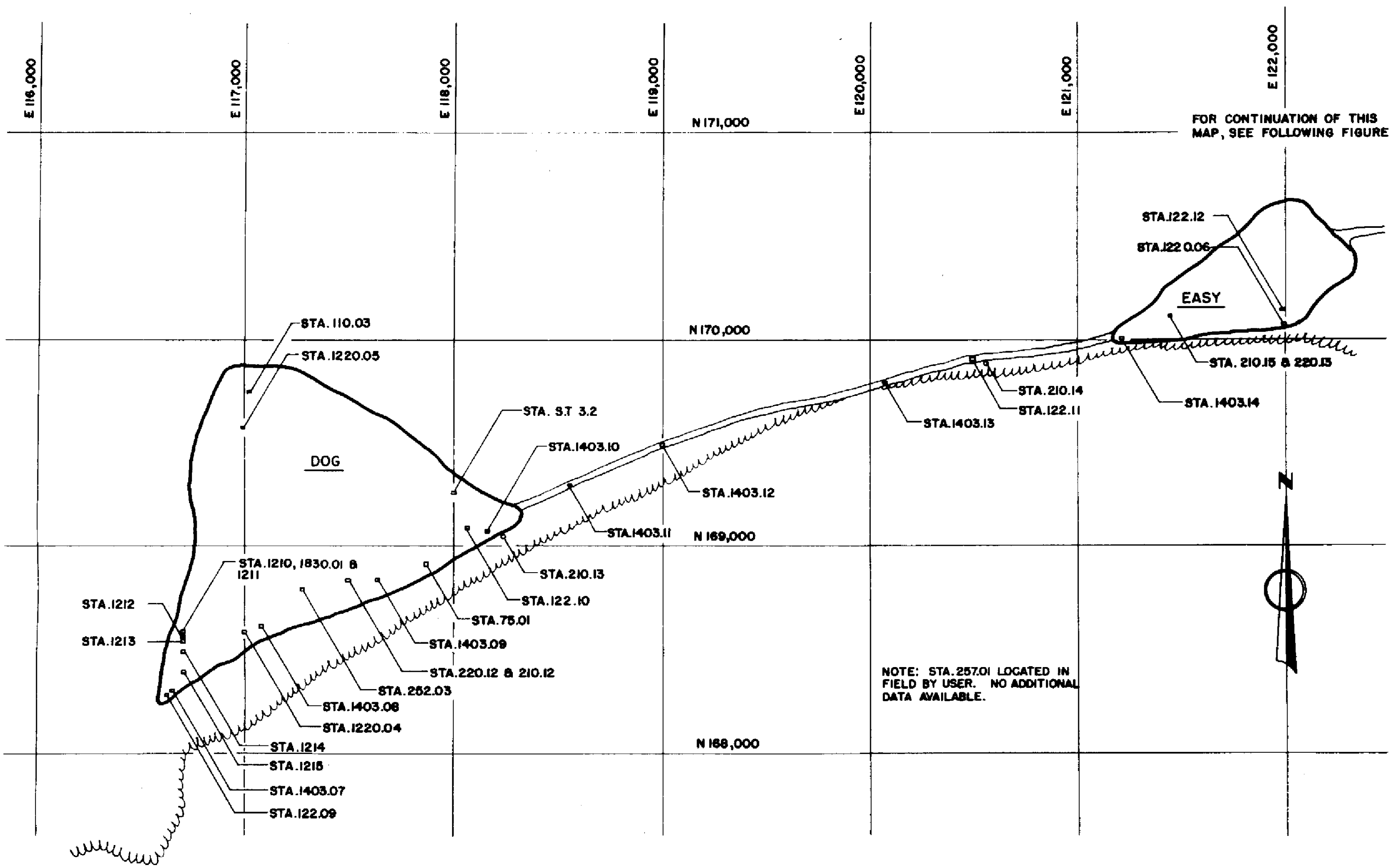


Figure 2-172. Scientific Station Sites - Dog-Easy

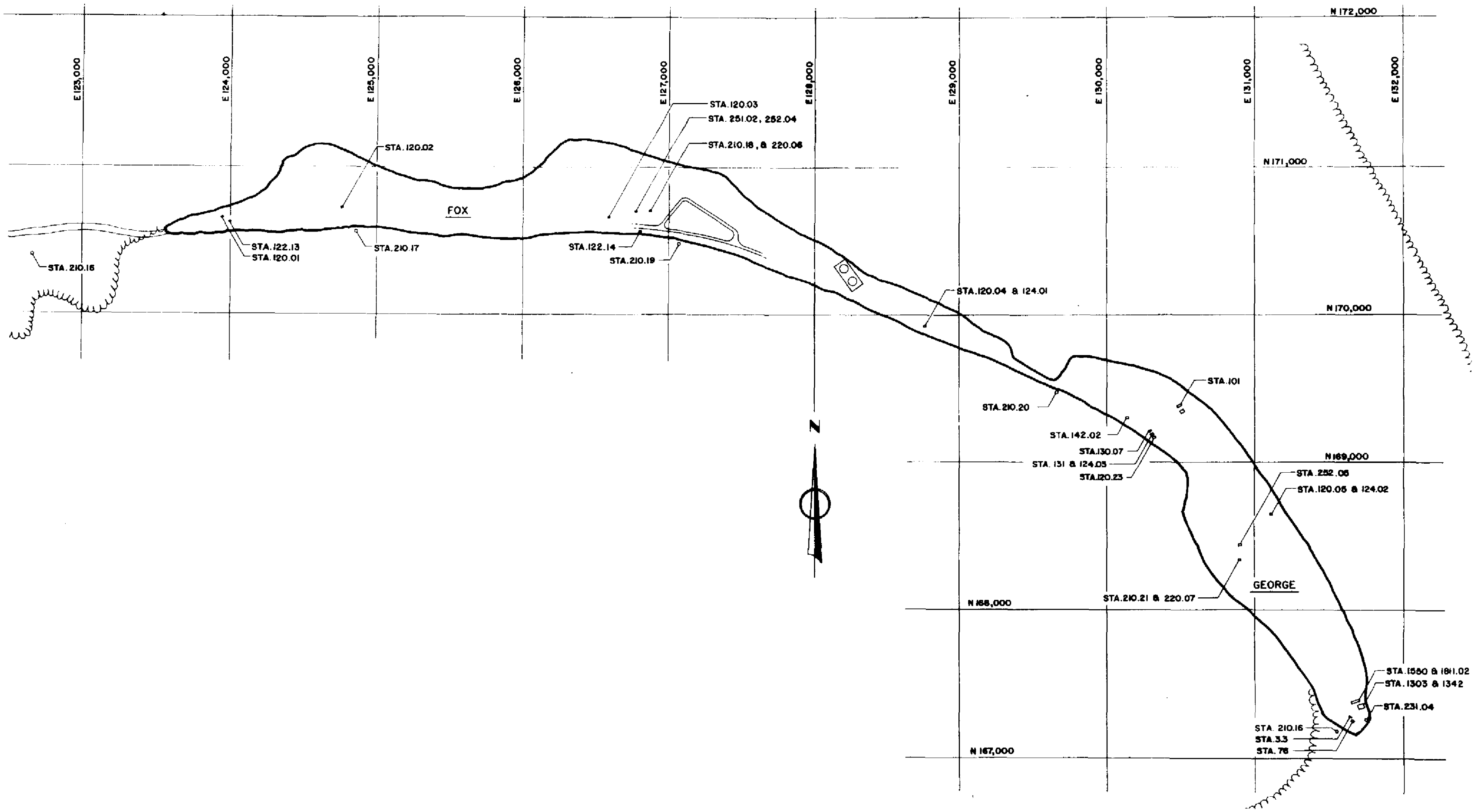


Figure 2-173. Scientific Station Sites - Fox-George

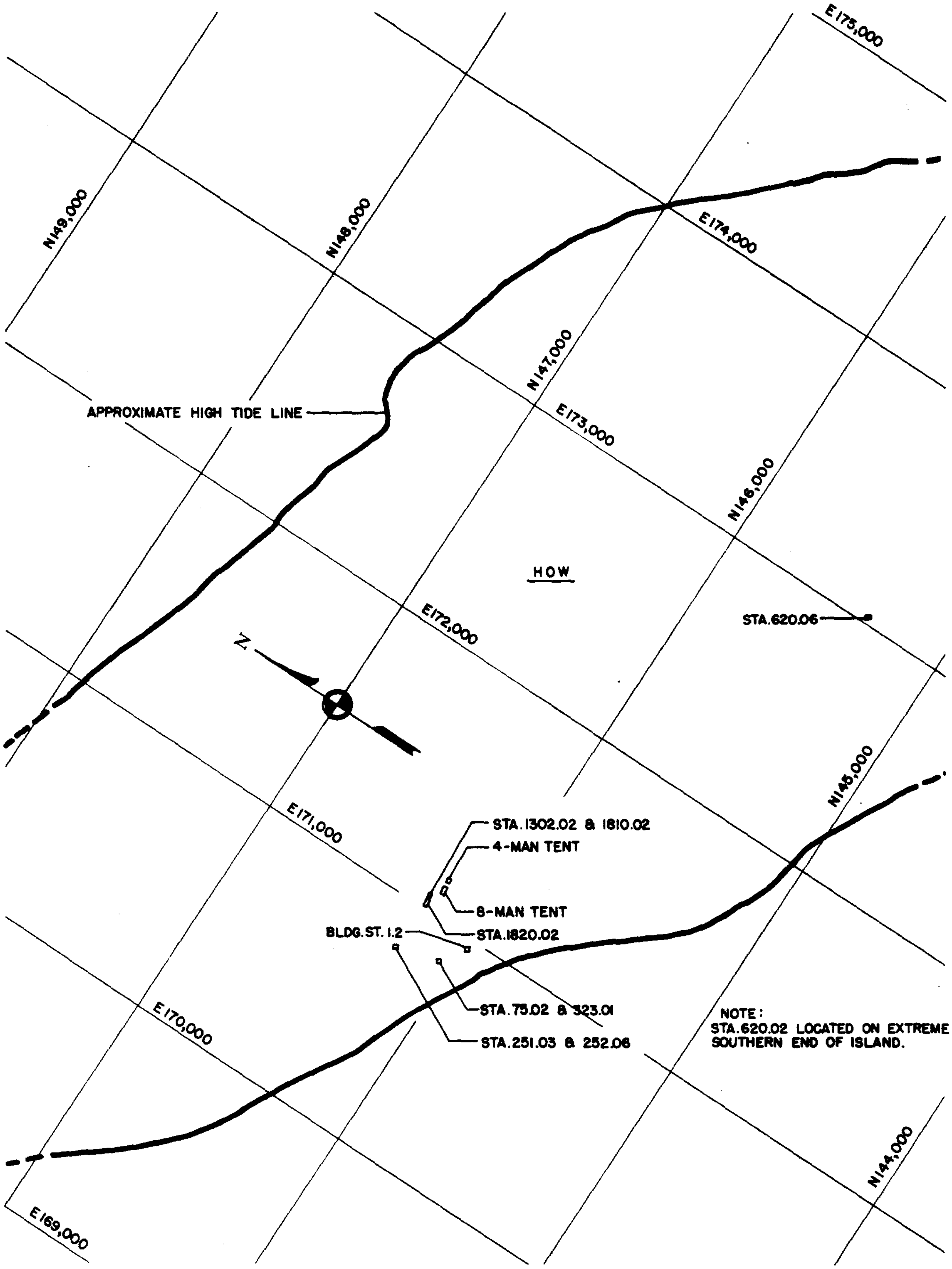


Figure 2-174. Scientific Station Sites - How

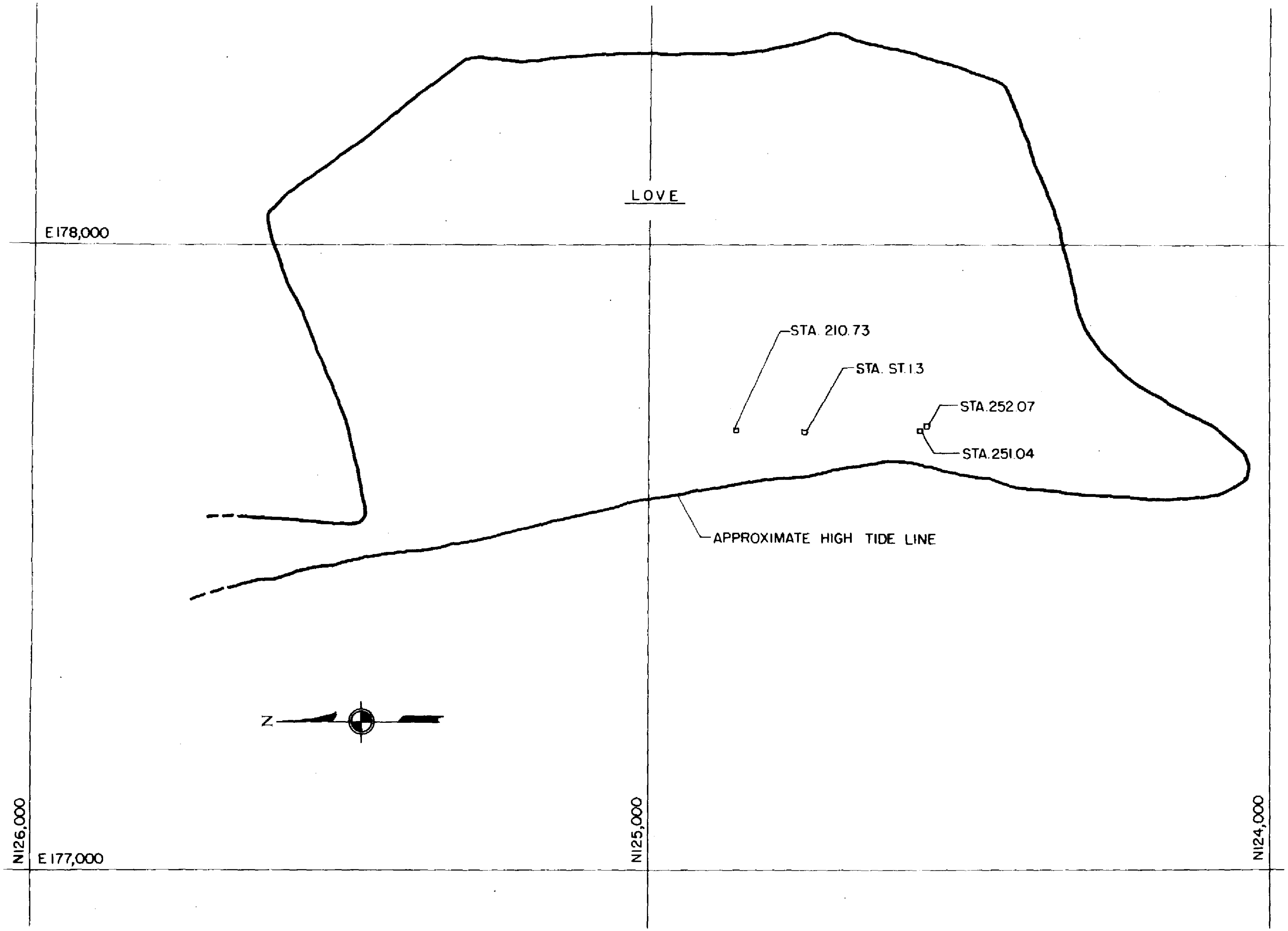


Figure 2-175. Scientific Station Sites - Love

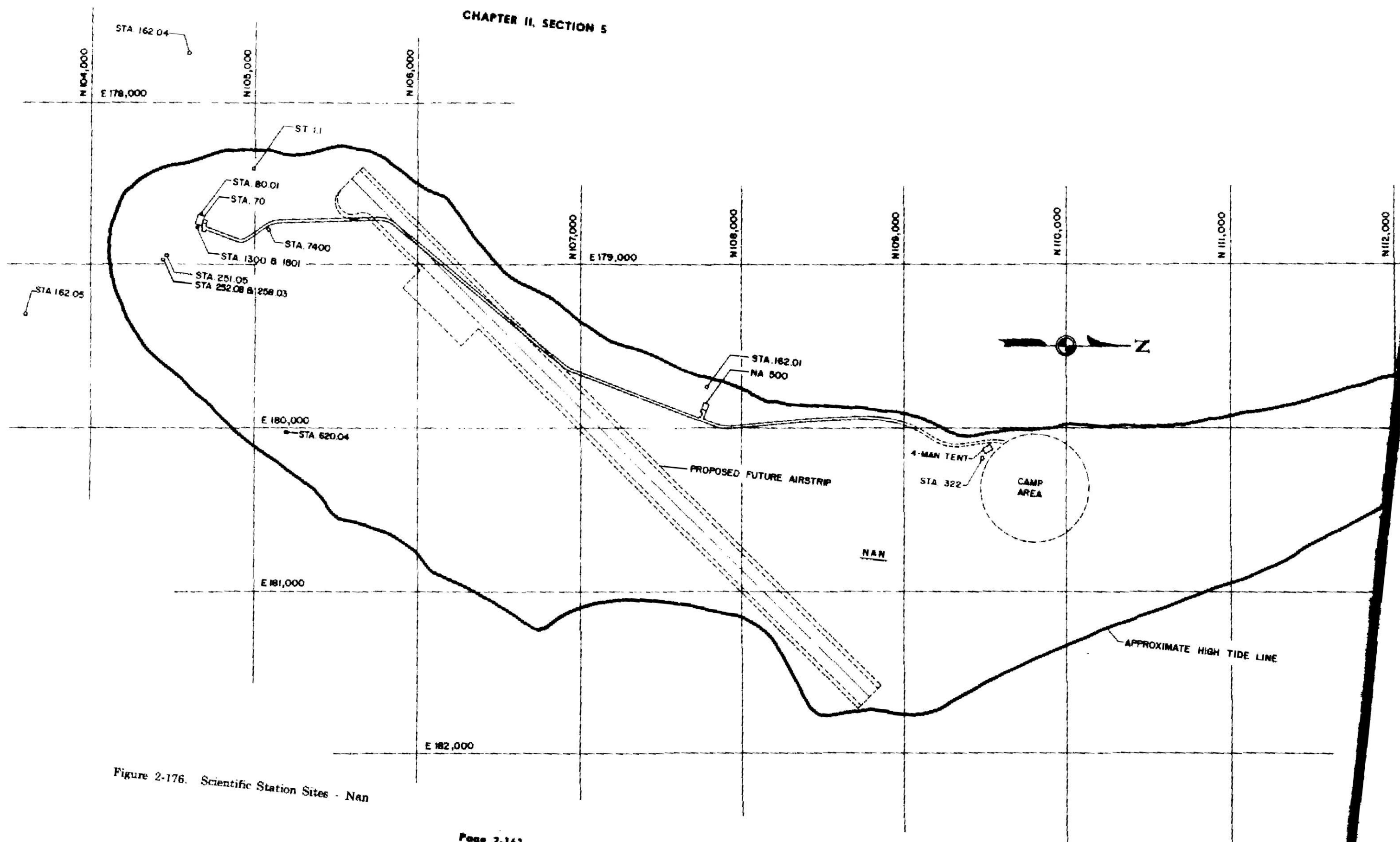
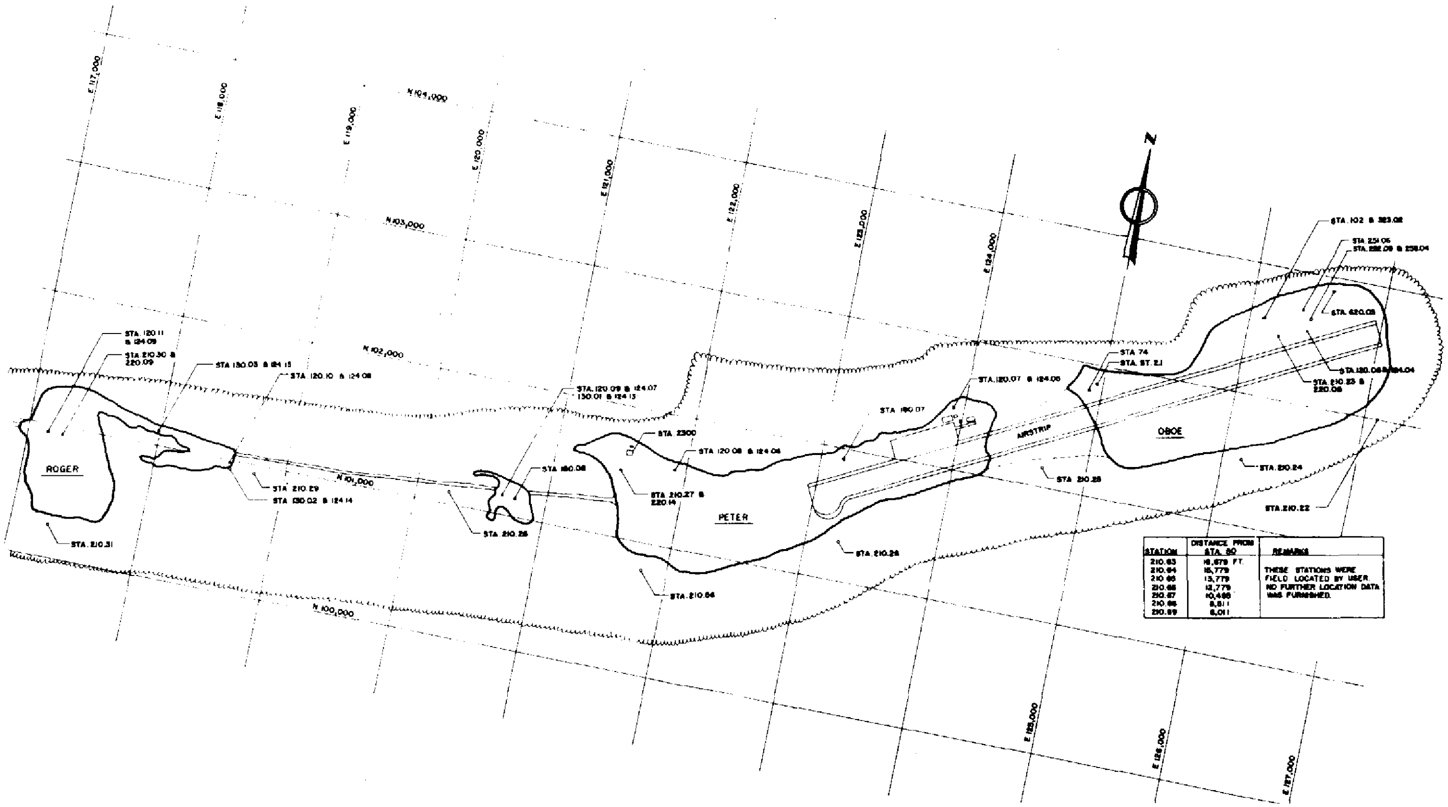
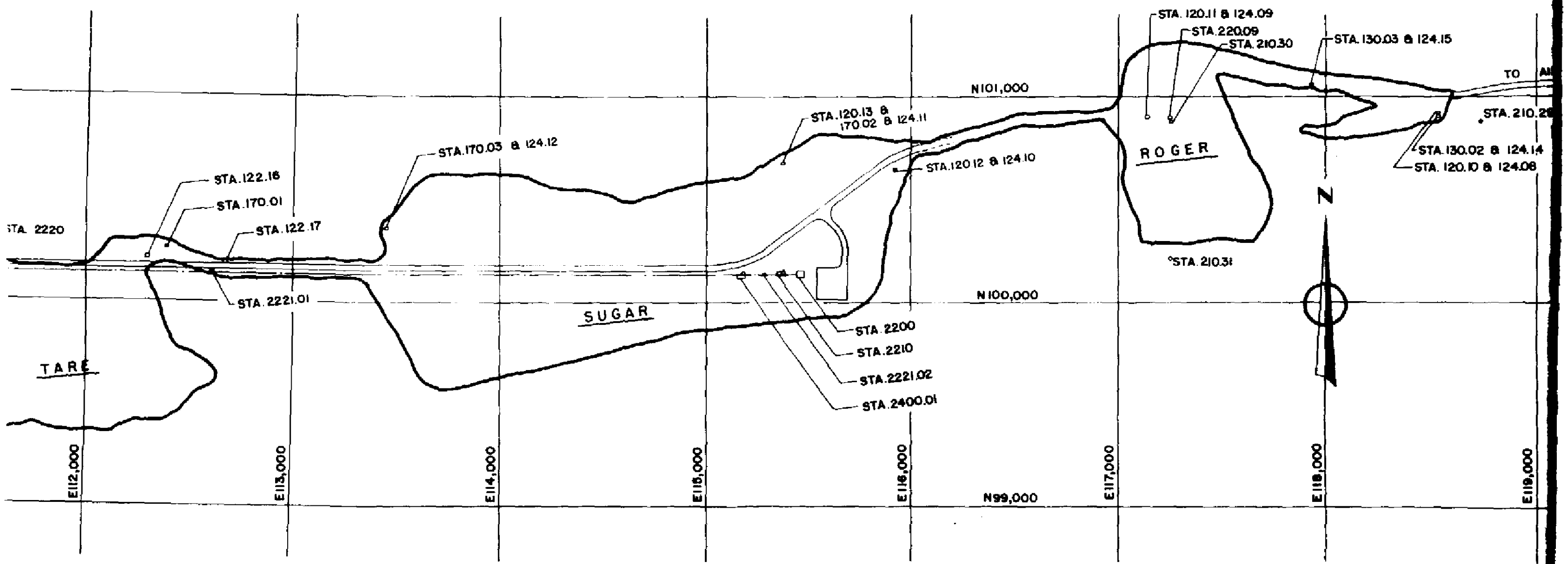


Figure 2-176. Scientific Station Sites - Nan



STATION	DISTANCE FROM STA. 80	REMARKS
210.63	16,879 FT.	THESE STATIONS WERE FIELD LOCATED BY USER. NO FURTHER LOCATION DATA WAS FURNISHED.
210.64	15,779	
210.65	13,779	
210.66	12,779	
210.67	10,496	
210.68	8,811	
210.69	8,011	

Figure 2-177. Scientific Station Sites - Oboe to Roger


STA. 120.11 & 124.09
STA. 220.09
STA. 210.30
STA. 130.03 & 124.15
TO
N101,000
STA. 210.2
STA. 120.13 &
170.02 & 124.11
ROGER
STA. 130.02 & 124.14
STA. 120.10 & 124.08
STA. 170.03 & 124.12
STA. 120.12 & 124.10
STA. 122.16
STA. 170.01
STA. 122.17
STA. 2220
N
STA. 210.31
STA. 2221.01
N100,000
SUGAR
STA. 2200
STA. 2210
TARE
STA. 2221.02
STA. 2400.01
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E118,000
E119,000
N99,000

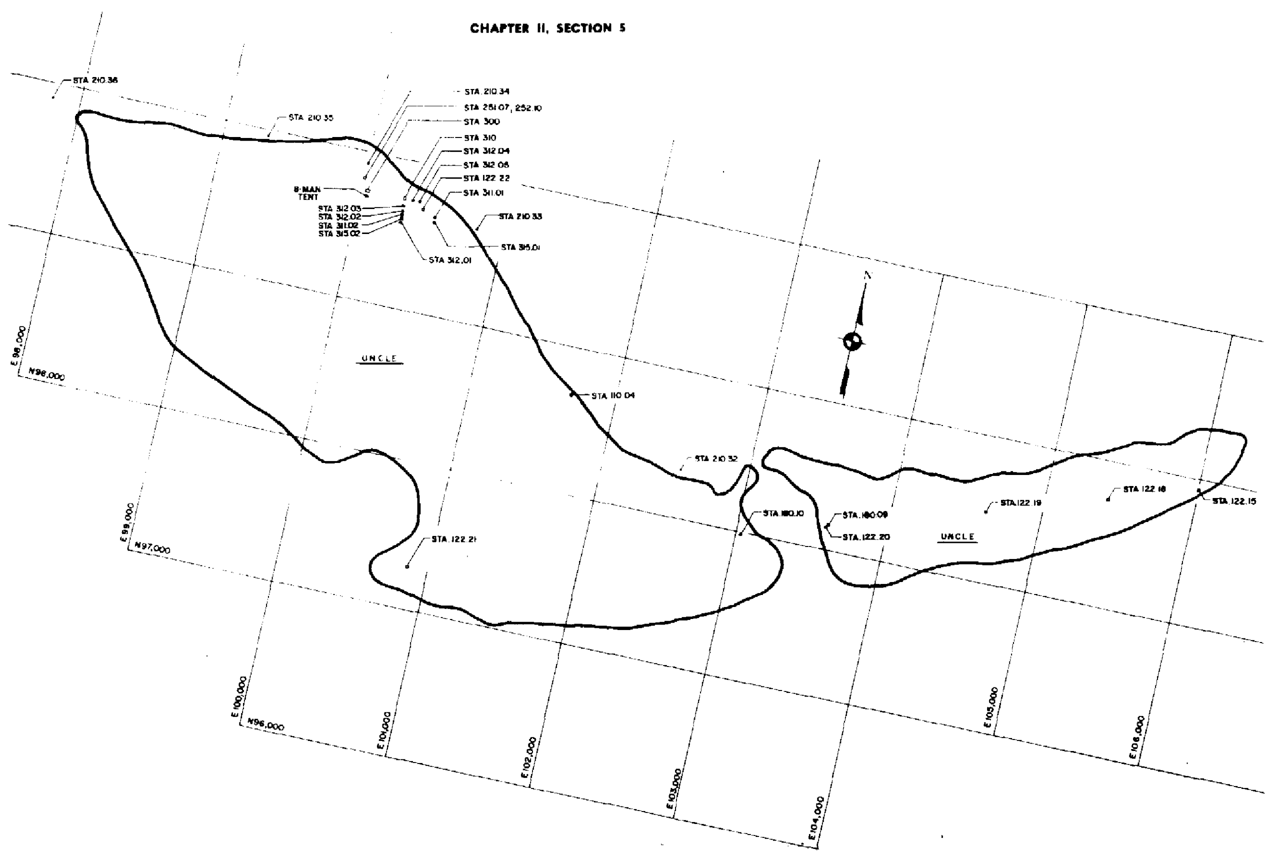


Figure 2-179. Scientific Station Sites - Uncle

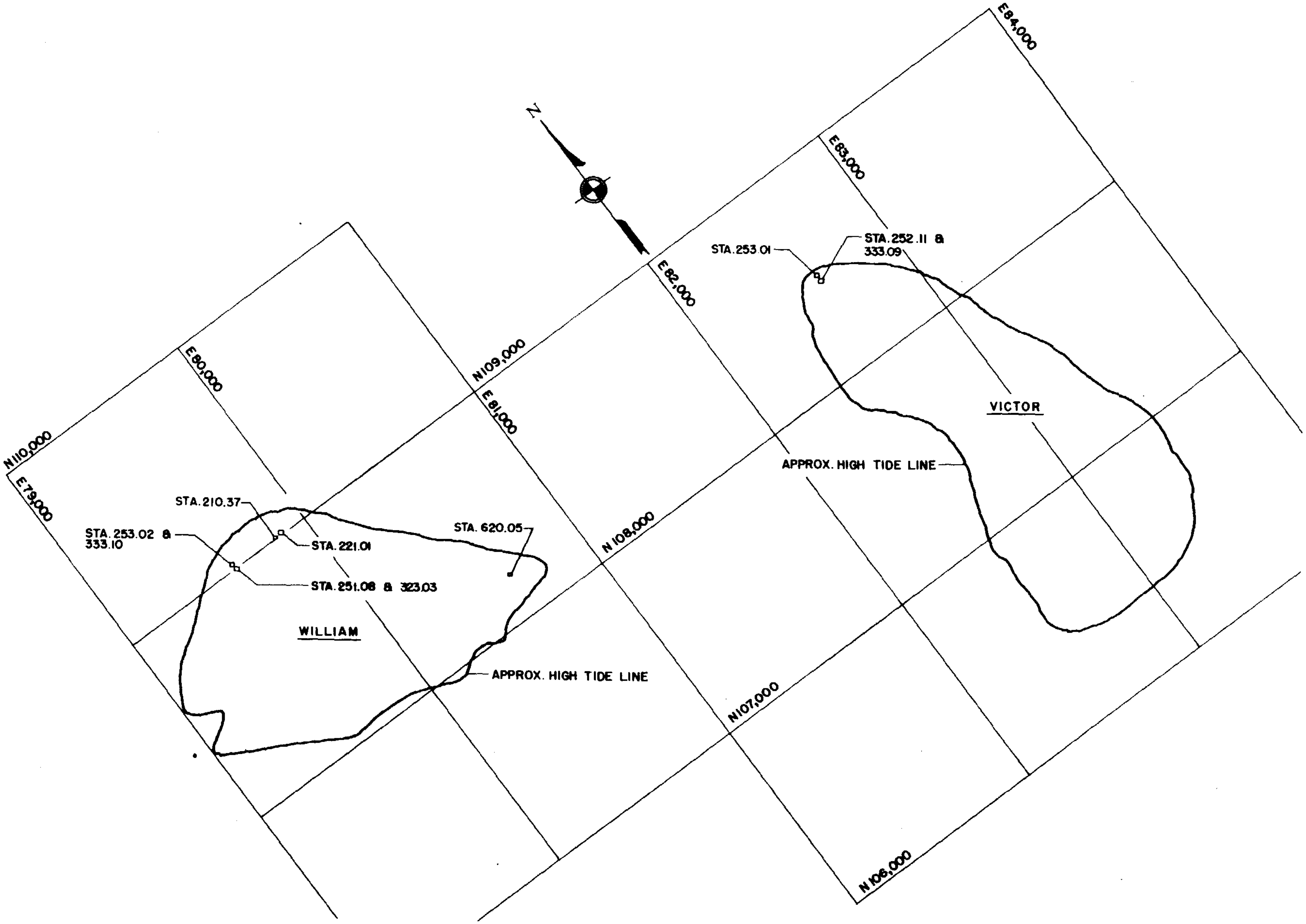


Figure 2-180. Scientific Station Sites - William to Victor

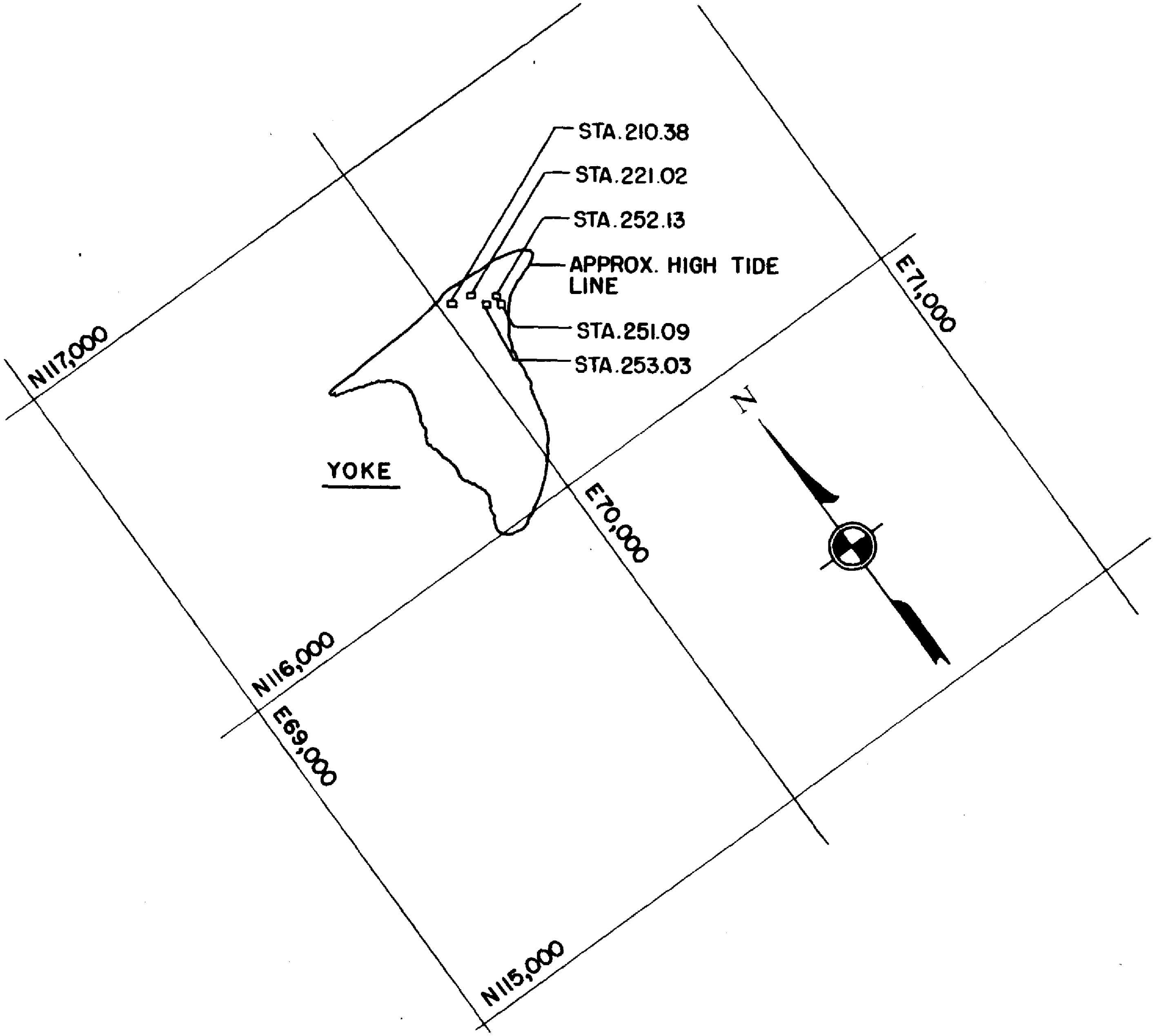


Figure 2-181. Scientific Station Sites - Yoke

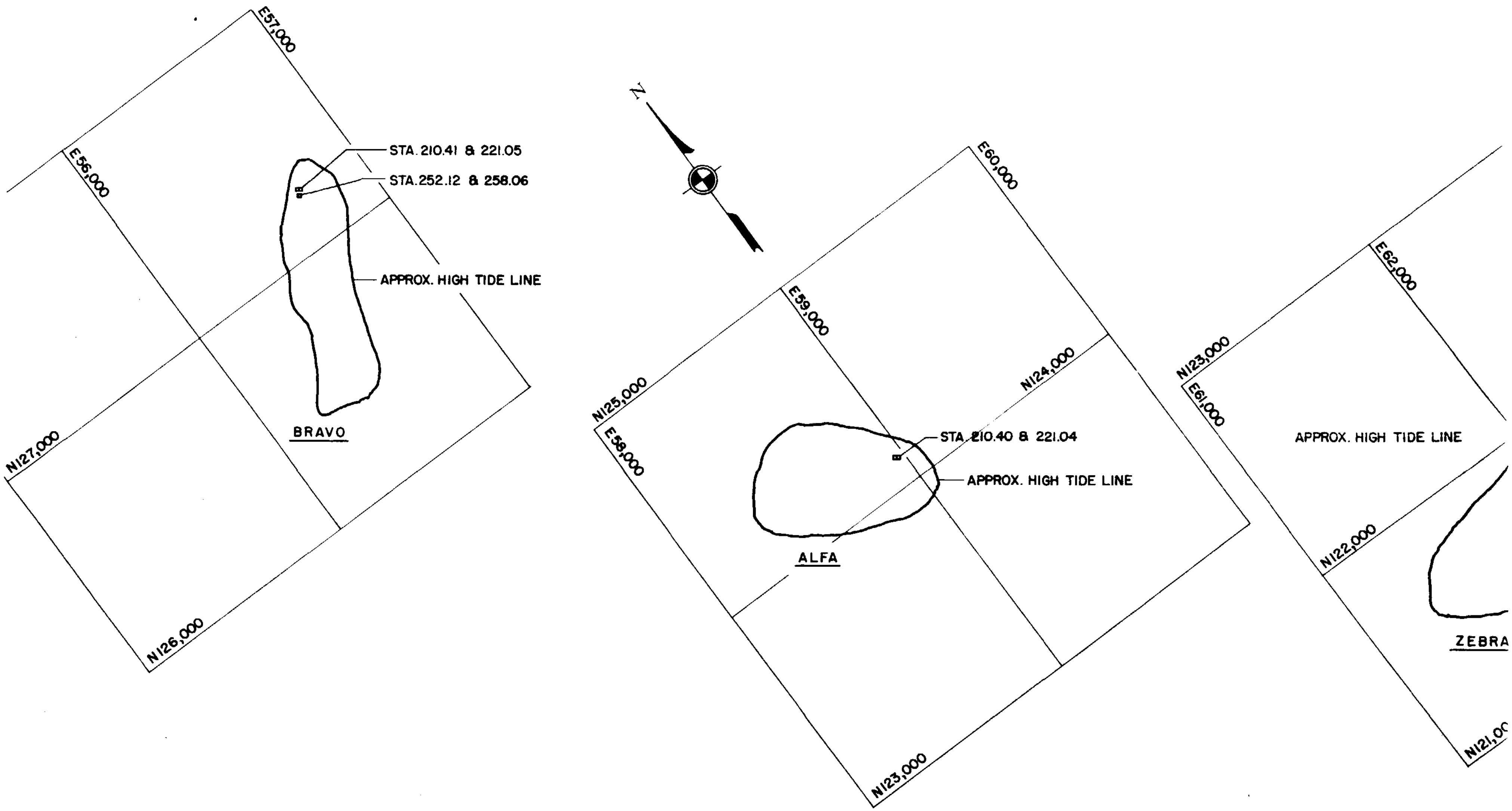


Figure 2-182. Scientific Station Sites - Zebra, Bravo and Alfa

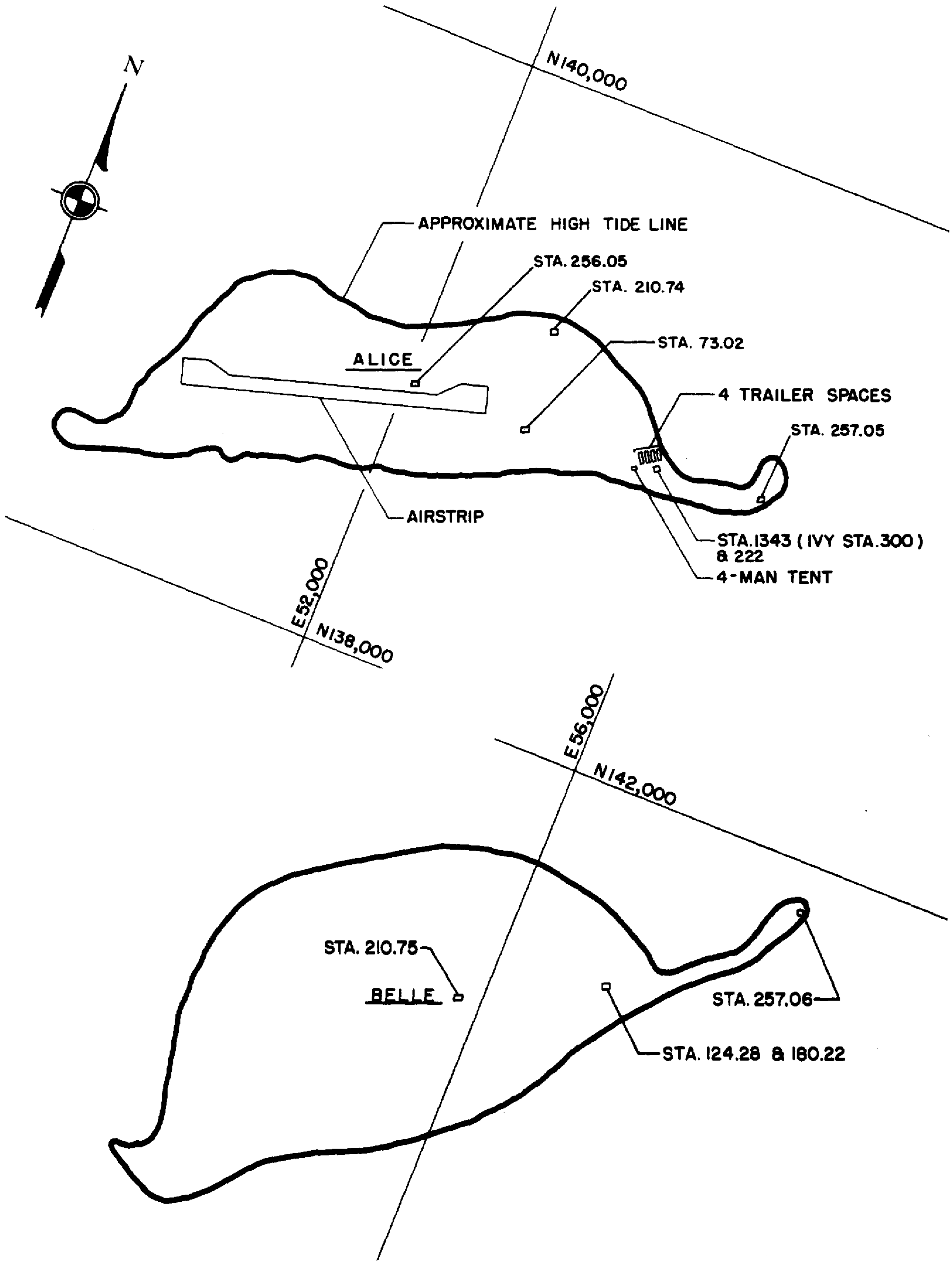


Figure 2-183. Scientific Station Sites - Alice and Belle

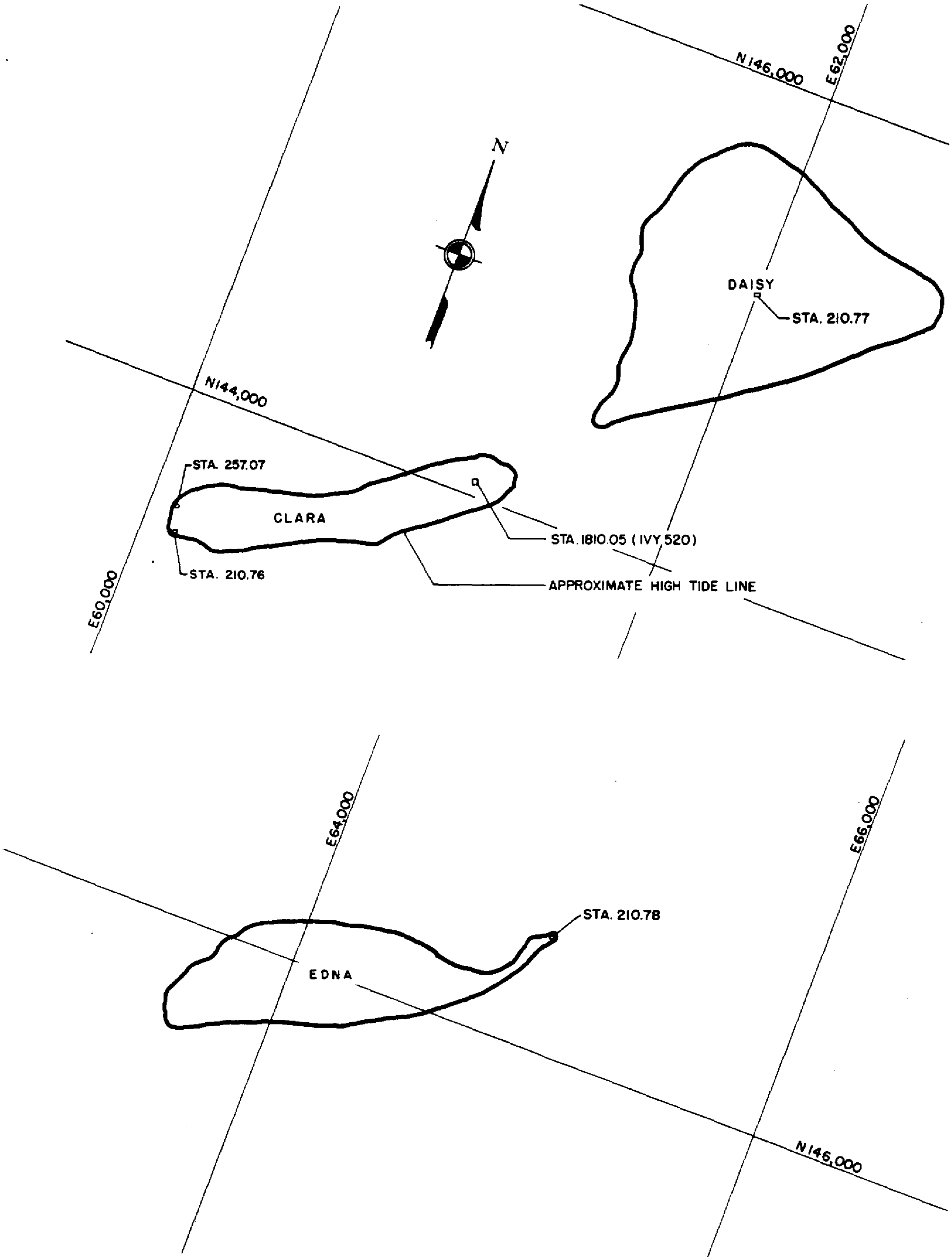


Figure 2-184. Scientific Station Sites - Clara, Daisy and Edna

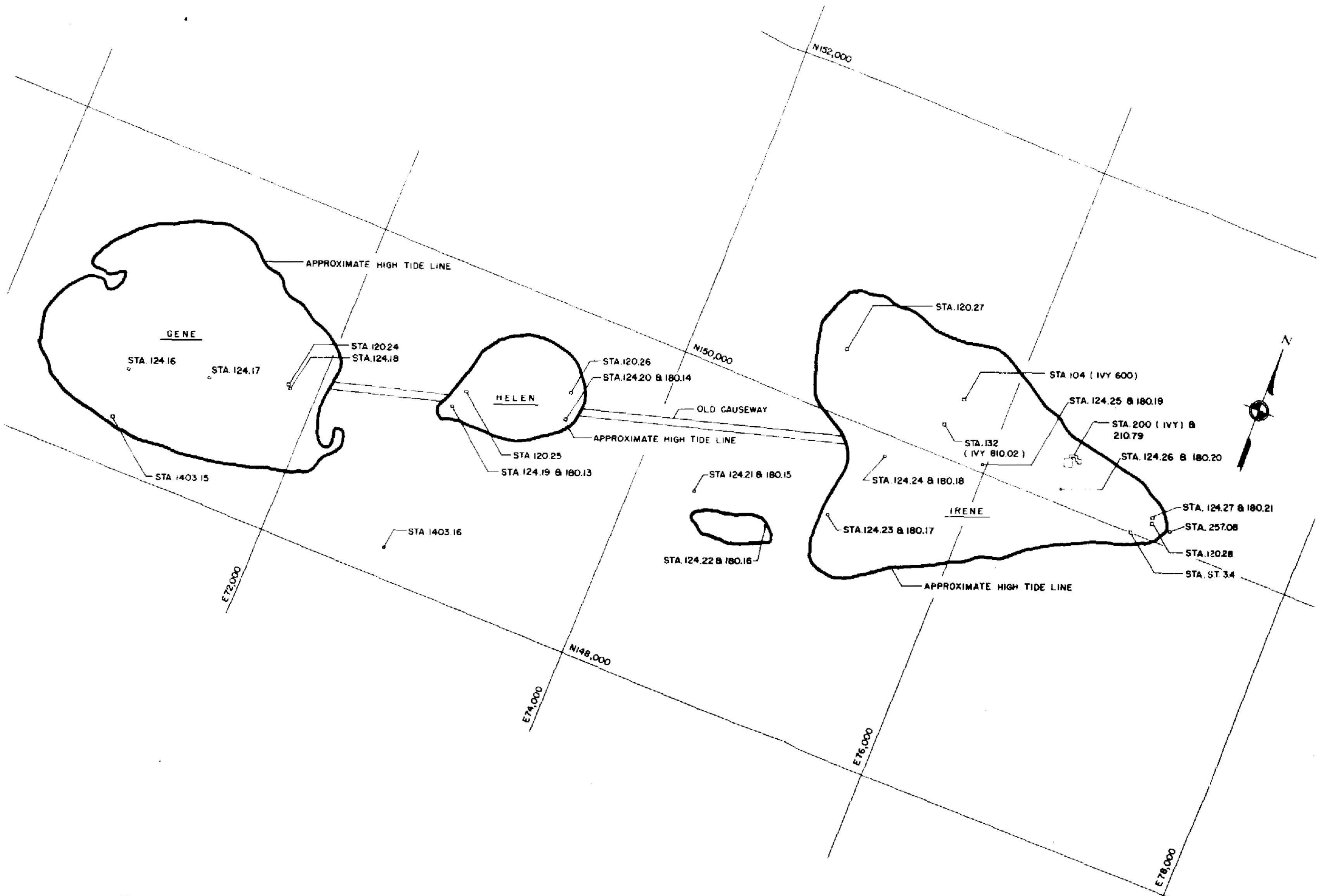


Figure 2-185. Scientific Station Sites - Gene, Helen and Irene

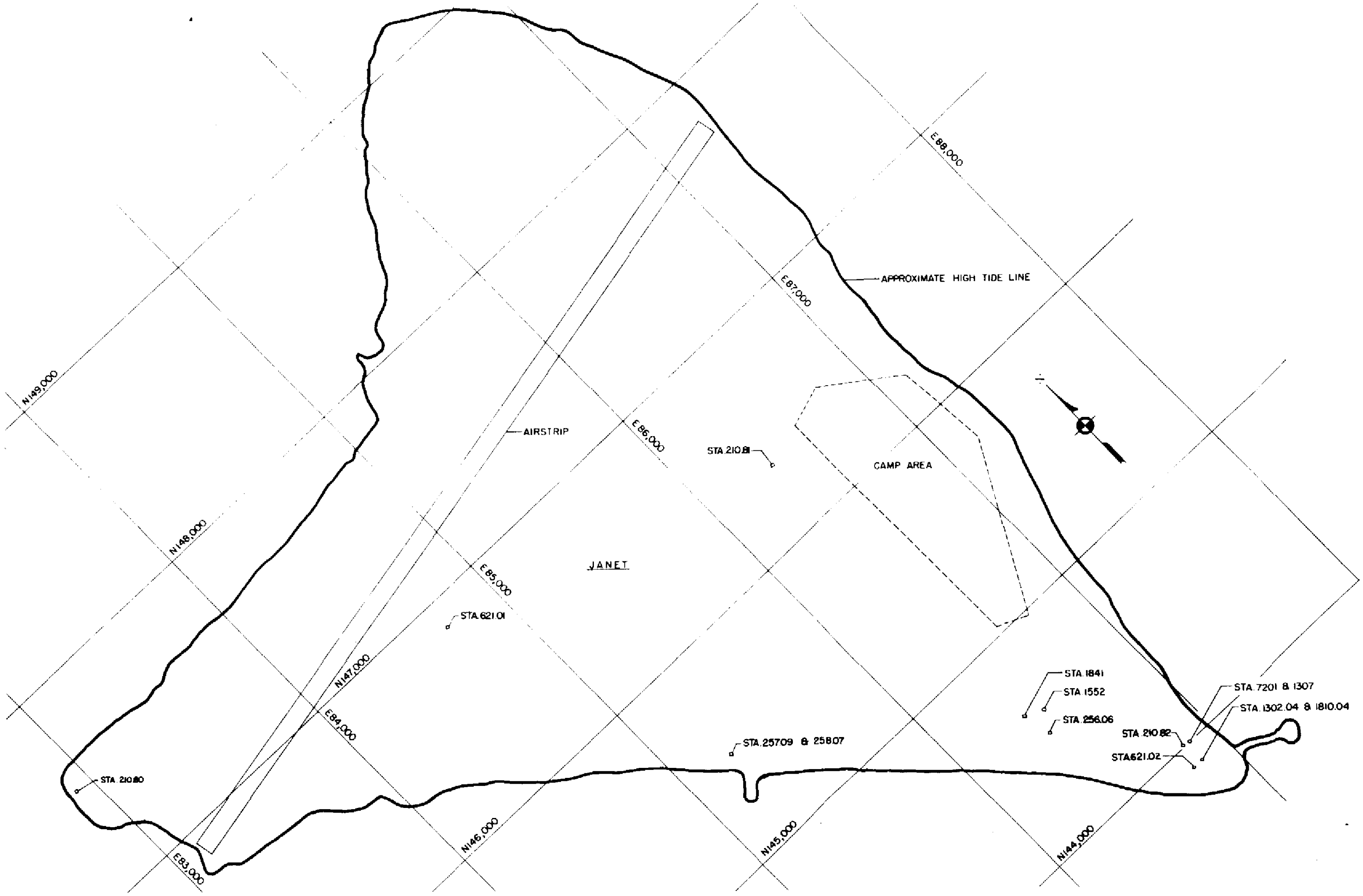


Figure 2-186. Scientific Station Sites - Janet

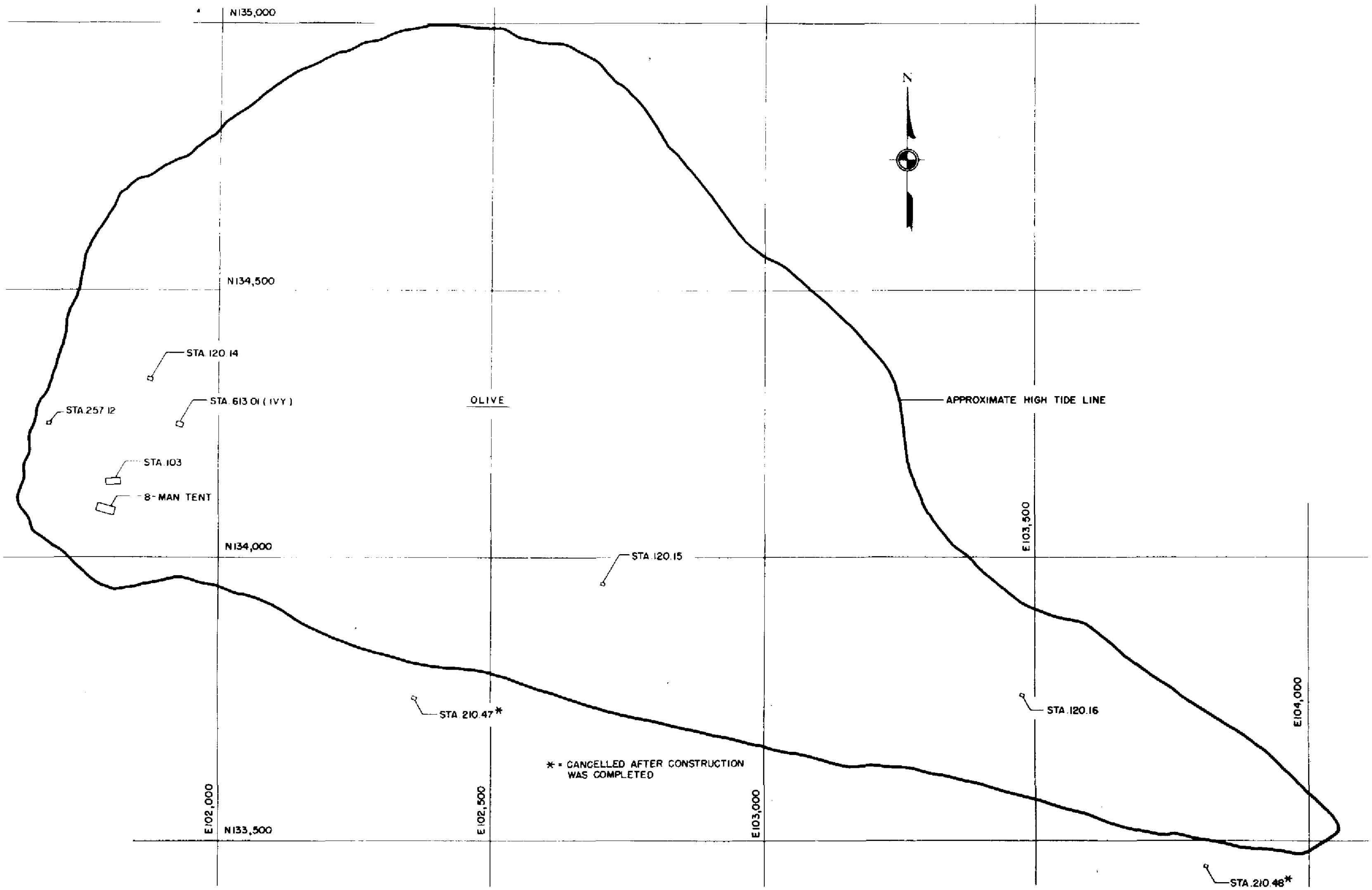


Figure 2-187. Scientific Station Sites - Olive

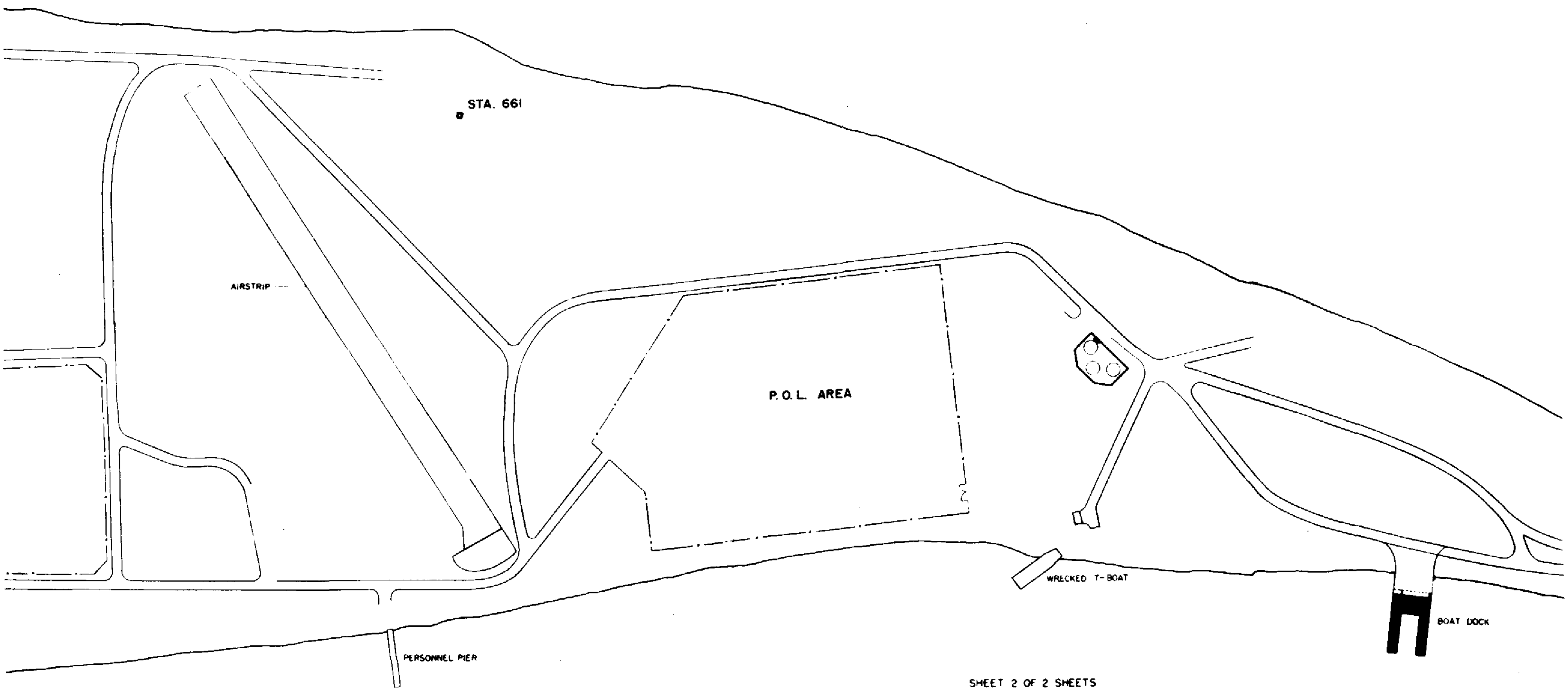


Figure 2-193. Scientific Station Sites - Elmer (Sheet 2 of 2)

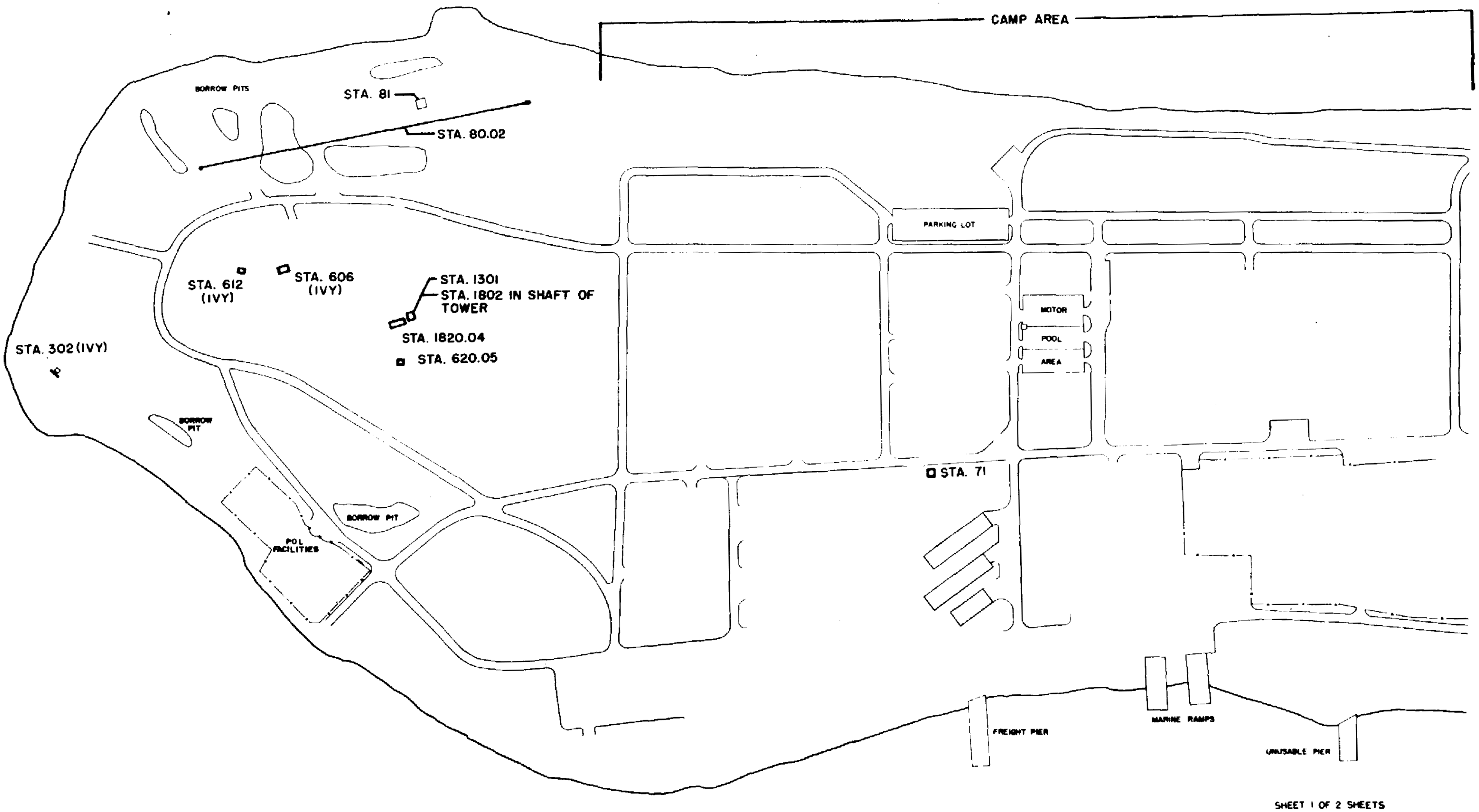


Figure 2-193. Scientific Station Sites - Elmer (Sheet 1 of 2)

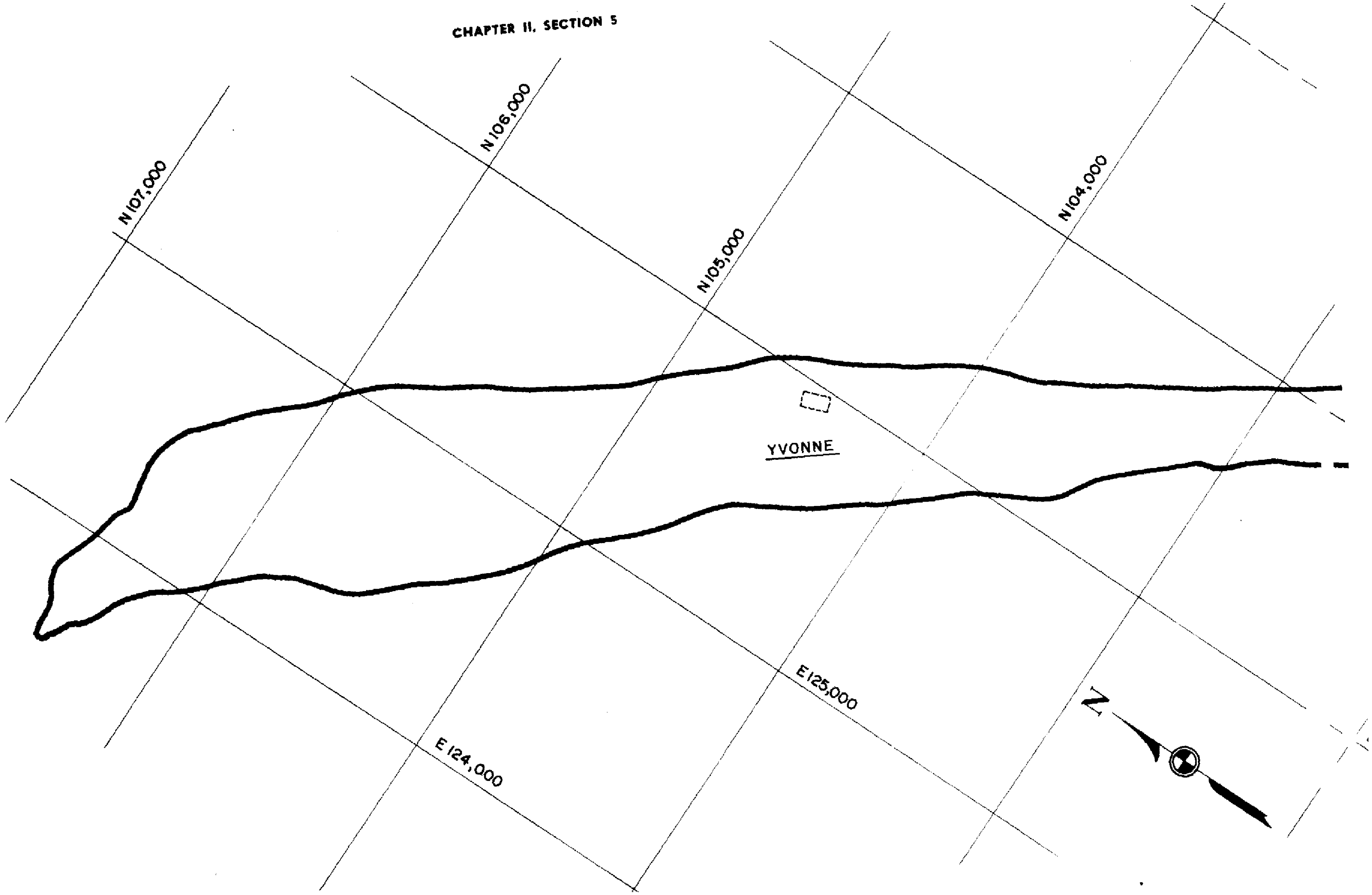
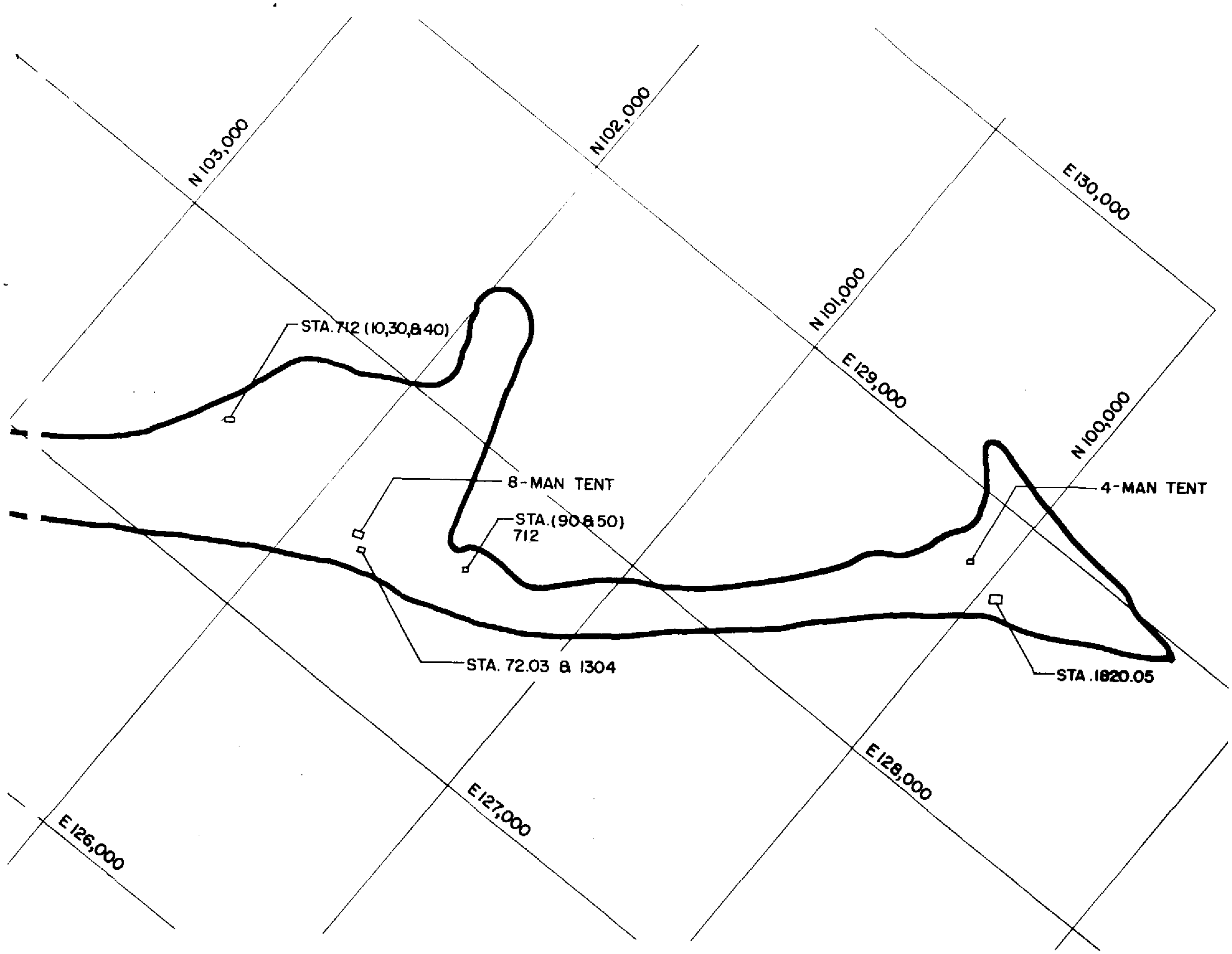


Figure 2-192. Scientific Station Sites - Yvonne


N 103,000
N 102,000
N 101,000
N 100,000
E 130,000
E 129,000
E 128,000
E 127,000
E 126,000
STA. 712 (10,30,&40)
8-MAN TENT
STA. (90 & 50)
712
STA. 72.03 & 1304
4-MAN TENT
STA. 1820.05

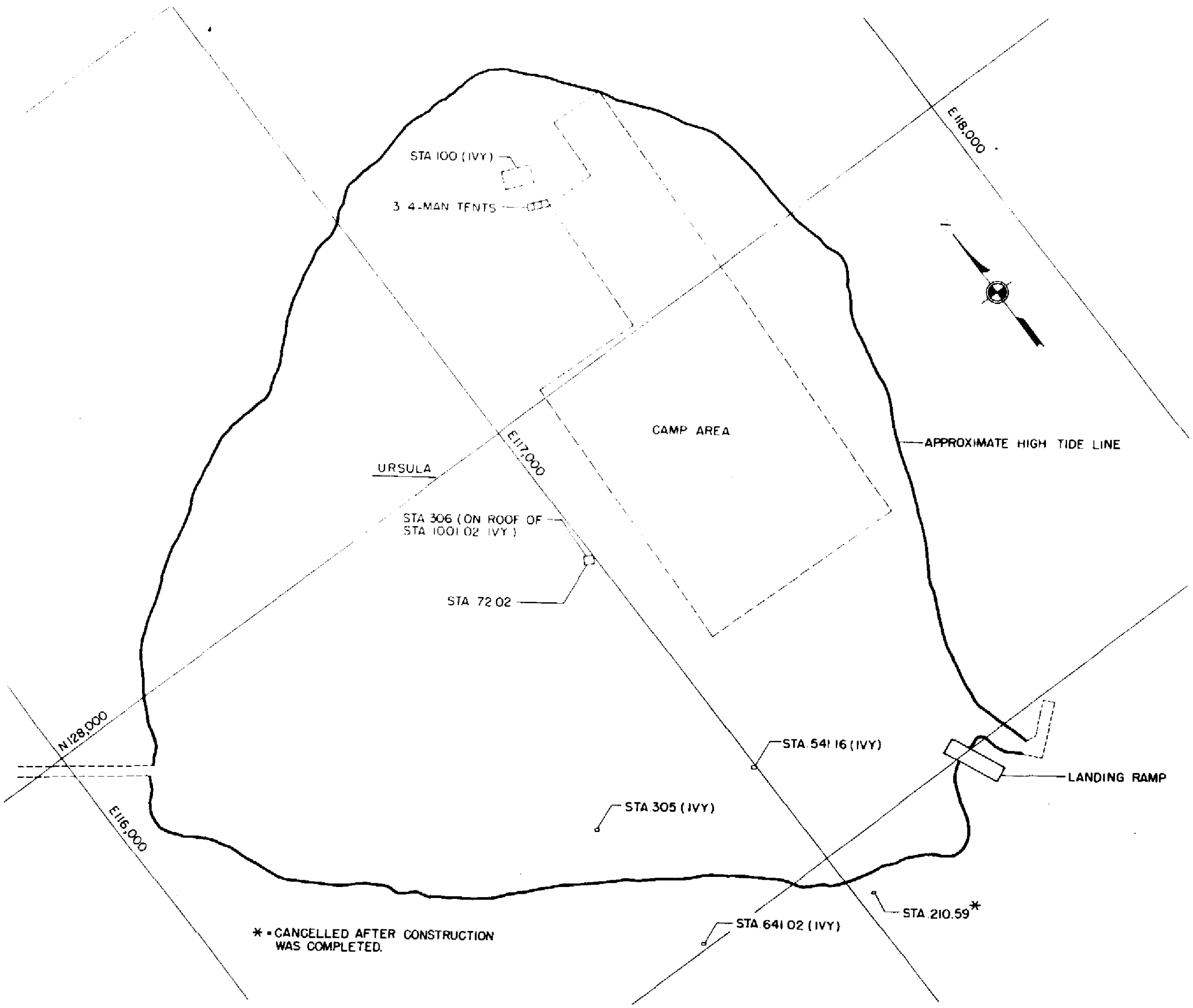


Figure 2-191. Scientific Station Sites - Ursula

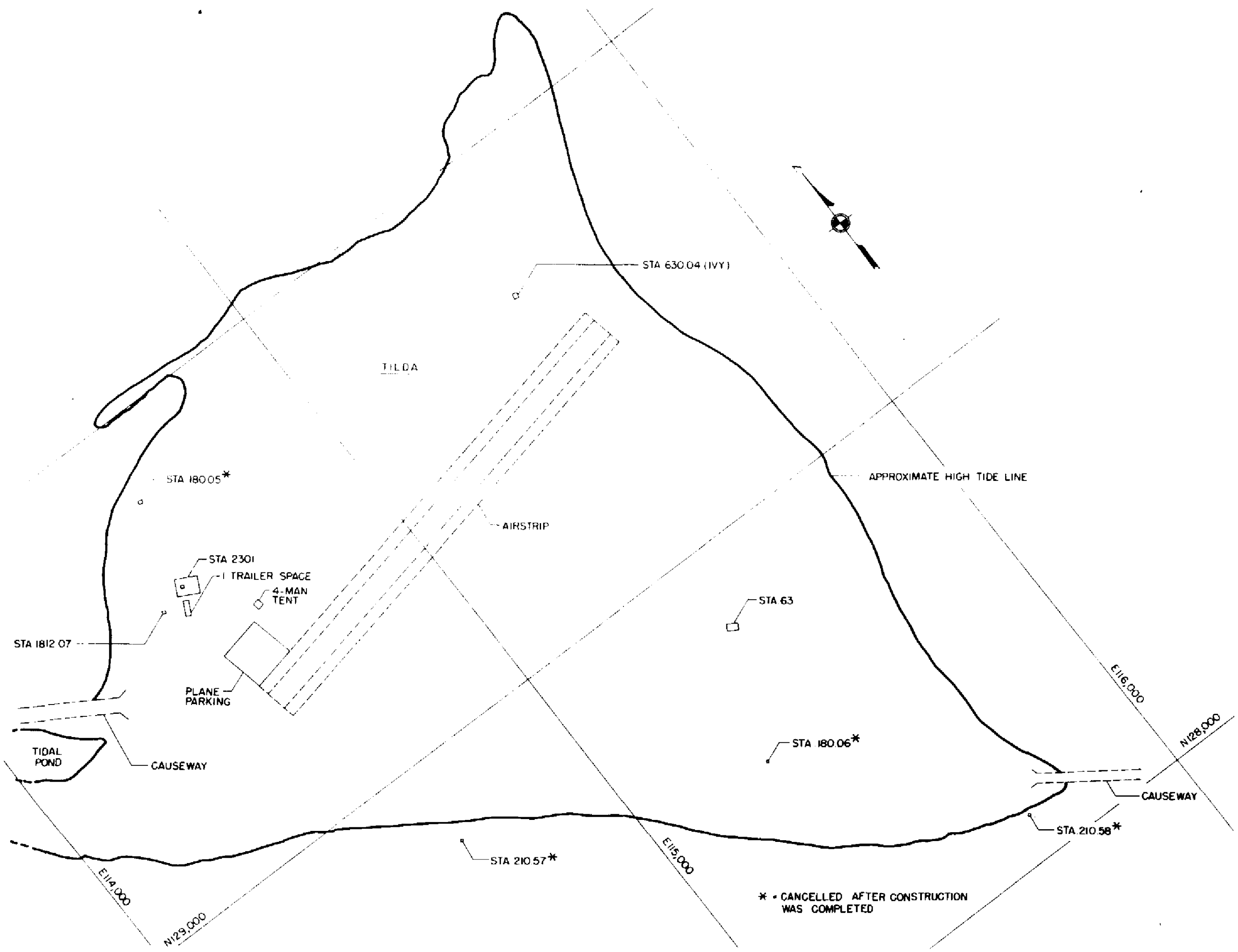


Figure 2-190. Scientific Station Sites - Tilda

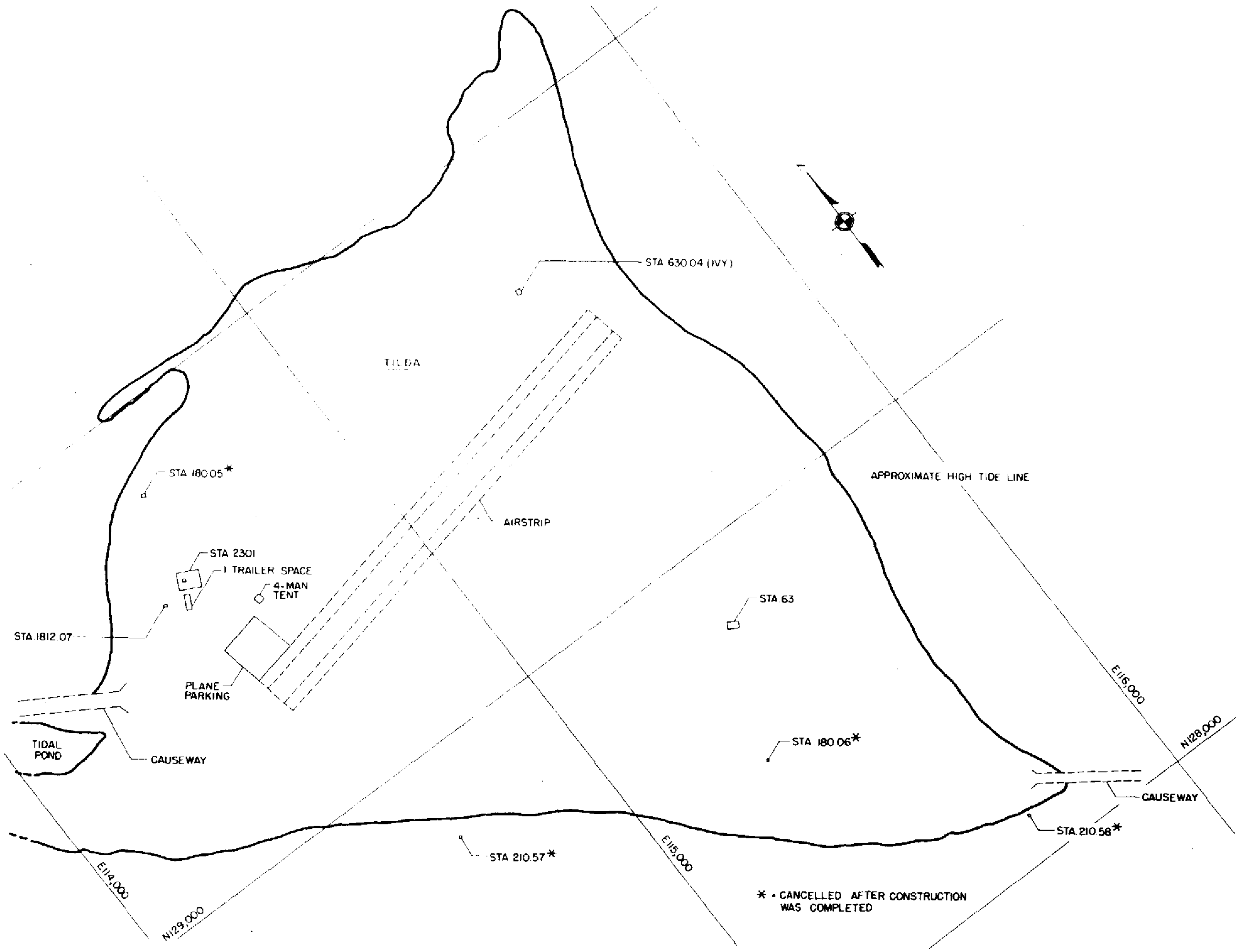


Figure 2-190. Scientific Station Sites - Tilda

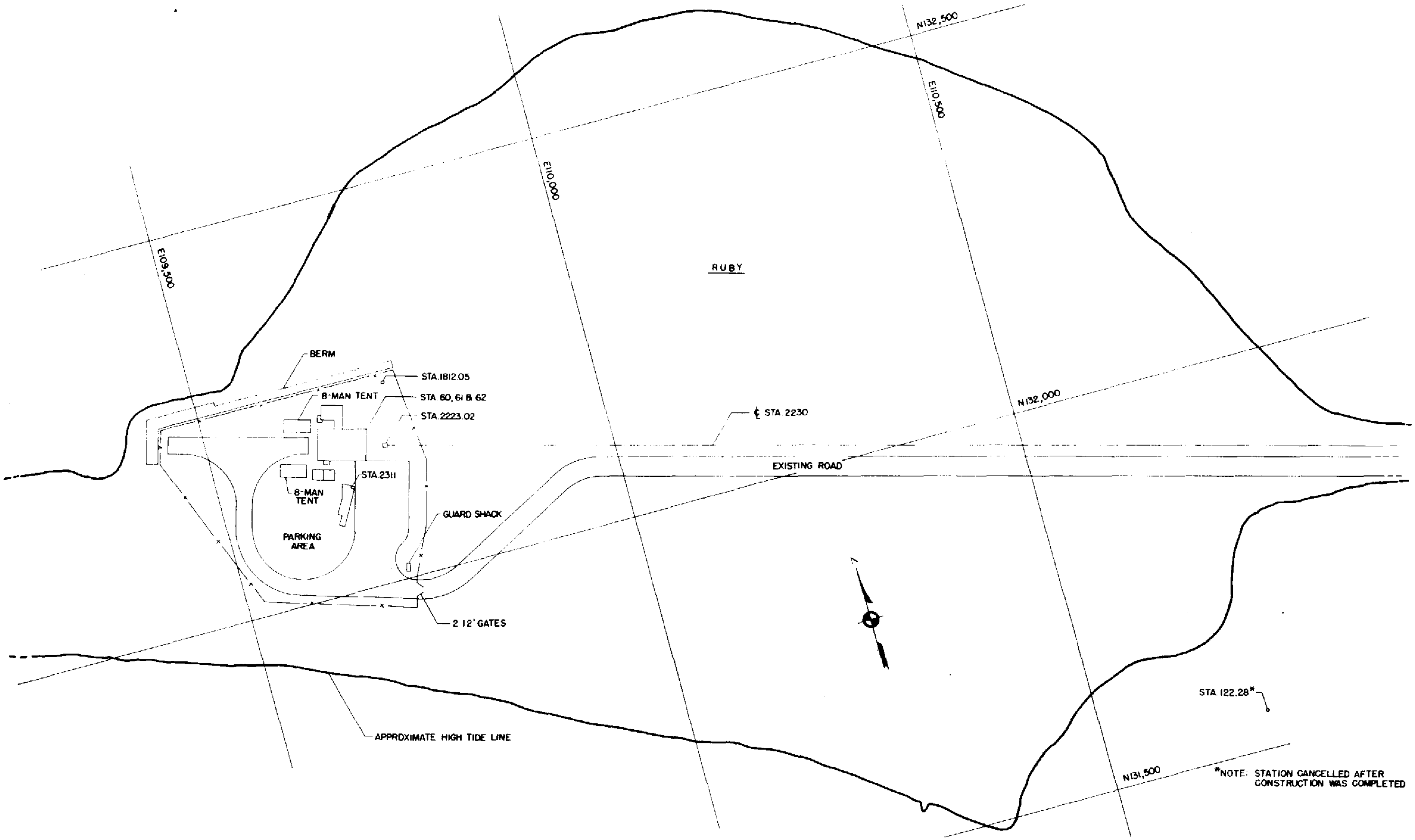


Figure 2-189. Scientific Station Sites - Ruby

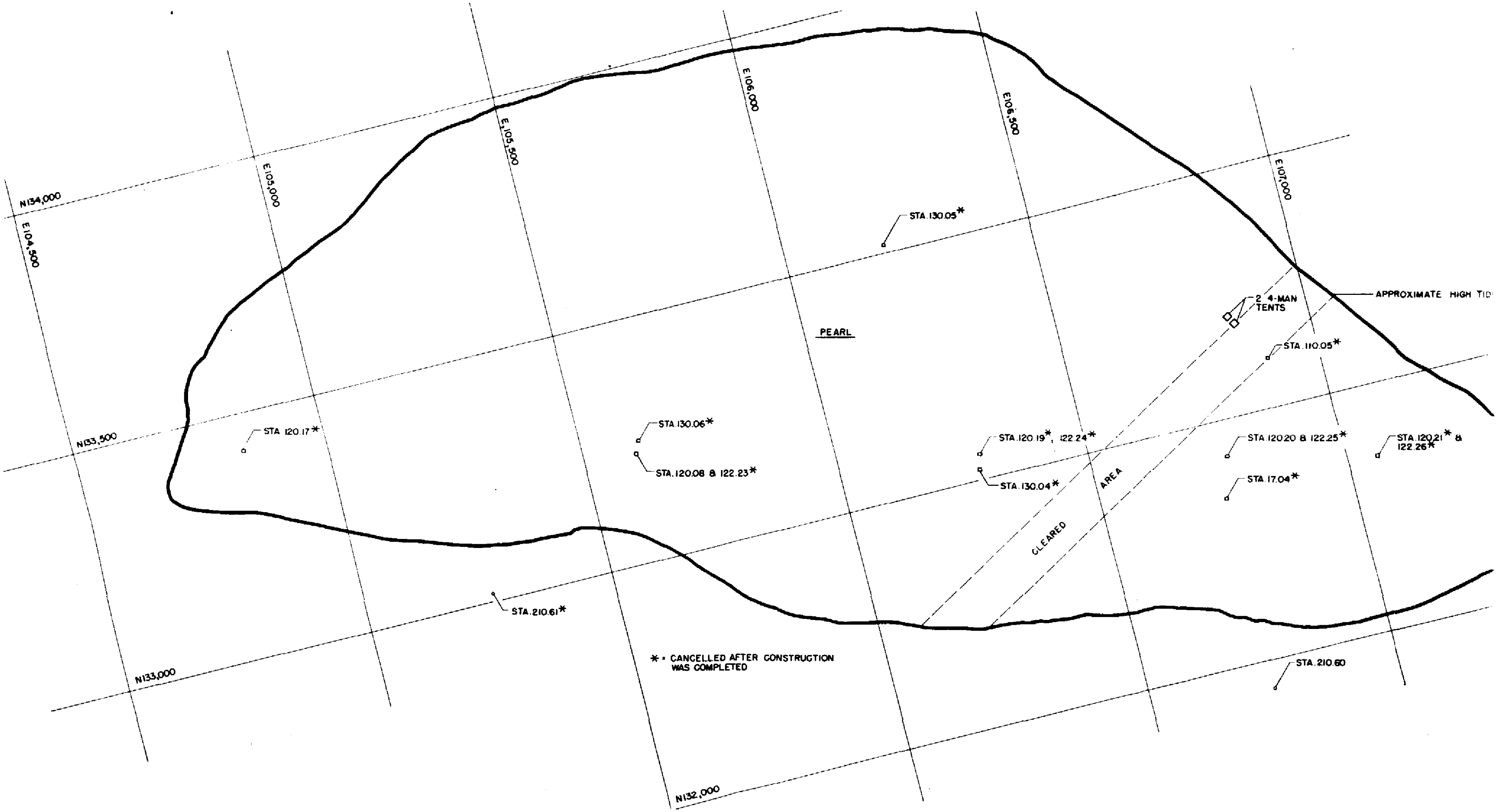


Figure 2-188. Scientific Station Sites - Pearl

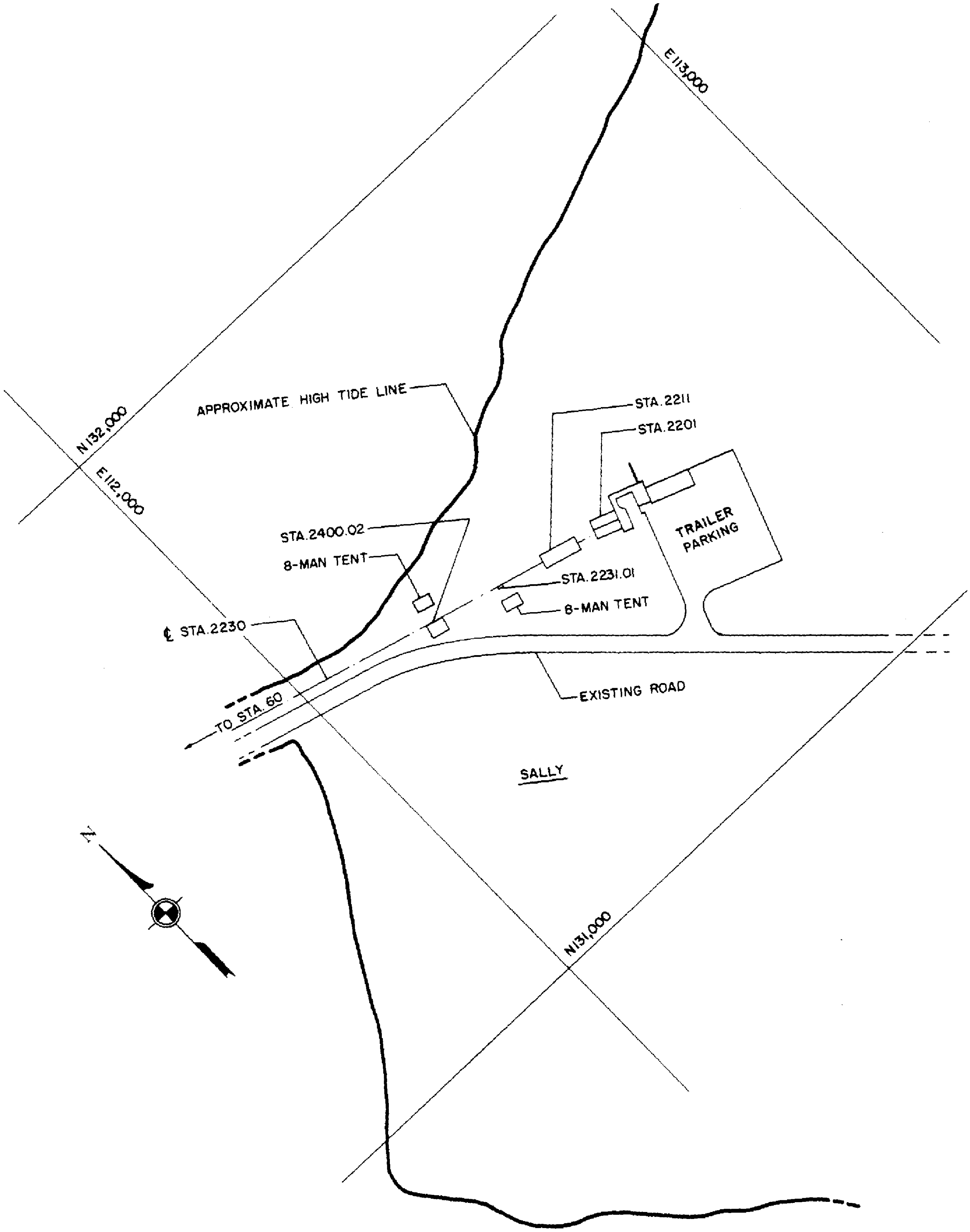


Figure 2-194. Scientific Station Sites - Sally

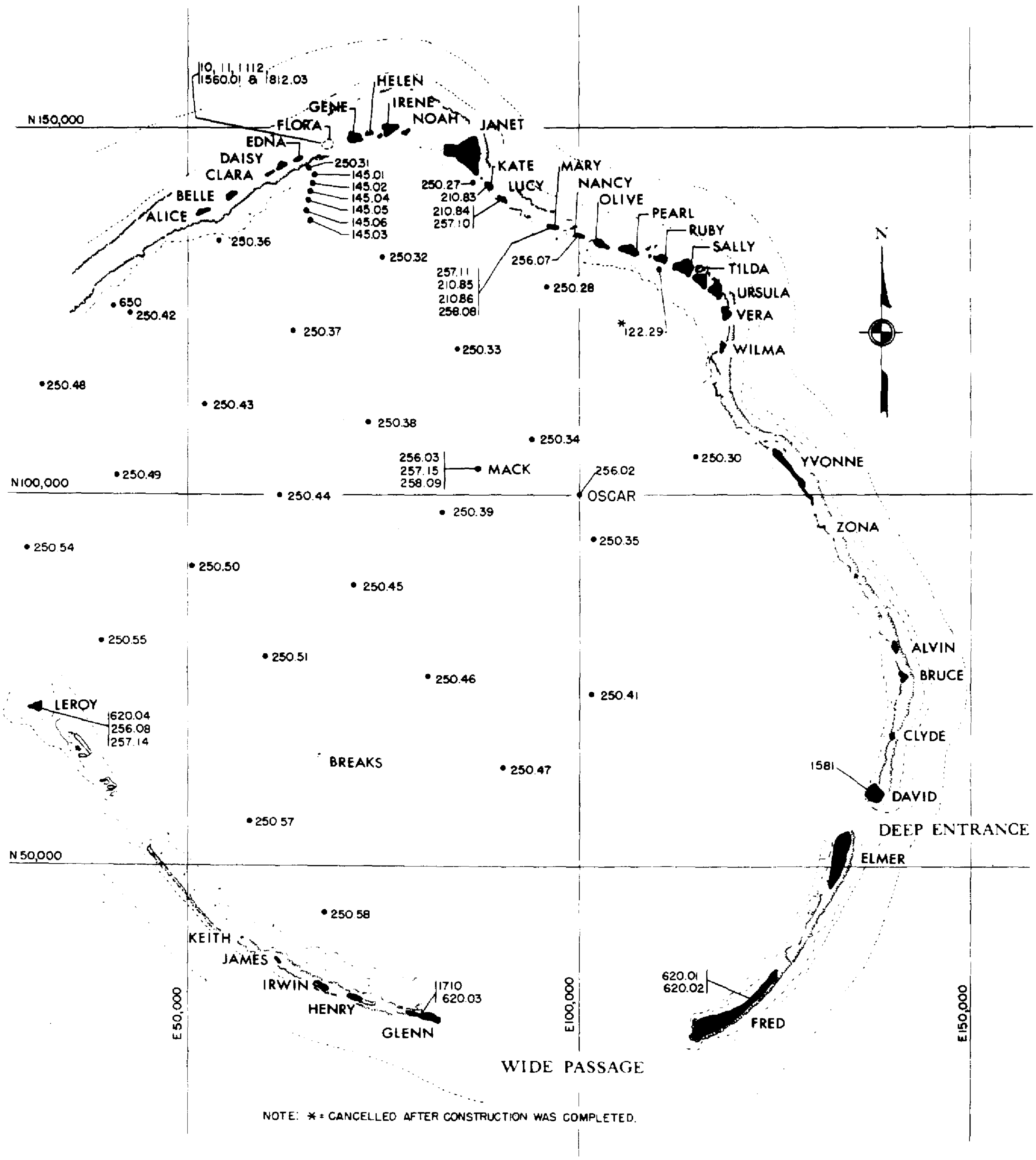


Figure 2-194A. Scientific Station Sites - Eniwetok Lagoon, Reefs and Minor Islands

Figure 2-195. Assembly Area - Aerial View

ASSEMBLY AREA - SITE ELMER

GENERAL. The Assembly Area, located at the south end of Elmer, contained a fenced-in area of approximately three acres. The purpose of this area was to handle, assemble and store key experimental units for operations at the PPG. This area housed the following structures:

Building No. 411 - Assembly Building, Building No. 412 - High Explosive Storage, Building No. 413 - Magazine, Building No. 414 - Guard House, Building No. 415 - Special Temporary Storage Building, Building No. 419 - Barge Slip.

Utilities for the area were supplied from facilities available on Elmer. Power was supplied from the Power Plant, Building No. 339 via a separate power line, fresh water from the water distribution system for Elmer, while salt water was supplied from the Salt Water Pump Station, Building No. 347, in the CMR Area. In addition, a salt water well equipped with a fire hydrant was located within the Assembly Area to provide additional water for fire fighting purposes. Since the area was used for the handling, assembling and storage of classified materials, it was fenced and equipped with a security lighting system. An area paging system was provided in addition to the normal telephone system facilities.

ENGINEERING. The original design criteria received on 26 March 1953 consisted principally of design criteria for the various buildings. Design work was started on 31 March. Three drawings and three sketches were prepared for the Area proper and were submitted from 24 June to 23 July. They were approved from 7 to 28 July.

CONSTRUCTION. The roads and stabilized areas were completed on 18 January 1954. The underground utilities were completed on 23 January, the electrical and signal systems were completed on 2 February and all work, including the security fencing, was completed on 13 March. Figure 2-195 is an aerial view of the Area and buildings as of 15 October 1953. The extreme white areas between buildings represents the stabilized coral areas.

BUILDING NO. 411
ASSEMBLY BUILDING - SITE ELMER

GENERAL. Building No. 411 was a steel frame structure with a lean-to along the full length of one side with roofing and siding of protected metal. Interior partitions were of wood-frame with plywood. The main building was 45′ - 8″ x 83′ - 0″. The lean-to was 16′ - 3¾″ x 83′ - 0″ and housed a layout room, a 50-man latrine, an instrument room and assembly room.

Figure 2-196. Assembly Area - Building 411

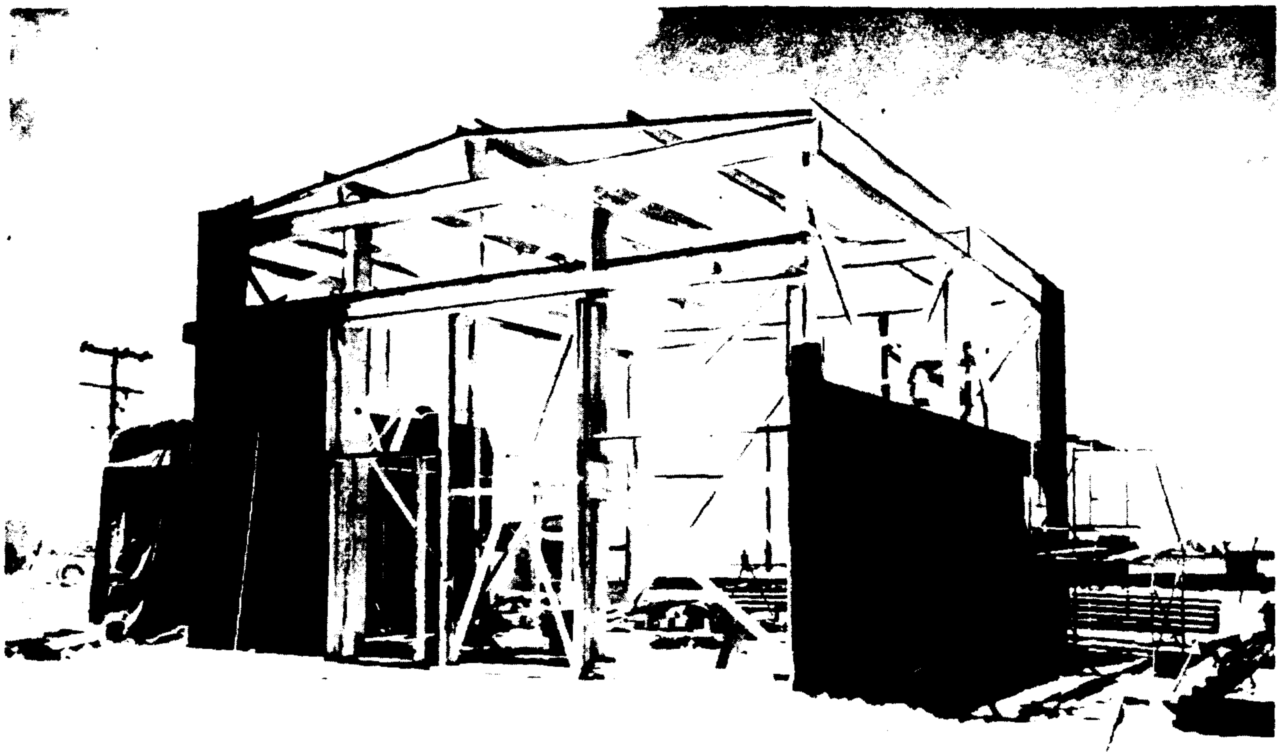


Figure 2-197. Assembly Area - Building 412

A concrete slab, 50 feet wide, extended for the full width of building and lean-to on one end along the lagoon side nearest the Barge Slip, Building No. 419. The purpose of the building was for handling and assembling of key experimental units for successive test operations.

MECHANICAL. The main building (Room 101) was served by a 25-ton traveling bridge crane with an auxiliary five-ton hook. Compressed air outlets and an air compressor were installed. Rooms 102 and 104 contained air conditioning units. Room 104 was provided with a one half-ton monorail hoist.

ELECTRICAL. Incandescent lighting was used in this building with high intensity lighting provided in the layout, instrument and assembly rooms. A considerable number of power outlets were provided in this building, all of which were specified by the User. The crane was powered by a 20 HP main hoist motor, a seven and one-half HP auxiliary hoist motor and smaller travel motors. Power was supplied from the area electrical distribution system through a Substation located outside of the building.

ENGINEERING. Original design criteria were received on 26 March 1953. Additional criteria were received on 7 May, 11 May and 22 June. Design work started on 31 March. Thirteen drawings were prepared and submitted on 23 April and approved on 9 June.

CONSTRUCTION. Work started on 3 July 1953 and was completed on 20 March 1954. Figure 2-196 shows the northeast corner of the building looking towards the lagoon. This building as shown on 15 October, was 76% completed.

BUILDING NO. 412
HIGH EXPLOSIVE STORAGE
SITE ELMER

GENERAL. Building No. 412 was a structural steel building and lean-to erected on reinforced concrete floor slabs with steel siding which was painted on both sides. The main building was 25′ - 6″ x 31′ - 6″ with a lean-to along the south side of the main building 9′ - 6″ x 25′ - 6″. The building was used in handling, storing and working with highly explosive experimental units.

MECHANICAL. The Mechanical features included a floor type drill press, a five-ton pneumatic traveling bridge crane, an air compressor and a dehumidification system.

ELECTRICAL. The wiring for the main area of this building was explosion-proof type. Incandescent lighting was used throughout and utility outlets were provided as directed by the User. A ground grid was provided outside of the building to provide a positive grounding system, and all steel in the building was grounded and bonded to this system. Power was sup-

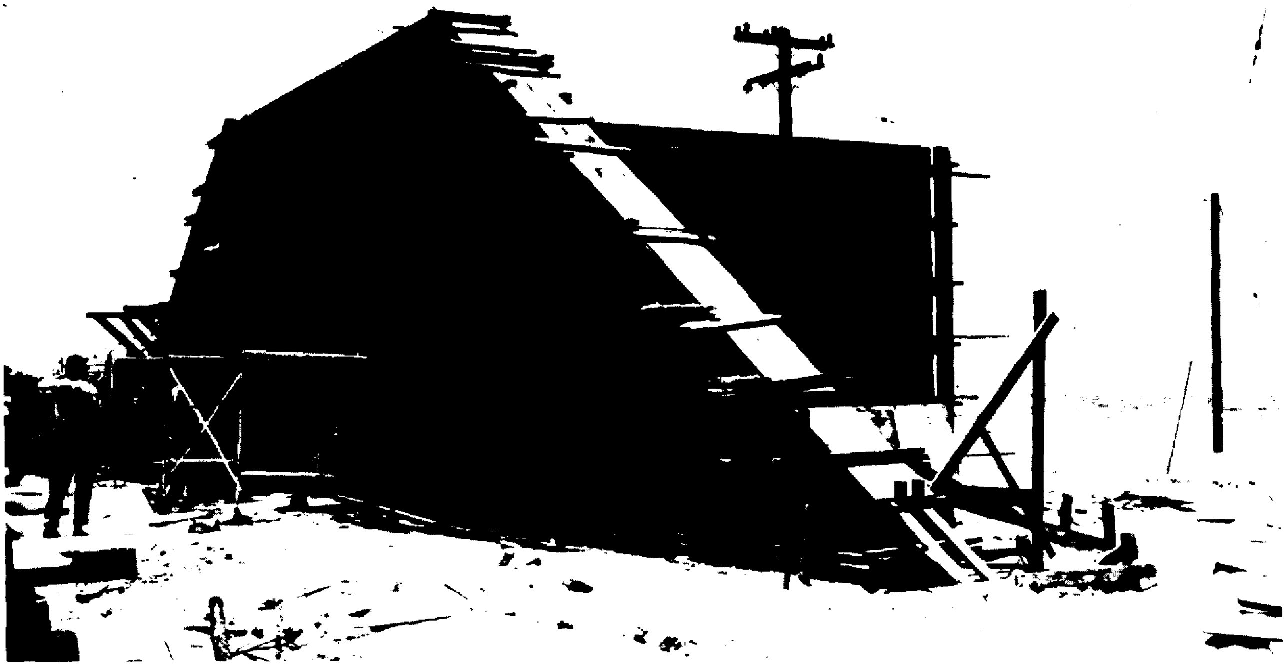


Figure 2-198. Assembly Area - Building 413

plied from the area electrical distribution system from the Sub-station located near Building No. 411.

ENGINEERING. The original criteria were received on 26 March 1953. Room arrangements were received from the User on 1 May. Design work started on 15 April. Three drawings and one sketch were prepared and submitted from 27 April to 8 June. Approvals were dated from 29 May to 1 July.

CONSTRUCTION. Work started on 17 April 1953 and was completed on 25 March 1954. Figure 2-197 notes the status of work as 46% completed on 15 October.

BUILDING NO. 413 MAGAZINE
SITE ELMER

GENERAL. Building No. 413 was a reinforced concrete structure 22' - 0" square with an earth covering of three feet and side beam protection and was used as a magazine for the storage of high explosives. Wing retaining walls held side fills to prevent door obstruction.

MECHANICAL. A ventilation system was installed which provided nine air changes per hour.

ELECRICAL. Explosion-proof incandescent lighting for Class 1, Group C locations was provided.

ENGINEERING. Criteria were received on 25 March 1953. Design work started on 15 April. Three drawings and one sketch were prepared and submitted from 27 April to 2 June. Approvals were dated on 19 June.

CONSTRUCTION. Work commenced on 16 July 1953 and was completed on 23 January 1954. Figure 2-198 shows the main and wing walls poured. The status of work on 20 August was estimated at 74% completed.

BUILDING NO. 414 GUARD HOUSE
SITE ELMER

GENERAL. This building was an 8' - 0" x 12' - 0" frame building with corrugated aluminum roofing and siding constructed on a concrete slab foundation, with open front. The building was used as a guard shelter.

ENGINEERING. Criteria were received on 25 March. One drawing was started on 10 April, submitted on 15 April and approved on 29 April 1953.

CONSTRUCTION. Work commenced on 1 July 1953 and was completed on 12 December.

BUILDING NO. 415
SPECIAL TEMPORARY STORAGE BUILDING - SITE ELMER

GENERAL. This building was constructed of reinforced concrete, 21' - 4" x 25' - 4" long, surrounded by a sloping earth berm the full height of building and had diagonal wing walls protecting the entrance. The building was used for general storage.

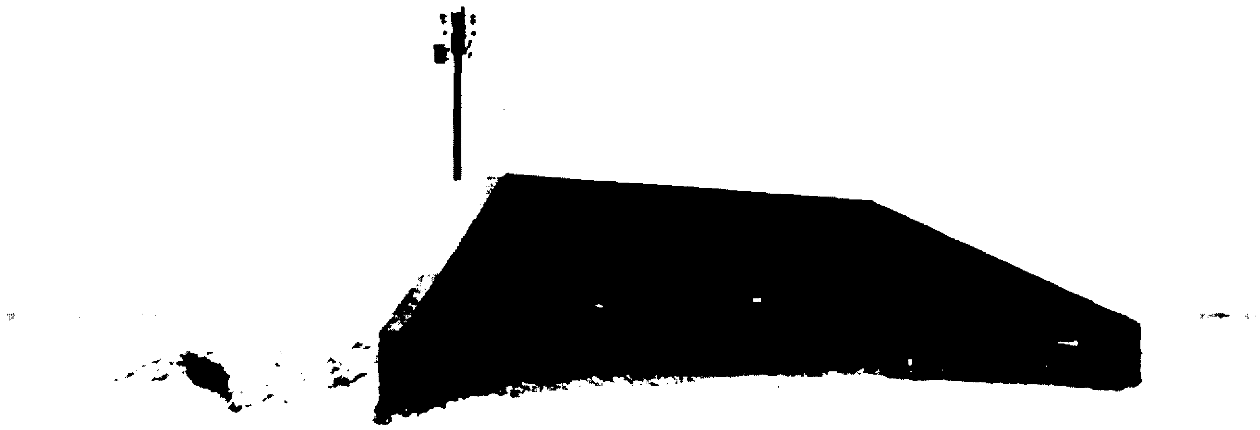


Figure 2-199. Assembly Area - Building 415

ENGINEERING. Criteria were received on 5 May 1953. Design work started on 25 May. Two drawings were prepared and submitted on 29 May and approved on 19 June.

CONSTRUCTION. Work started on 21 July 1953 and was completed on 23 January 1954. Figure 2-199 shows the structure as 90% completed on 15 October. The door opening, as

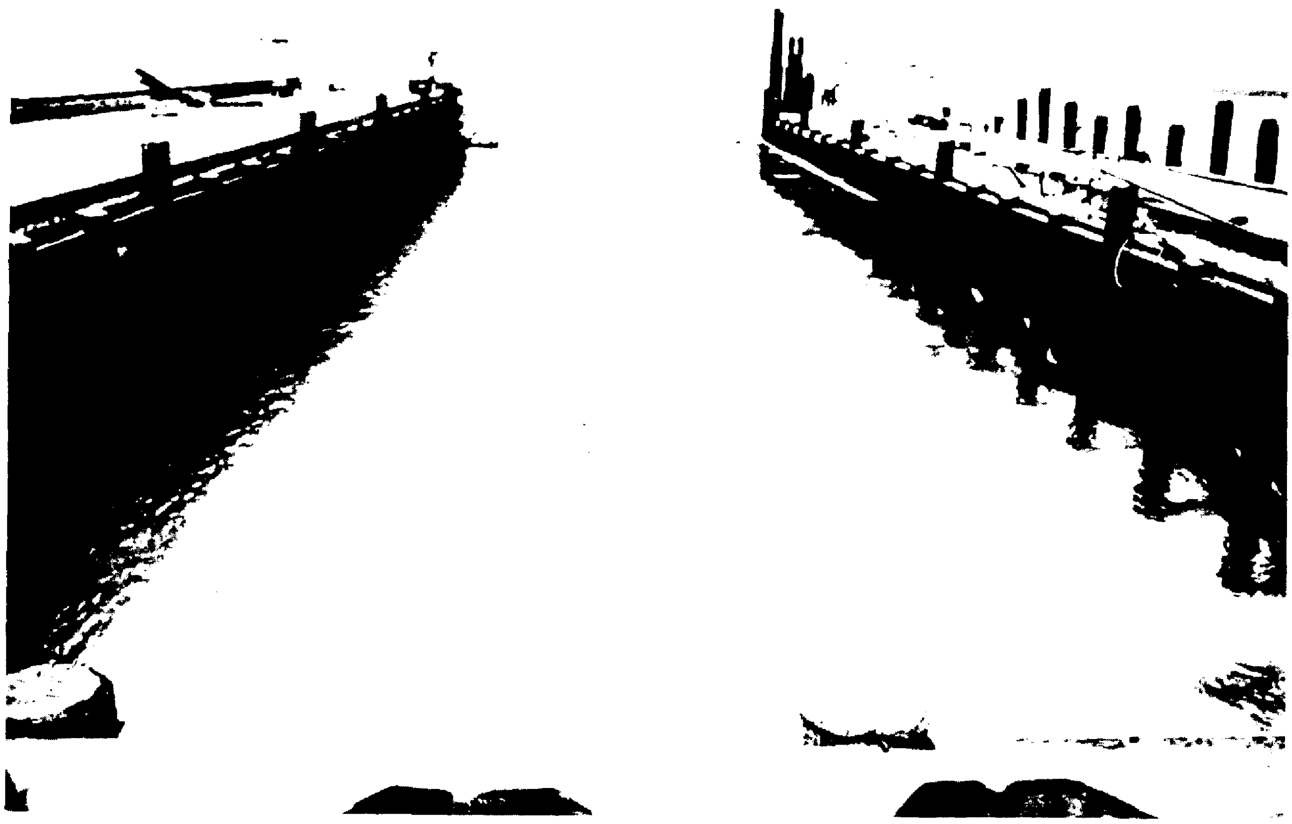


Figure 2-200. Assembly Area - Barge Slip

shown, was six feet wide by six feet eight inches high.

BUILDING NO. 419 - BARGE SLIP SITE ELMER

GENERAL. This structure consisted of a steel sheet-pile enclosed mole, 81′ - 8″ wide by 86′ - 8″ long, beyond which were two creosoted pile finger piers, each 20′ - 0″ x 132′ - 0″, enclosing a slip for barge mooring. Spanning the slip was a steel gantry crane of 60′ - 0″ span. The enclosed barge slip was 40′ - 0″ x 130′ - 0″ and was fitted with guide pile-wings for aid in docking floating craft. The finger piers were designed to accommodate a ten-ton tractor crane for loading or unloading barges. The pier and slip were used as an adjunct of the Assembly Area which was located immediately adjacent to the land end of the pier. The mole and piers were also available for the handling of any general cargo. Floodlighting was provided for night operation, and power outlets were provided as directed by the User.

MECHANICAL. A steel gantry crane serves the barge slip. The main hook has a capacity of 25-tons with a 37-foot hook lift above the crane rails. An auxiliary hook with a five-ton capacity also serves the slip.

ENGINEERING. The original criteria were received on 6 March 1953. The criteria developed as the design progressed and many changes were made. Final criteria were approved on 15 June. Design work started on 15 April. Four drawings and one sketch were prepared and submitted from 29 April to 11 August. Approvals were dated from 22 May to 21 August.

CONSTRUCTION. Work commenced on 17 June 1953 and all work was completed on 5 March 1954. Figure 2-200 shows the barge slip as 90% completed as of 15 October. Figure 2-76 (see Station 10) shows the slip completed with gantry crane in operation. Barge Stations 10 and 40 were undergoing repairs and alterations to fit them as Stations.

SCIENTIFIC POWER PLANTS SITES VARIOUS

GENERAL. The scientific power requirements known in early 1953 were examined and it was determined that one central electric power generation plant for a closely related group of Scientific Stations, to be used for one test, would be the most feasible. A single plant with a few large units(in lieu of single independent plants) was more economical to build and operate, more reliable in voltage and frequency control, more stable under varying load conditions within the limits of an economical distribution system, and where the function of a unitized system could be related to a single test. On 1 May 1953 it was recommended that central Power Plants for power generation be established at sites Charlie, Dog, Nan, Tare and Ursula. On 5 June 1953 these recommendations were approved. At site Ursula, IVY Station U-108 was reactivated for this purpose. At sites Charlie, Dog and Tare, expendable construction was used. At site Nan, Building NA-500 was a 38′ - 0″ x 49′ - 0″ x 14′ - 0″ high reinforced concrete structure with earth fill on one end and two sides to the finished grade. The roof had a two-foot thick earth fill over it and the exposed end wall of the building had a 15′ - 0″ long by 19′ - 6″ high maximum retaining wall

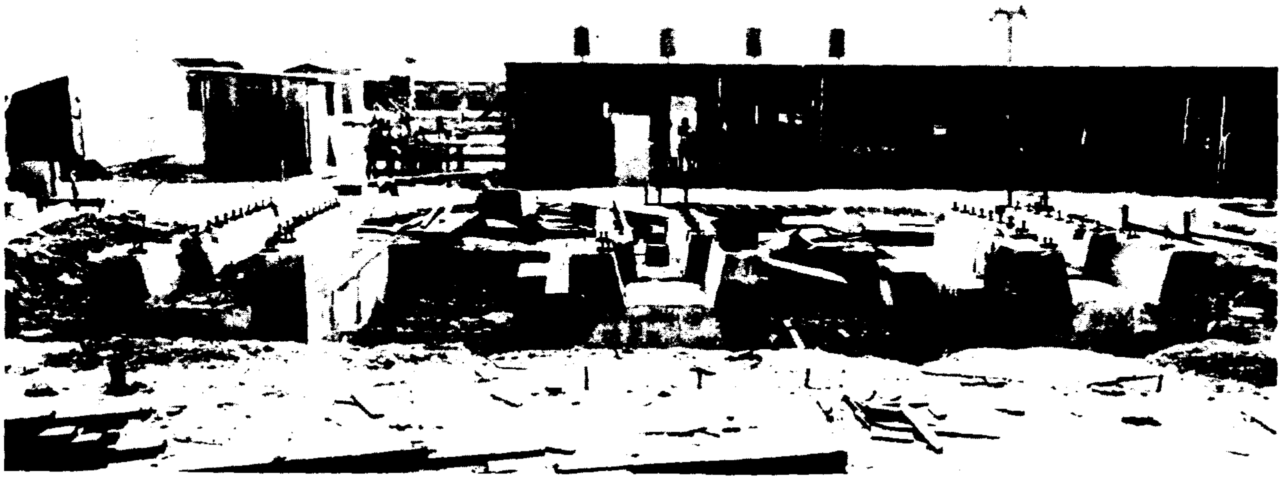


Figure 2-201. Scientific Power Plants - Typical Foundations

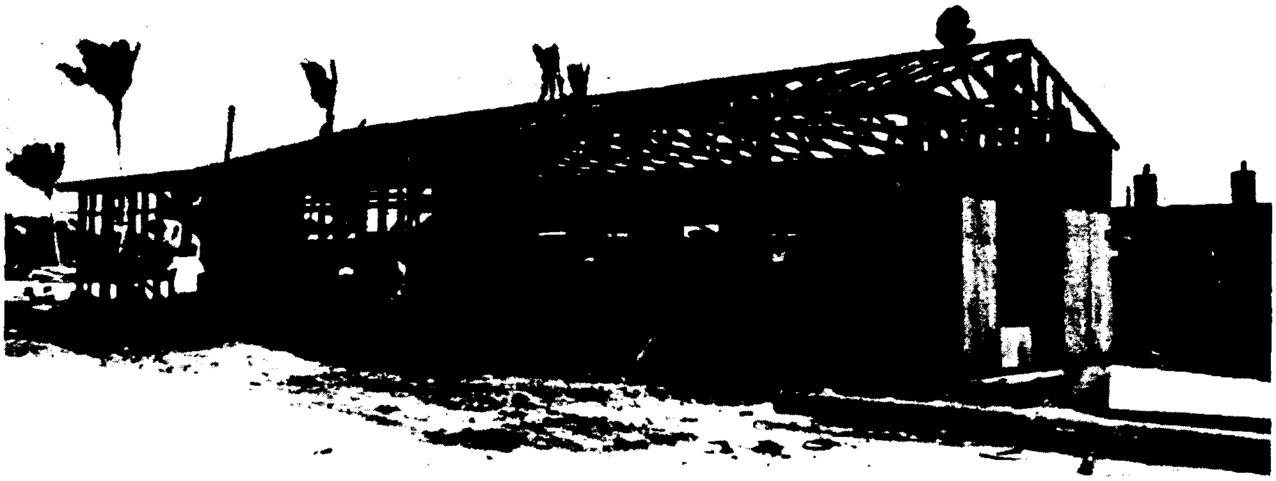


Figure 2-202. Scientific Power Plants, Installed Generator

at each end and parallel to the side walls. At the centerline of the building there was an inverted reinforced concrete beam at the roof. This beam extended the full length of the building and rested on two-foot by one-foot reinforced concrete columns at each end. The end wall at the retaining walls extended above the roof slab and acted as a retaining wall for the earth on the roof slab. Adjacent to the inverted beam and spaced 15-foot on centers were three reinforced concrete boxes 3′ - 10″ x 6′ - 2″ x 6′ - 6″ high which opened into the building through the roof. Each of these boxes had a steel shutter on the three-foot ten-inch side, and the shutters rested on the inverted beam. The inverted concrete beam was supported by steel columns which rested on spread footings below the concrete floor slab. Generator foundations were located under each of the three box openings in the roof. Figure 2-201 shows typical foundation for generator mount.

ELECTRICAL. Building NA-500 was the electric power generation plant that supplied the scientific power requirements at site Nan. There were two 100KW and one 122KW, 2400 V, 3 phase diesel generator units or firm capacity of 200KW and a maximum capacity of 322KW. Each generator had its own generator control panel in the main switchboard. In addition to this, the main switchboard contained a synchronizing panel plus three feeder sections. A pushbutton was provided in Station 70 to shut down the entire power plant. This pushbutton also controlled the detonation of the explosive links which caused the closing of the blast doors on this building. The building was lighted by standard industrial lighting fixtures.

Building TA-500, at site Tare, served the Stations on site Sugar and Tare. It was located next to the camp power house and a "tie feeder" was provided so that a portion of the camp electrical load could be supplied from TA-500 until scientific demands required its entire output. As the criteria for the Stations became firm, power requirements were continuously increased. On 28 August 1953, it was necessary to add a 135KW portable generator in order to increase the KW capacity to 366KW. Figure 2-202 shows a generator installed with wall framing in place and wall siding being installed.

Building CH-500, at site Charlie, served the Stations on that island. Like TA-500, provisions were made to connect this power house to the camp power house. The characteristics of the electrical distribution system were 2400 V, 3 phase, 60 cycle, 3 wire and it was delivered by direct burial cable to local transformer Sub-stations. At these Sub-stations the primary voltage was stepped down to a nominal secondary voltage of 120/208V, 3 phase where it was delivered to each of the main switchboards of the respective Stations. Figure 2-203 shows a typical generator control panel.

At Ursula an existing protected power house, Building U-108, was reactivated. A 4160 V, 3 phase distribution system was decided on so that a minimum voltage drop would occur at the Scientific Stations. To accomplish this with a minimum of new equipment, three 100 KVA, 2400/2400, 1 phase transformers were connected in delta-wye and located just outside the power house. This 4160V, 3 phase distribution system served six transformer banks, one located at each of the following Stations: 72.02, 63, 2301, 2201, 2231.01 and 60. The scientific electric power requirements for the Scientific Stations served by this power house increased and it was found necessary to increase the capa-

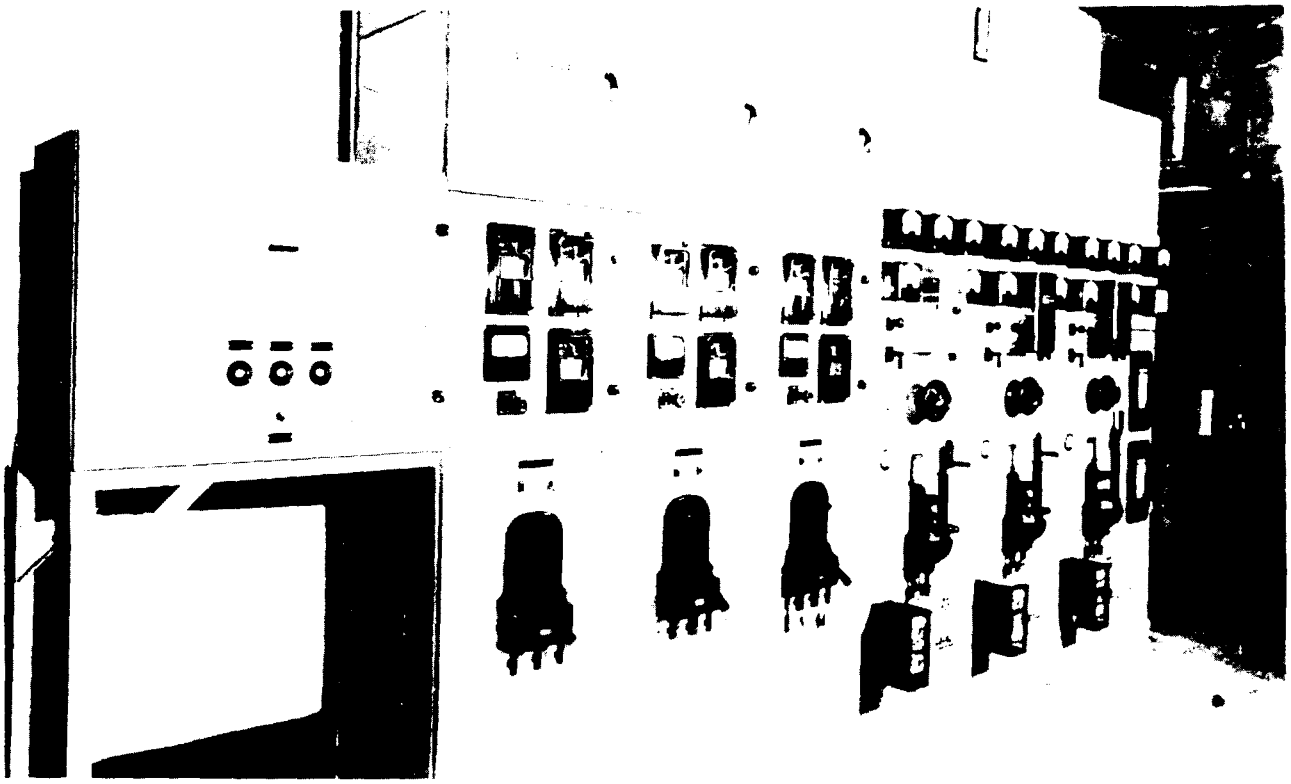


Figure 2-203. Scientific Power Plants - Typical Control Panels

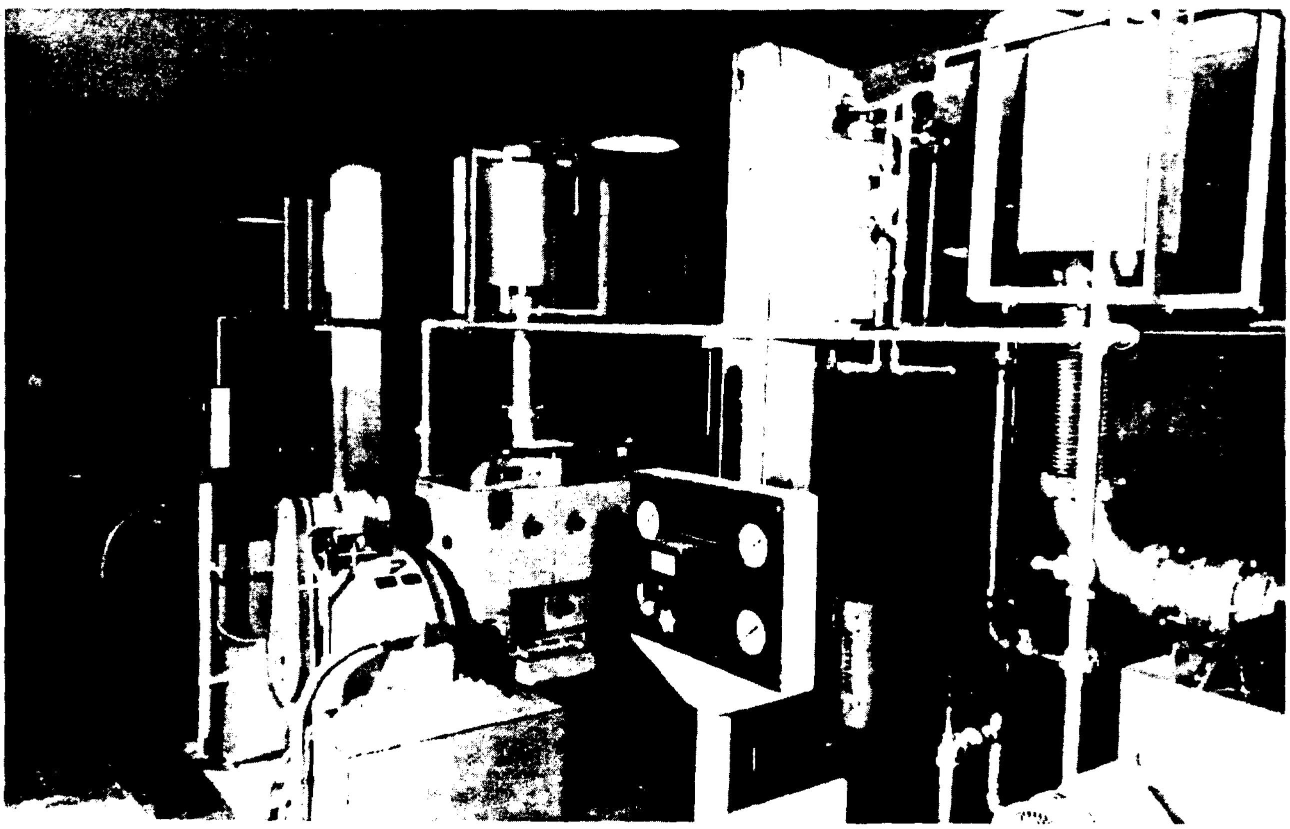


Figure 2-204. Scientific Power Plants - Typical Interior

Figure 2-205. Scientific Power Plants, NA-500 - 31% Completed

city of the powerhouse. There was no room for an additional Fairbanks-Morse unit, therefore a 135KW portable heat-exchanger unit was decided upon. This unit was located inside the entrance to the building so it could be within the protection of the Station. In addition to this portable generator as a supplement to scientific power, a 30KW portable was also provided to serve the Station power requirements. Figure 2-204 is a typical interior view of these Scientific Power Plants.

ENGINEERING. Seventeen drawings and one sketch were prepared and submitted from 30 June to 11 August 1953. These plans were approved at various dates from 3 July to 14 August.

CONSTRUCTION. Building NA-500 was started on 16 September 1953 and was completed on 5 January 1954. Figure 2-205 shows NA-500 as 31% completed on 2 November with the outer walls poured. CH-500 was started on 16 September 1953 and was completed on 14 January 1954. DO-500 was started on 20 November 1953 and was completed on 14 January 1954. Figure 2-206 shows the entrance of NA-500 on site Nan. Work on reactivating U-108 was started on 8 September 1953 and was completed on 9 October. TA-500 was started on 15 October 1953 and was completed on 2 January 1954. Figure 2-207 shows the interior of a power house as completed.

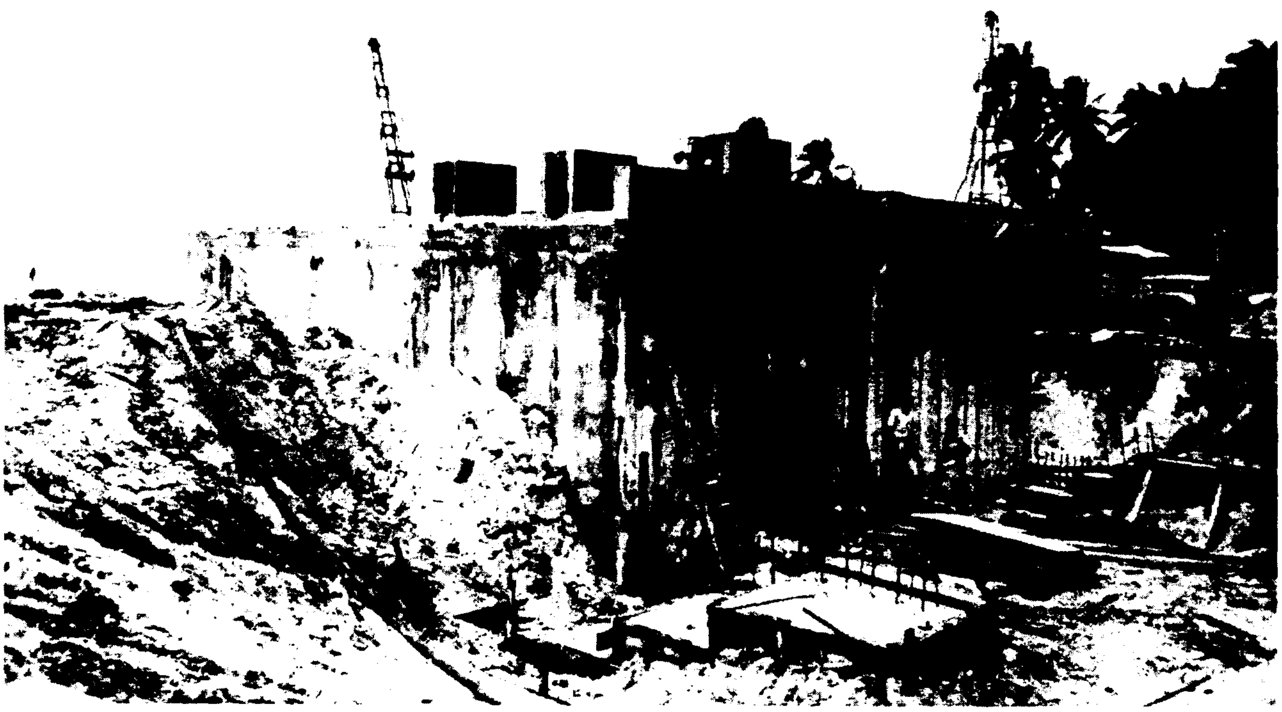


Figure 2-206. Scientific Power Plant NA-500 - Entrance

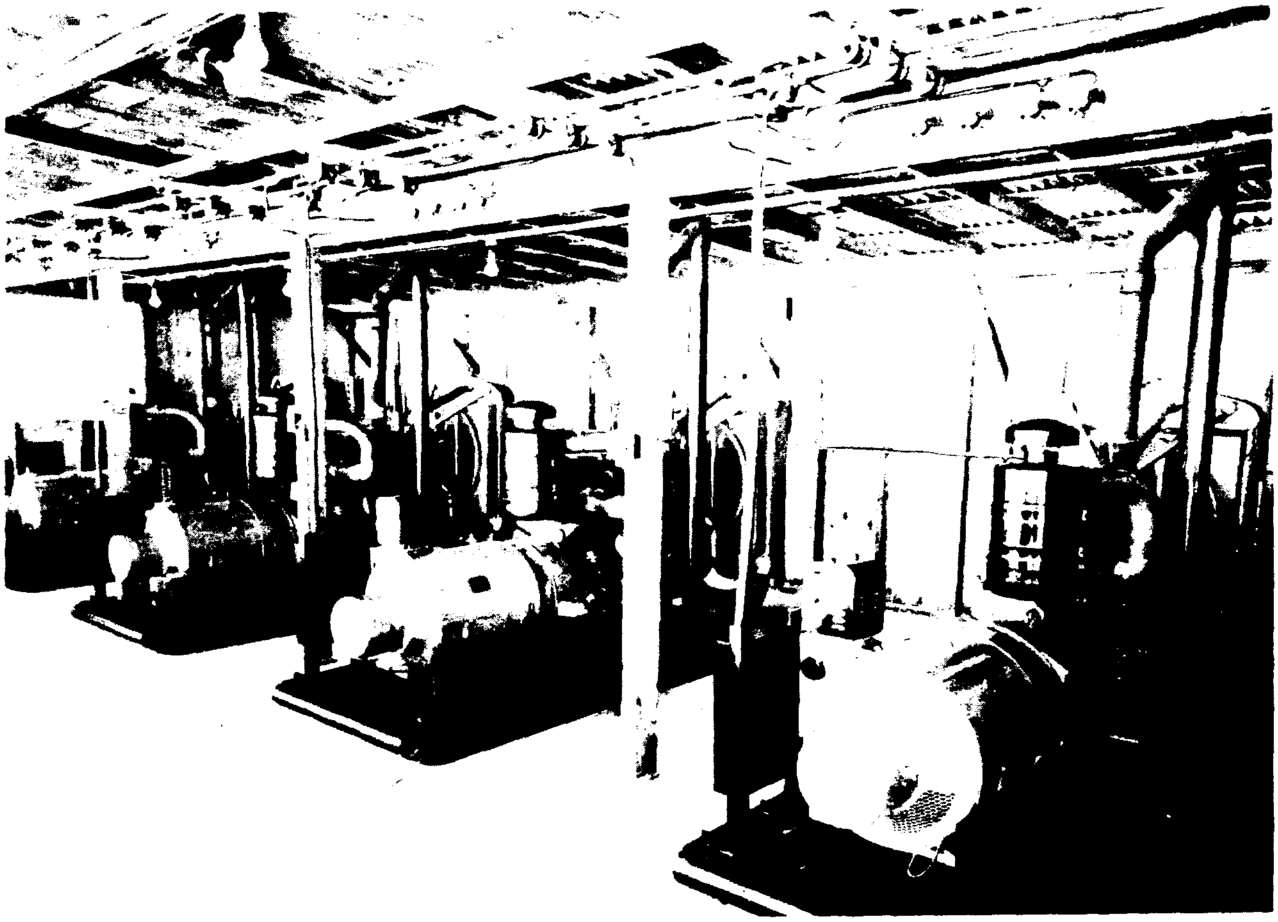


Figure 2-207. Scientific Power Plants - Interior Completed

SECTION 6
CAUSEWAYS

CONTRACT ITEM NUMBER A-25-25.2
AIRSTRIP AND ACCESS ROADS
TARE GROUP

GENERAL. When the Tare camp was established at Bikini and construction of the Peter-Oboe Airstrip authorized in October 1952, land access between the five islands of the Tare group became necessary for economical construction operations. The causeway between Peter and Oboe at the east end of the chain became part of the airstrip runway. (See discussion under Contract Item A-25, Section 4.) The causeways joining Peter to Roger and Roger to Sugar were built primarily to establish land access to construction and operation of the airport facilities as well as for the P. O. L. farm on site Sugar, which served the entire Bikini Atoll. The causeway between Sugar and Tare carried an access road and the UCRL vacuum pipeline between Stations 50 and 2210. (See discussion following on Contract Item A-26). All access causeways were used for construction of the seven major Scientific Stations on this island group as well as the numerous associated minor Scientific Stations.

Causeway locations and approved borrow areas are shown on Figure 2-208.

ENGINEERING. The Field Engineering Division processed the necessary work orders and, in addition, conducted hydrographic and location surveys, inspection and test control on construction. Specifications on the airstrip causeway fill and a layout drawing were prepared by the Home Office.

CONSTRUCTION. The access causeways constructed under this item were as follows:

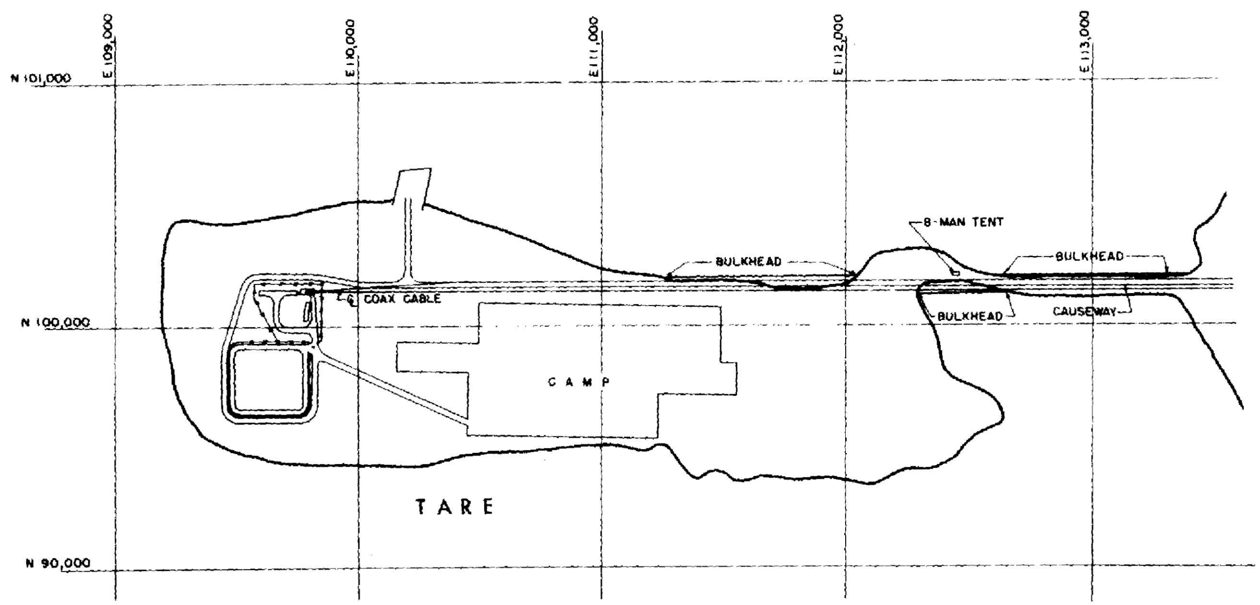
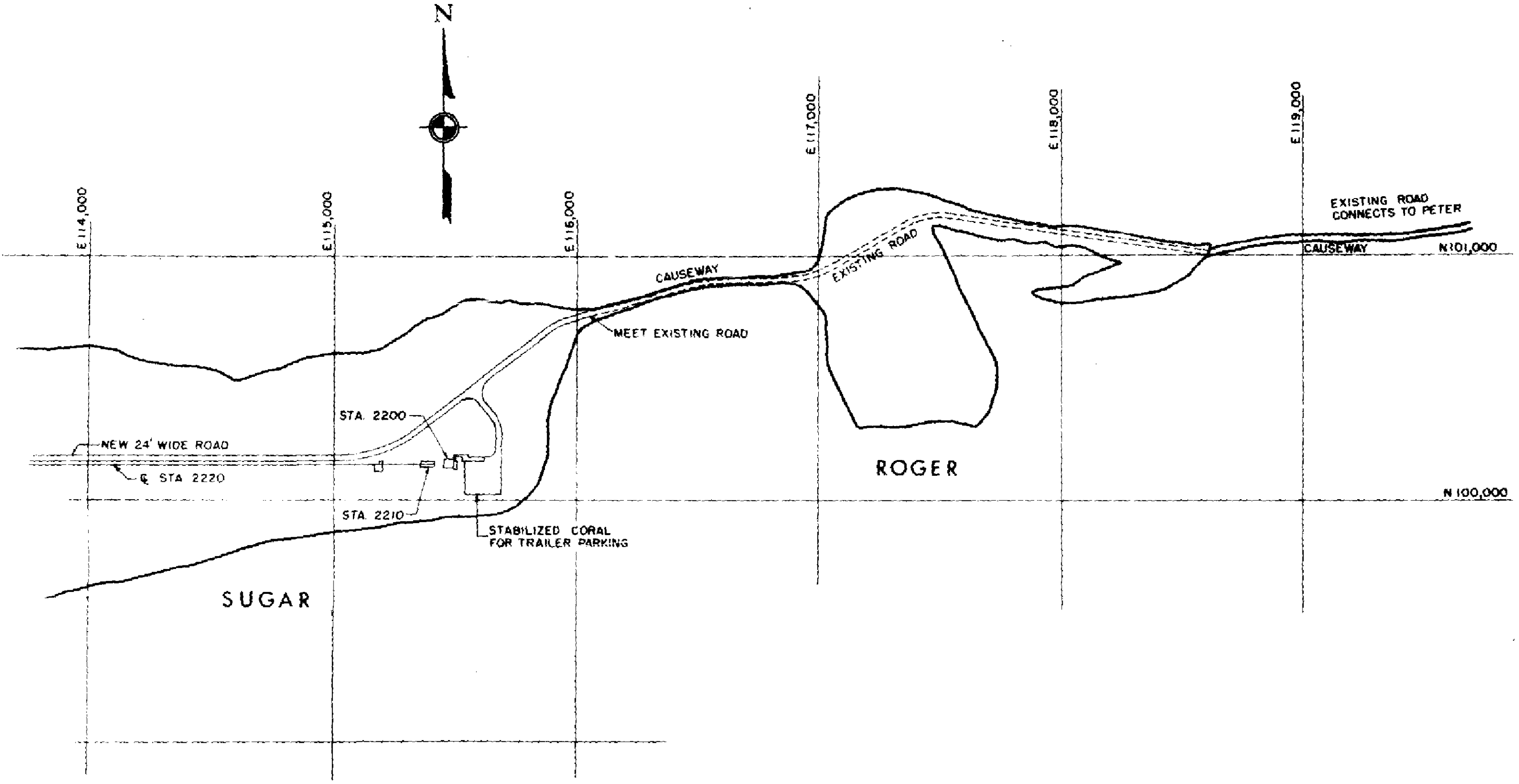


Figure 2-208. Causeway Plan - Tare to Roger



N
E 114,000
E 115,000
E 116,000
E 117,000
E 118,000
E 119,000
EXISTING ROAD CONNECTS TO PETER
CAUSEWAY
N101,000
CAUSEWAY
EXISTING ROAD
MEET EXISTING ROAD
STA. 2200
NEW 24' WIDE ROAD
℄ STA. 2220
STA. 2210
STABILIZED CORAL FOR TRAILER PARKING
ROGER
N 100,000
SUGAR

Figure 2-209. Causeway - Sugar to Tare

Peter to Roger - Approximate length 3000 feet.
Roger to Sugar - Approximate length 1000 feet.

Available bank and reef coral was used, the surface being traffic compacted and stabilized with sea water. From May 1953, when first opened, until heavy construction started and traffic to and from the batch plant on Oboe increased materially, single-lane roads were adequate. In August 1953 approval was obtained to widen these causeways to provide for a 25-foot road and to raise the elevation to plus 8.5 feet in order to minimize washouts at high tide. Final completion was on 5 September 1953.

CONTRACT ITEM NUMBER A-26-26.1
CAUSEWAYS TARE AND CHARLIE

GENERAL. In March 1953 it was established that causeways would be required on sites Charlie and Tare for the vacuum pipe arrays to be used in connection with experiments at those sites. Straight lines 7500 and 5600 feet in length respectively, were necessary, connecting the Scientific Stations at their ends. By suitably locating the Scientific Stations involved, it was possible to obtain these pipeline lengths with the construction of a causeway approximately 3000 feet long extending westward from site Charlie, and a causeway 1100 feet long joining sites Sugar and Tare - Figure 2-209. The Charlie causeway included at its end an island approximately 0.8 acres in area at elevation plus 10.0 feet on which were located Stations 20, 1110, 1202, 1351, 1560.02, 1812.01 and a number of scientific tents and trailers. Both causeways were also used as access roads.

The Charlie causeway location and approved borrow areas are shown on Figure 2-211.

ENGINEERING. Criteria for location of the pipelines and pipeline causeways were finalized in the Home Office early in March 1953. The location selected for the Tare pipeline and causeway was reviewed and checked by Field Engineering, insofar as possible conflict with the development of Tare camp facilities was concerned. Drawings showing the plan and profile of both causeways were approved in May 1953. Field Engineering processed the necessary work orders, surveys and inspection of construction.

CONSTRUCTION - CHARLIE CAUSEWAY. This causeway was 87 feet wide at an elevation of plus 9.0, and was bulkheaded on the lagoon

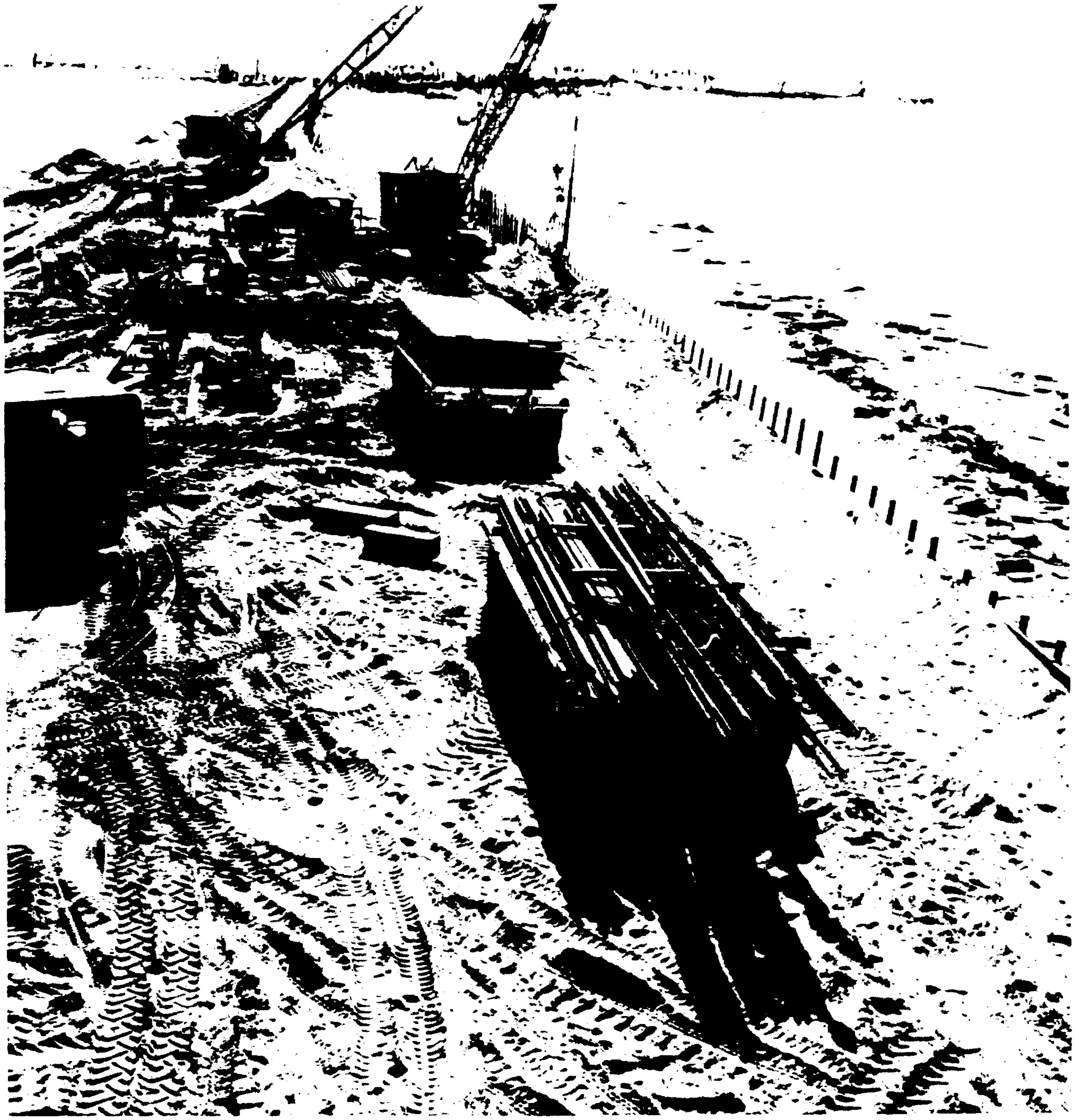


Figure 2-210. Charlie Causeway - Construction of Bulkhead

side only with a three-inch thick timber bulkhead. Figure 2-210 notes this construction and status of work on 15 September. The bulkhead is supported by 60-pound used rail driven on four-foot centers, without tie-backs. The pipeline required approximately 32 feet of this right-of-way; the 24-foot access road, including safety shoulders, required 40 feet; and the shoulder on the ocean side for pipeline construction was 15 feet wide. After partial completion of fill and rough grading in mid-July 1953, observations of wave action under severe wind and tide conditions indicated that the ocean side bulkhead as originally designed was unnecessary. A Contractor recommendation that this be deleted, at a saving of approximately $60, 000, was approved on 13 August 1953. The DUKW ramp was relocated from the ocean side to the lagoon side of the working area at the end of the causeway where natural accretion

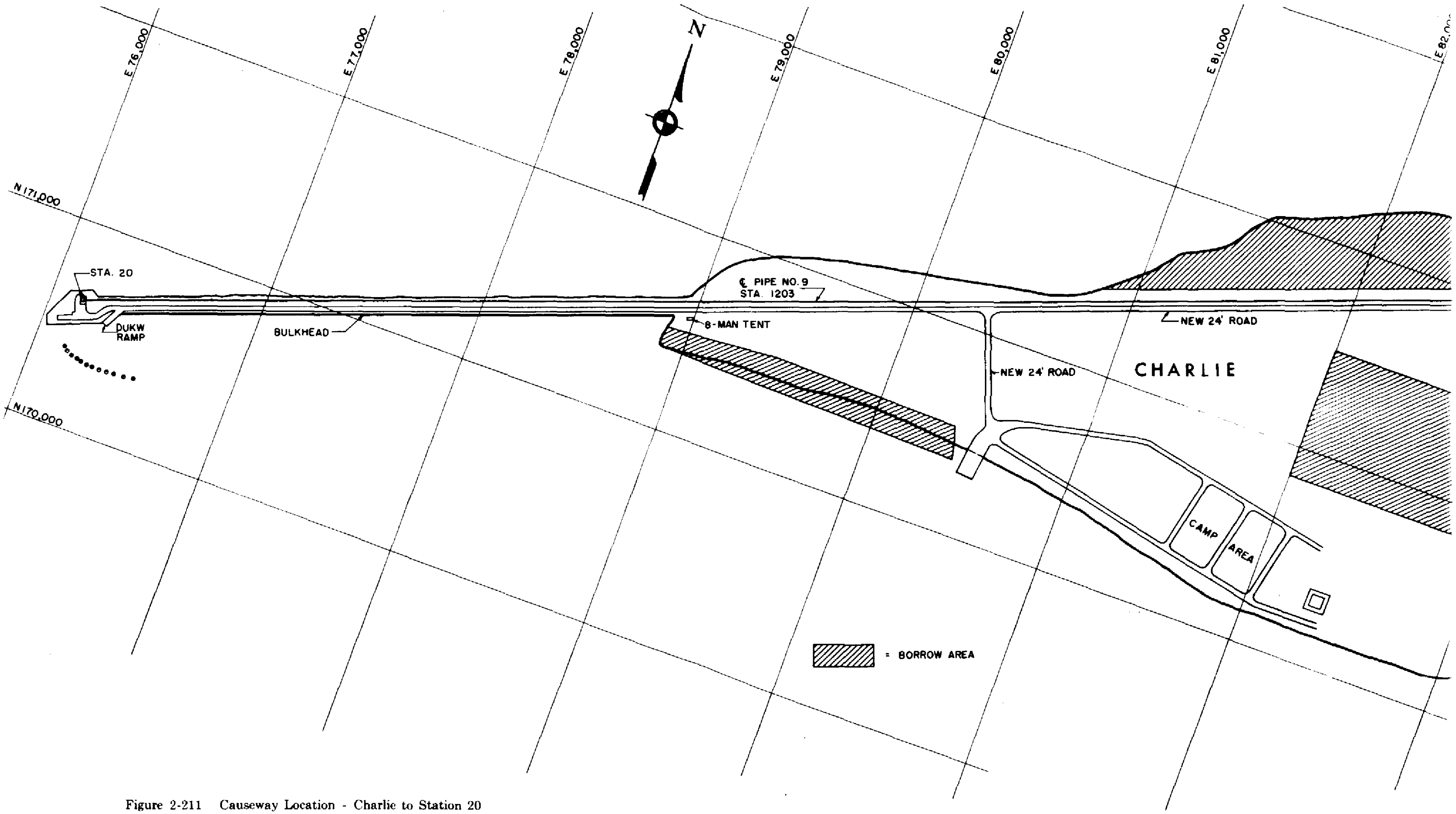


Figure 2-211 Causeway Location - Charlie to Station 20

Figure 2-212. Charlie Causeway - DUKW Ramp

of sand provided an ideal approach. Figure 2-212 shows this DUKW ramp on the lagoon side.

Grading was completed on 5 September 1953, driving of rail for the bulkheads completed on 12 September 1953, and all timbering and backfill were completed early in October. Figure 2-213 shows a typical example of erosion due to wave action on the ocean side. This photograph was taken on 4 December 1953. On the lagoon side the bulkheads experienced some damage due to tidal action. Figure 2-214 is a typical example in this respect.

Figure 2-213. Charlie Causeway - Erosion from Wave Action

CONSTRUCTION - TARE CAUSEWAY. The Tare pipeline causeway was approximately 60 feet wide and carried a pipe array with ten-foot wide supports, a 24-foot wide road with safety shoulders, and rights-of-way for power, telephone and coaxial cables. Earthwork for the causeway, which made maximum use of the existing access causeway between Sugar and Tare, was begun immediately after approval in May and completed early in June 1953. Bulkheading with rail and timber as shown by the original design proved unnecessary, adequate protection being provided by rip-rap which could be bulldozed up from the adjacent reefs.

CONTRACT ITEM NUMBER A-27
GENERAL SITE WORK FOR SCIENTIFIC STATIONS DOG - GEORGE CAUSEWAY

GENERAL. Causeways connecting the four islands of the Dog-George group were constructed for land access to all construction sites immediately after establishment of the beachhead camp in May 1953. These causeways were essential for delivery of concrete from the batch plant on site Easy to all islands in the chain, for delivery of surface shipments of cargo from the boat ramp on site George and for transportation to and from the camp on Fox. They were used for construction of the four major Scientific Stations on this island group as well as the numerous associated minor Scientific Stations. Figure 2-216 notes the causeway as it appeared on 13 August 1953.

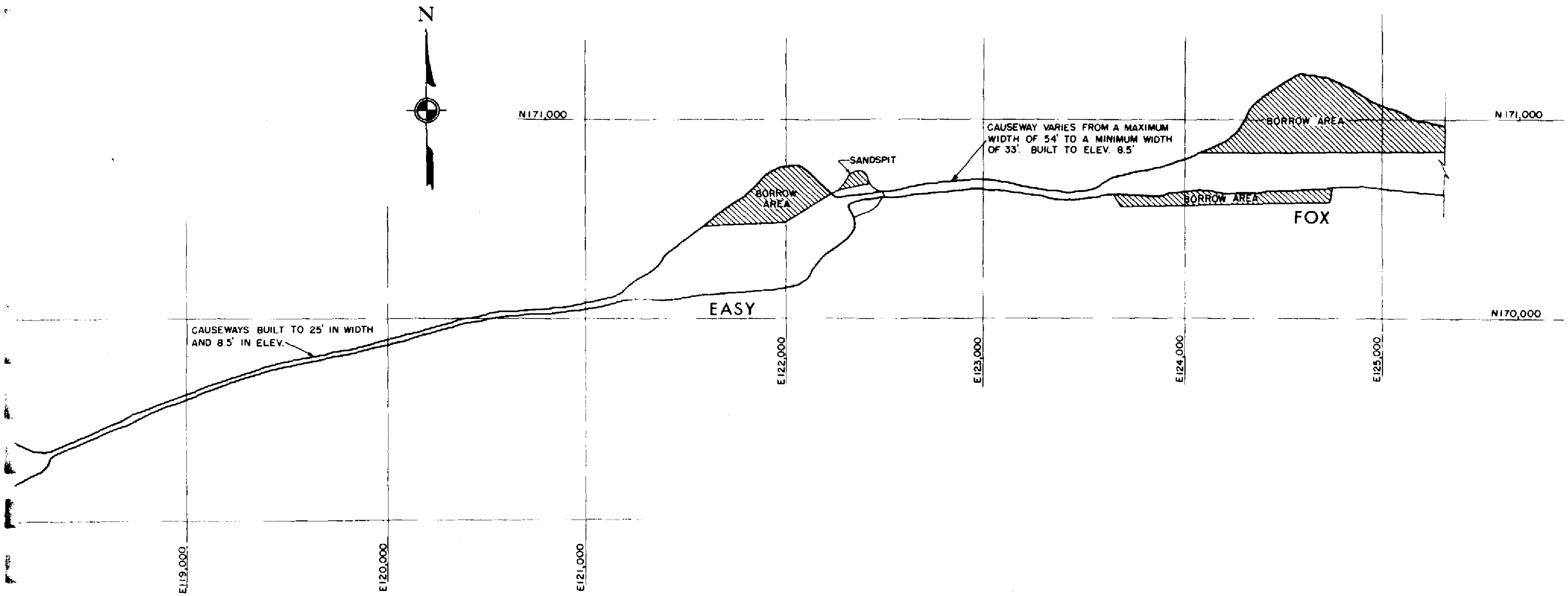
Causeway locations and approved borrow areas are shown on figure 2-215.

ENGINEERING. The Jobsite Engineering Division processed the necessary cost estimates and work orders, and in addition conducted hydrographic and locations surveys, inspection and test control on construction. An "as-built" location plan was prepared.

CONSTRUCTION. The three causeways involved were as follows: Dog to Easy, approximate length 3000 feet. Easy to Fox, approximate length 1200 feet. Fox to George, improvement of access via connecting reef only.

Available bank and reef coral was used, the surface being traffic compacted and stabilized with sea water. From late June 1953, when

Figure 2-214. Charlie Causeway - Tidal Damage



Causeway Location - Fox to Dog

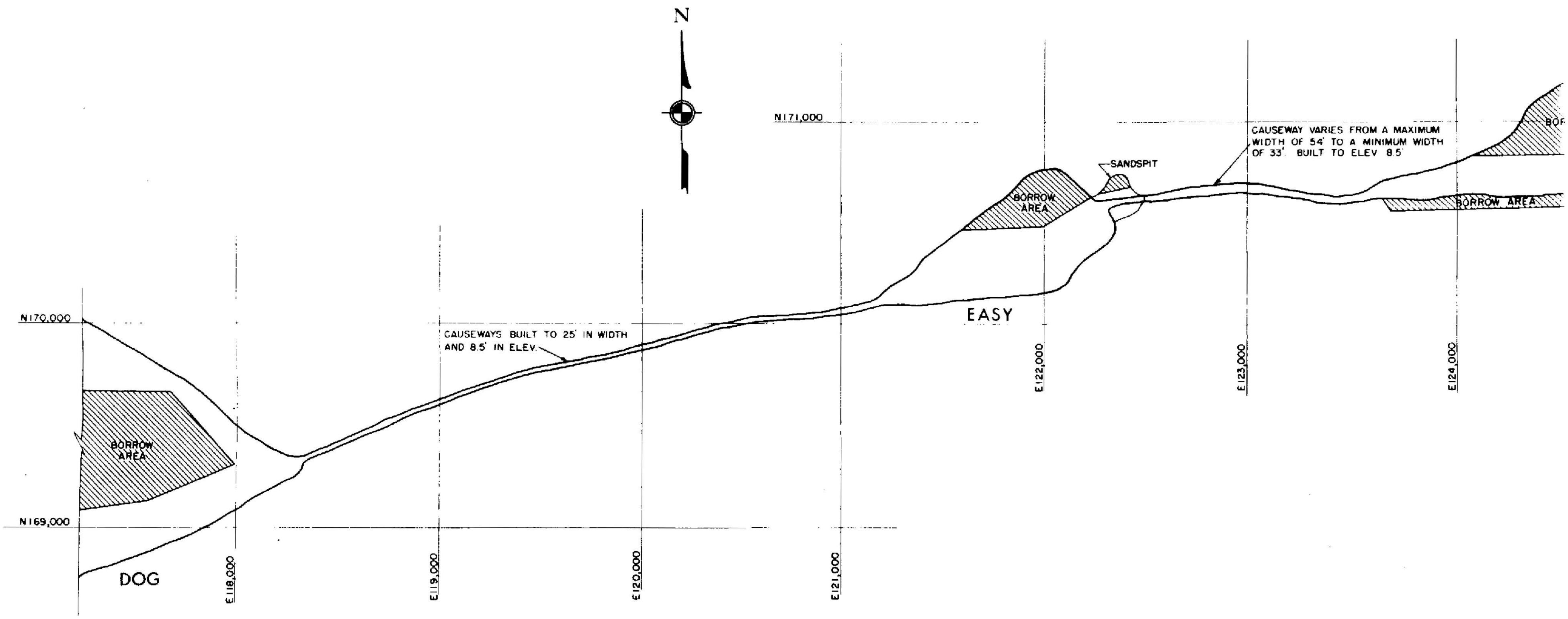


Figure 2-215. Causeway Location - Fox to Dog

Figure 2-216. Causeway - Fox to Easy

Figure 2-217. Causeway Location - Able to Delta

Figure 2-218. Able-Delta Causeway

first opened, until heavy construction started and traffic to and from the batch plant on Easy increased materially, single-lane roads were adequate. In August 1953 approval was obtained to widen these causeways to a minimum of 25 feet and to raise the elevation to plus 8.5 feet in order to minimize washouts at high tide. This latter work was accomplished on a fill-in basis, involving the least possible interference with the Scientific Program.

ABLE - DELTA CAUSEWAY

GENERAL. Shortly after site Charlie was selected for the Bravo experiment, a requirement developed for a camera bunker location 7500 feet distant from Station 20 at the end of the

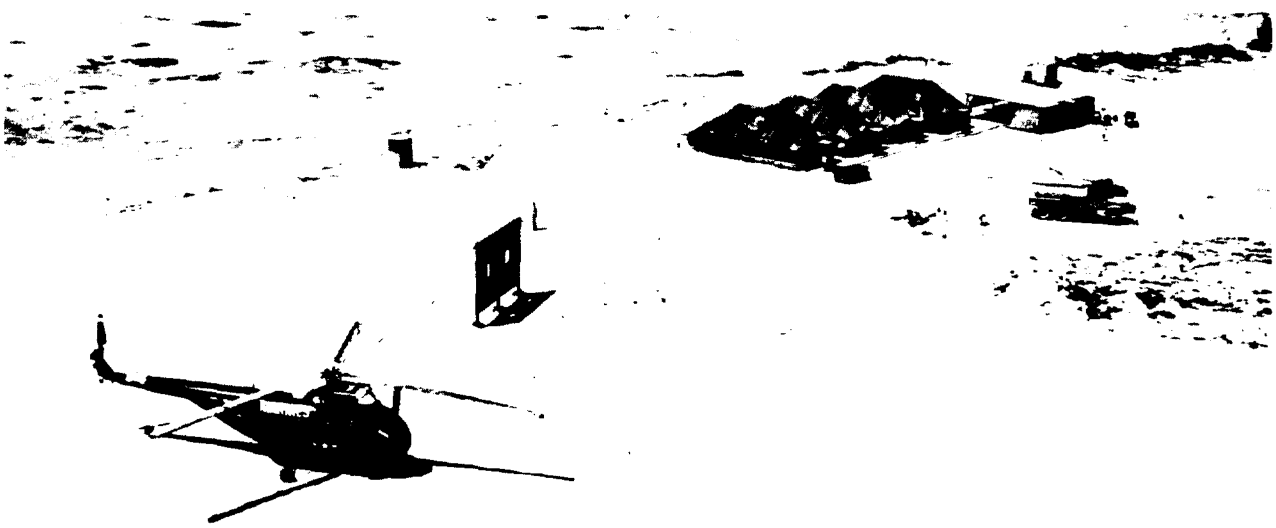


Figure 2-219. Temporary Camp at Able

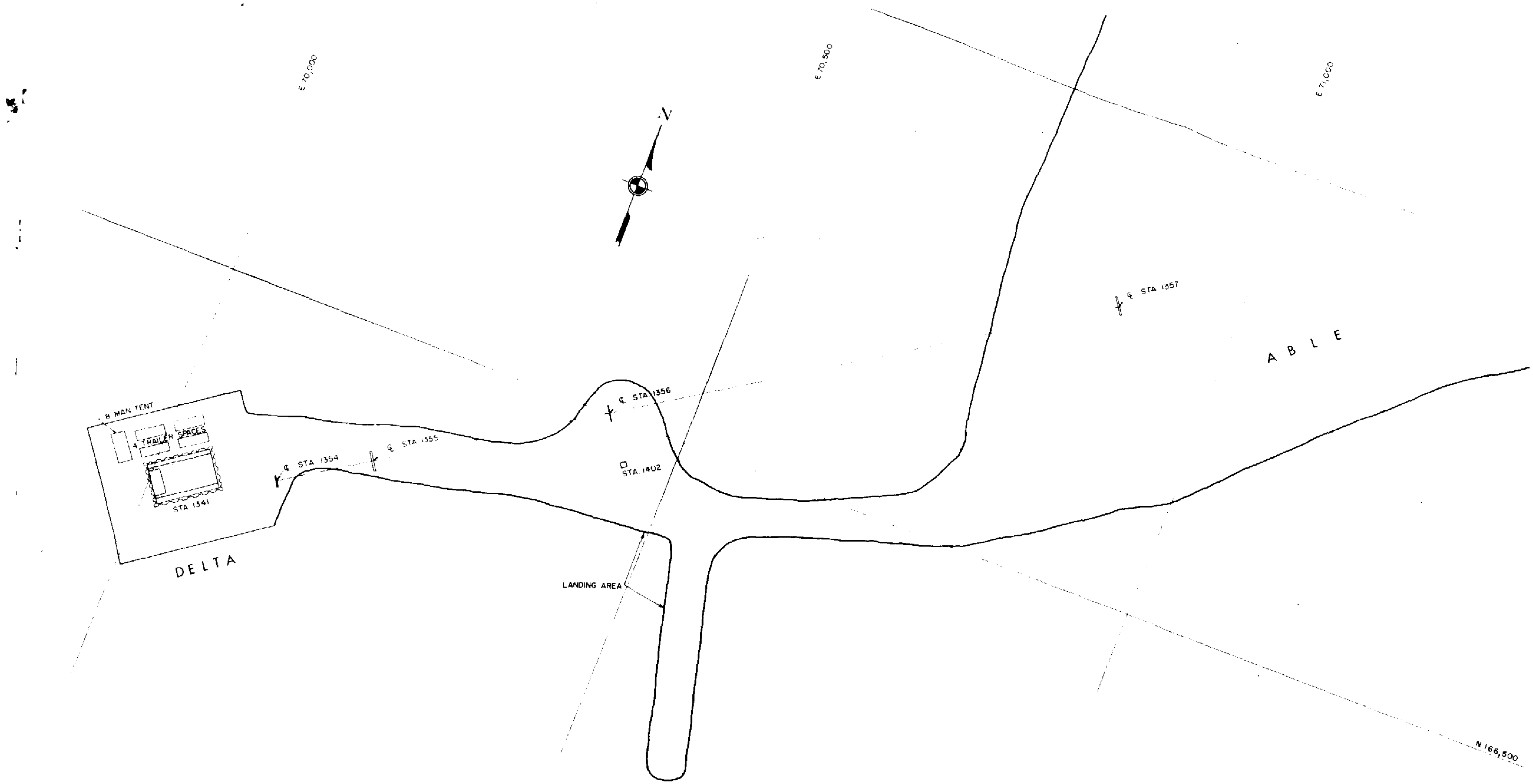
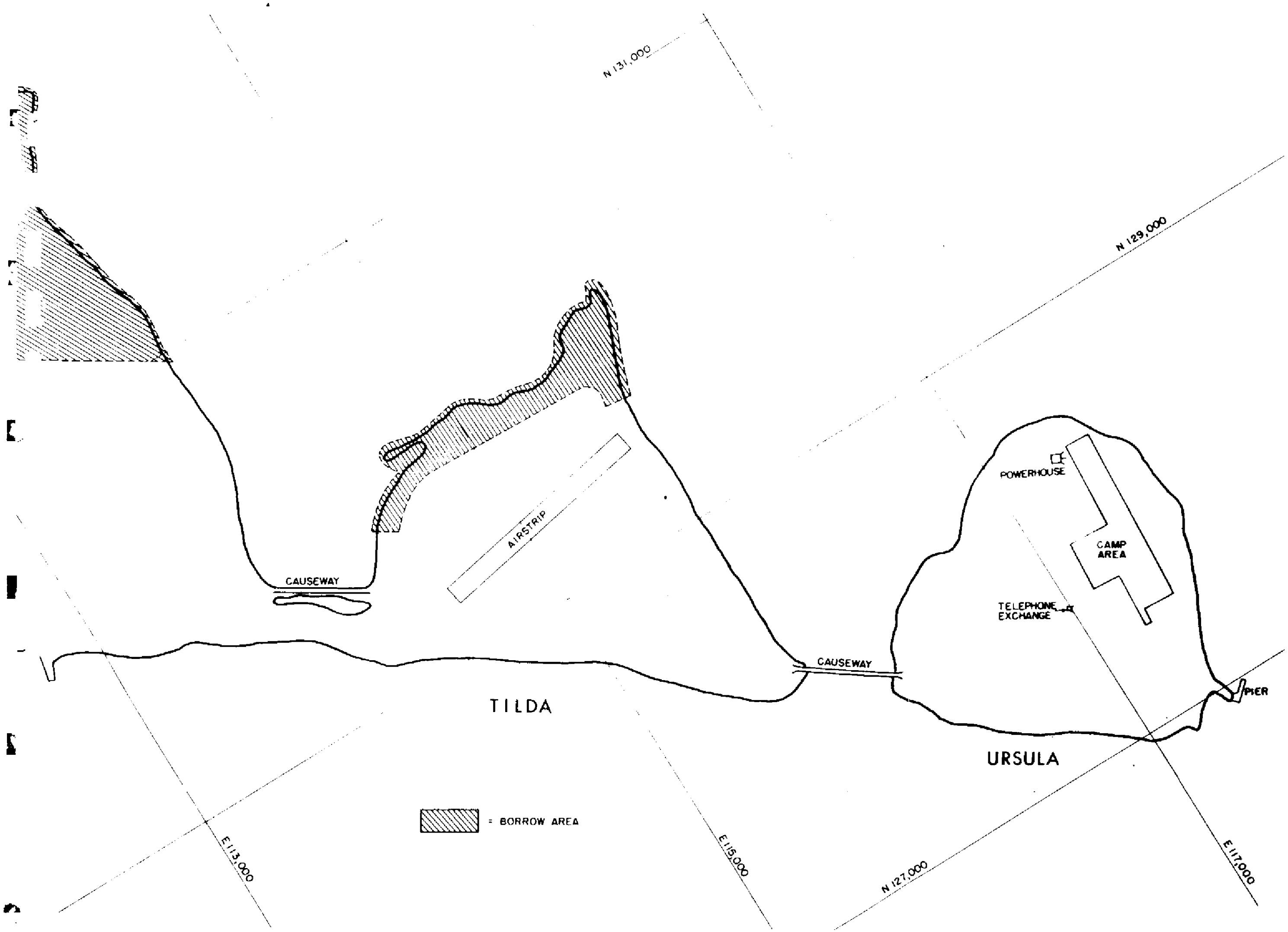


Figure 2-220. Able Delta Causeway


N 131,000
N 129,000
N 127,000
E 113,000
E 115,000
E 117,000
CAUSEWAY
AIRSTRIP
CAUSEWAY
POWERHOUSE
CAMP AREA
TELEPHONE EXCHANGE
PIER
TILDA
URSULA
= BORROW AREA

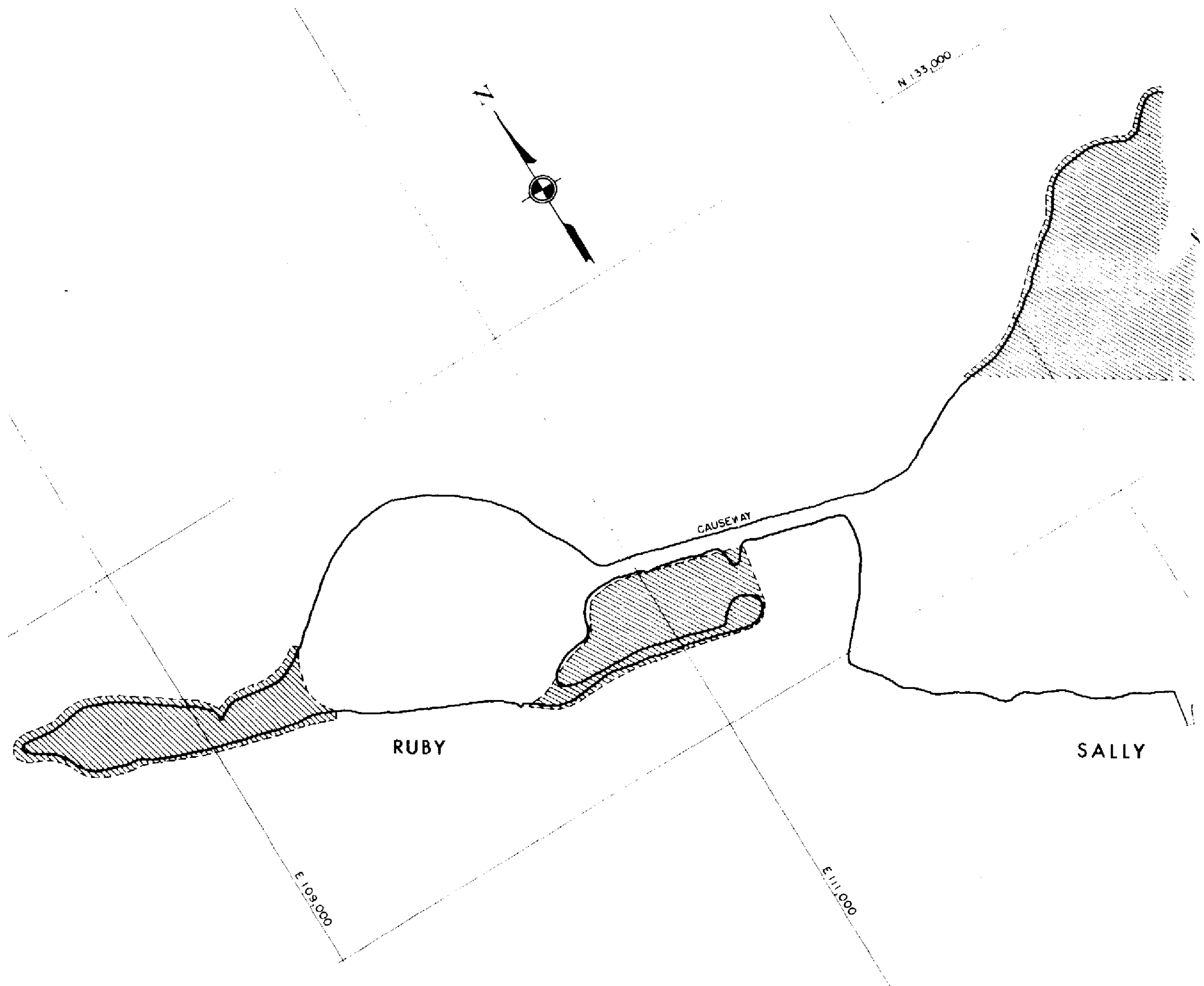


Figure 2-221. Causeway Location - Ruby to Ursula

Figure 2-222. Ruby to Sally Causeway - Primary Grading

Charlie pipeline causeway. To meet this requirement it was necessary to dredge the reef 700 feet west of site Able and provide a working area slightly over 0.5 acres in area at an elevation of plus 8.5 feet. This was known as site Delta. The causeway location is shown in Figure 2-220. Figures 2-217 and 2-218 note this site (Delta) and status of work on 12 August 1953. The development of site Delta, with progress photographs, is reported under Station 1341. Stations 1341, 1352, 1354, 1355, 1356, 1357, 1401, 1402, and a number of scientific tents and trailers were located within this area. The perimeter of the working area was bulkheaded with a three-inch thick timber bulkhead supported by 60-pound used rail driven on four-foot centers, without tie-backs. A mole for landing craft approximately 250 feet long, and a 25-foot wide access road connecting the working area with site Able were also provided.

ENGINEERING. The location was selected by Field Engineering on the basis of providing minimum construction cost; a detailed layout of facilities at this location was provided by the Home Office. Field Engineering processed the necessary work orders, surveys and inspection of construction.

CONSTRUCTION. The work of dredging began as a marine operation on 17 July 1953. Shortly thereafter, a field kitchen and several tents were set up on Able. This provided noon feeding facilities, which later developed into a small temporary camp for both construction and scientific personnel and minimized the time lost in commuting to and from the construction camp at site Charlie. Figure 2-219 shows this camp with a helicopter landing mat and status of work as of 5 February 1954. As of 26 September 1953 the causeway and work area were in use for Scientific Station construction. Final completion was on 17 October 1953.

RUBY - SALLY CAUSEWAY

GENERAL. In March 1953 it was established that a vacuum pipe array, approximately 2700 feet in length, would be required connecting a new station on site Ruby with a Station proposed for construction adjacent to an existing Station on site Sally. It proved possible to so locate the pipe array that, with minor widening only, an existing access road approximately 1000 feet long between Ruby and Sally could be used both as an access road and as a pipeline causeway.

ENGINEERING. Criteria for location of the pipeline and pipeline causeway were finalized in the Home Office in March 1953. The location was then reviewed in the Field to insure most effective utilization of the existing causeway. Drawings showing the causeway and pipeline layout were approved in May 1953. Field Engineering processed the necessary work orders, surveys and inspection of construction. Figure 2-221 shows the causeway location.

CONSTRUCTION. This causeway was approximately 60 feet wide and carried a pipe array with ten-foot wide supports, a 24-foot wide access road with safety shoulders, and rights-of-way for power, telephone and coaxial cables.

Placing of additional causeway fill was started late in July 1953 and completed early in August, ready for construction of the pipe array. Figures 2-222 and 2-223 show this work underway.

Figure 2-223. Ruby to Sally Causeway

During the storms of November 1953, high tide wave action caused considerable erosion of the causeway fill and threatened the pipe supports. On 9 December 1953 additional construction was approved for protection of this causeway. Work was started immediately and consisted of driving steel rails on four-foot centers, to an elevation of plus 10.0 feet, with three-inch by 12-inch planking laid horizontally behind the rails, then back filling with coral. This bulkheading was completed on 18 January 1954 and proved adequate.

GENE - IRENE CAUSEWAY

Figure 2-224 notes the conditions existing on the IVY Flora to Irene causeway prior to the CASTLE tests.

SECTION 7
INTERISLAND CABLES

CONTRACT ITEM A-29
BIKINI ATOLL

Experience gained during previous test operations with the installation, testing and repairing of submarine cables laid in deep water indicated that it would be more advantageous for future installations to lay cables in shallow water (20 to 30 feet). In checking cable No. 105 for OPERATION IVY, it was found fouled around a coral head in 200 feet of water and it could not be freed. As this depth of water was beyond allowable limit for deep sea diving operations at the Jobsite, the cable had to be cut at two widely separated points so that it could be brought to the surface. The two cut ends were then reconnected by splicing in additional cable to replace the lost section. In laying cables it was a far simpler operation to buoy the end of the cable in shallow water at the completion of the days work, than in deep water. When buoys were lost, the fact that the cable was laid in shallow water simplified recovery operations. The laying of cable in shallow water had the further decided advantage in eliminating the need for deep sea diving operat-

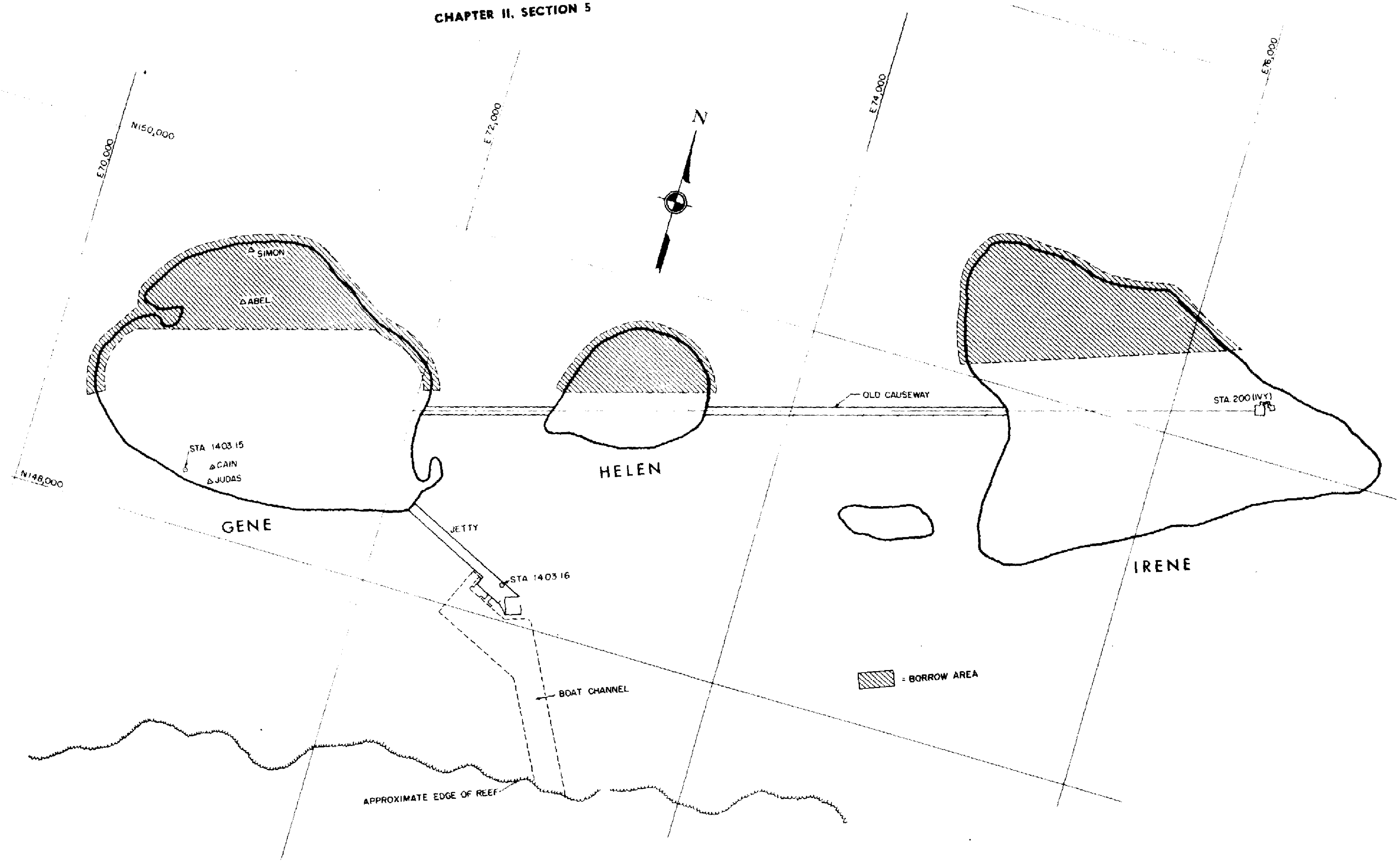


Figure 2-224. Causeway Location - Gene to Irene

ions, which by the very nature of this type of work are hazardous. This also resulted in economy of installation, testing and maintenance. For the foregoing reasons new submarine cables for OPERATION CASTLE were laid in shallow waters.

For OPERATION GREENHOUSE some cables from OPERATION SANDSTONE were utilized and for OPERATION IVY both SANDSTONE and GREENHOUSE cables were utilized. In a sense the submarine cable system at Eniwetok Atoll "grew" from a system originating with OPERATION SANDSTONE and resulted in providing for separate cables for telephone and signal or control circuits. In planning for OPERATION CASTLE at Bikini it was decided to provide for both telephone and signal or control circuits in one cable system. This required special splice boxes to provide inductive loading coils for the lines used for telephone trunking. However, the use of one cable for the combined circuits permitted a reduction of approximately 50% in cable requirements. The saving in cost of installation was directly proportional to the reduction in length of cable used.

At the request of the Manager, Eniwetok Field Office on 4 February 1953, inquiries were made as to the cost and delivery dates for 90 miles of 16 pair or 45 miles of 32 pair submarine cable. A review of the replies of the cable manufacturers indicated that a double system of 16 pair would cost 30% more than a single system of 32 pair, but that the delivery of the 16 pair cable could be made in time to assure completion within the desired schedule, whereas delivery of the 32 pair cable would be such as to delay the completion date. In addition, by using two cables of 16 pair in lieu of one of 32 pair cable more reliable "back up" circuits could be provided, as a break in a 32 pair cable in all probability would affect all 32 pair wires. This would also affect long term maintenance. In view of the foregoing reasons the Contractor recommended to the Manager, Eniwetok Field Office the use of the two systems of 16 pair cable in lieu of one of 32 pair cable.

The specifications prepared and approved for the system in March 1953 permitted the use of plastic insulated and jacketed cable as well as the conventional and more expensive

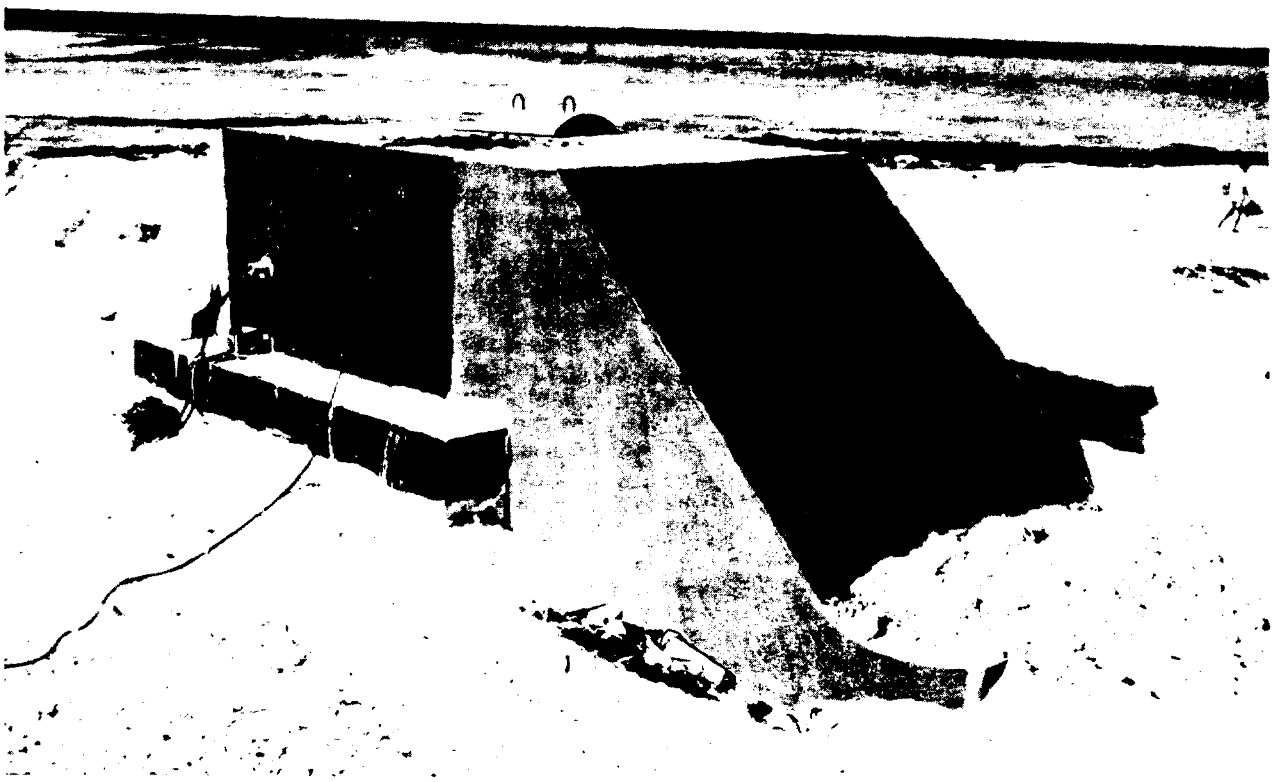


Figure 2-225. Submarine Terminal Station 3.3. Typical

paper insulated lead armored cable that had been used in previous installations. Due to the large amount of cable involved with relatively short delivery requirement, it became necessary to split the order, and approximately 85% of lead armored cable and 15% of plastic covered cable was ordered. As of 23 April 1953 when authorization was received to place the order, 775,000 lineal feet of 16 pair cable was required. Subsequently the deletion of Scientific Stations west of site Tare caused a reduction in these requirements, but the Contractor was authorized by the Manager, Eniwetok Field Office to accept delivery of the entire order so that it would be on hand for possible use at other locations then unknown. Drawings approved on 30 July 1953 indicated that all but 94,000 lineal feet would be required.

Another departure from previous test installations was the use of reinforced concrete vaults for housing submarine cable terminals. This cable system was designed for use with several successive tests. These vaults provided for protection against blast effects and a means for ready access to the terminal boxes. They had the further advantage of providing some protection from radioactive contamination for the employees required to work at the terminals between tests. These terminal structures proved entirely adequate as evidenced by the lack of damage after the various detonations and the few difficulties encountered in preparing the submarine cable system for each succeeding test.

These terminal vaults consisted of reinforced concrete buildings with a gravel floor and a 3′ x 3′ hatch opening. Stations ST 1.1 through 1.3 and ST 2.1 were 8′ x 8′ x 7′ high and projected 1′ - 0″ above grade. Stations ST 3.1 through 3.4 were 11′ x 11′ x 8′ high and projected 2′ - 6″ above grade. Earth fill was placed on a slope to the tops of the Stations. The location of Station ST 3.3 was on solid coral and the building was constructed on grade. Due to the anticipated high blast pressures, this necessitated the addition of buttresses to this Station which were embedded one-foot into the coral with the reinforcing steel of the buttresses embedded in holes drilled in the coral. This Station is shown in Figure 2-225. Each of these buildings was equipped with a watertight terminal box for the submarine cable ends and another watertight terminal for the termination of lead covered cables which were run underground to other Stations. Figure 2-226 shows a typical terminal Station with the foundation poured and the sides formed.

The system as finally installed consisted of 620,000 feet of 16 pair, 19 gauge submarine cable, running in a single system from site Able to Charlie, thence as a double system around the atoll to Oboe. From Oboe the circuits were completed to Tare via a 51 pair, 19 gauge underground cable. The reason for the use of 51 pair underground cable for this run was that the same cable could be used to provide the signal, control and telephone needs of all the islands between Tare and Oboe. This was a more economical installation than providing submarine cable from the control at Nan to Tare and separate cables for all other island needs. Three telephone buoys in the lagoon were connected to the Tare telephone exchange.

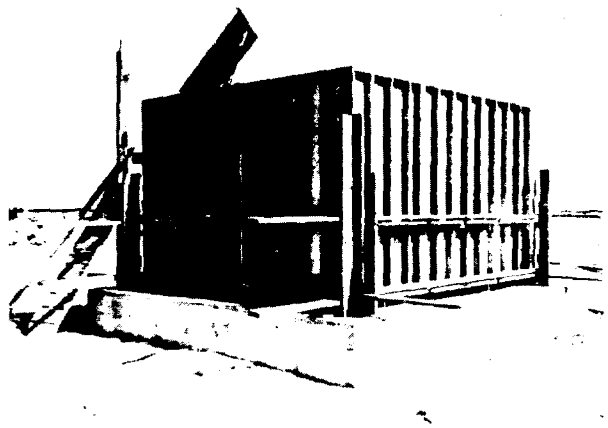


Figure 2-226. S. T. Station - 50% Completed Typical

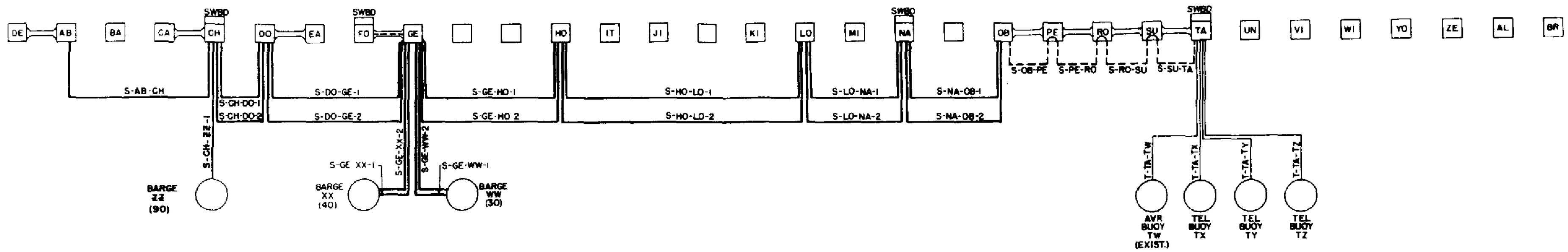
The signal, control and telephone cable system as finally completed is indicated in the Block diagram Figure 2-227.

The actual mechanics of laying of the cables were facilitated by fitting out an LCM as a cable laying and repair boat. The deck and bottom of this boat were reinforced, a gasoline engine driven winch was installed alongside the wheelhouse and four davits, each carrying a large sheave, were placed along one side of the boat. The cable reel was placed in a special cable dolly in the well deck of the boat, and the cable then run over the winch drum from where it was paid out as the boat moved forward. The cable was laid on a designated course so as to pass over the shortest distance in shallow water between the terminals. For the long run between Nan and Oboe requiring 65,874 feet of cable to be laid in fairly deep water, a helicopter was utilized for assistance in maintaining the proper course. Figure 2-229 shows men laying cable in shallow waters from a terminal station.

The changes effected in laying interisland cables for the CASTLE OPERATION are summarized as follows: (1) Cables were gener-

DESIG. JOB 884	DELTA	ABLE	BAKER	CAUSEWAY CHARLIE	CHARLIE	DOG	EASY	FOX	GEORGE			HOW	ITEM	JIG	
ISLAND NAME	-	BOKOBYA-ADAA	BOKON-EJIEN	NAMU	NAMU	YUROCHI	UORIKKU	ROMU-RIKKU	AOMOEN			BIKINI	BOKON-FUAAKU	YOMY-ARAN	
CABLE TERMINAL	STA. 1341	STA. 73.03			S.T. 3.1	S.T. 3.2			S.T. 3.3			S.T. 1.2			
TIMING STATION		STA. 73.03			STA. 73.01	STA. 75.01			STA. 76			STA. 75.02			
SWITCHBOARD					BD-89G			BD-89G							
TEL. EXCHANGE					BLDG.CH-7			BLDG.FO-30							

DESIG. JOB 884	KING	LOVE	MIKE	NAN		OBOE	PETER	ROGER	SUGAR	TARE	UNCLE	VICTOR	WILLIAM	YOKE	ZEBRA	ALFA	BRAVO
ISLAND NAME	ENIAIRO	ROCHI-KARAI	IONCHEBI	ENYU		AIRU-KIIJI	AIRU-KIRARU	BIGIREN	REERE	ENINMAN	ENI-IRIKKU	RUKOJI	CHIE-ERETE	ARRI-IKAN	OURU-KAEN	BOKOAE-TOKUTOKU	BOKORO-RYURU
CABLE TERMINAL		S.T. 1.3		S.T. 1.1		S.T. 2.1				BLDG. TA-23							
TIMING STATION				STA. 70		STA. 74				BLDG. TA-23							
SWITCHBOARD				KELLOGG 60 C.B. 10 MAG						KELLOGG 100 C.B. NO MAG							
TEL. EXCHANGE				STA. 70						BLDG. TA-23							



BLOCK DIAGRAM

SIGNAL CABLE DATA

CABLE NO.	CABLE LENGTH IN FEET	CABLE SIZE		LOADED PAIRS		NON LOADED PAIRS		FROM	TO	REMARKS
		PRS	GA	PR COUNT	NO. PRS	PR COUNT	NO. PRS			
S-AB-CH	15,720	16	19	1-6	6	7-16	10	AB	CH	
S-CH-DO-1	45,540	16	19	1-11	11	12-16	5	CH	DO	
S-CH-DO-2	45,540	16	19	1-11	11	12-16	5	CH	DO	
S-DO-GE-1	16,150	16	19	1-11	11	12-16	5	DO	GE	
S-DO-GE-2	16,150	16	19	1-11	11	12-16	5	DO	GE	
S-GE-WW-1	15,500	16	19	1-11	11	12-16	5	GE	WW	
S-GE-WW-2	15,500	16	19	1-11	11	12-16	5	GE	WW	
S-GE-HO-1	63,494	16	19	1-11	11	12-16	5	GE	HO	
S-GE-HO-2	63,494	16	19	1-11	11	12-16	5	GE	HO	
S-HO-LO-1	25,158	16	19	1-11	11	12-16	5	HO	LO	
S-HO-LO-2	25,158	16	19	1-11	11	12-16	5	HO	LO	
S-LO-NA-1	22,931	16	19	1-11	11	12-16	5	LO	NA	
S-LO-NA-2	22,931	16	19	1-11	11	12-16	5	LO	NA	
S-NA-OB-1	65,874	16	19	1-11	11	12-16	5	NA	OB	
S-NA-OB-2	65,874	16	19	1-11	11	12-16	5	NA	OB	
S-OB-PE	4,792	51	19			1-51	51	OB	PE	
S-PE-RO	7,140	51	19			1-51	51	PE	RO	
S-RO-SU	3,593	51	19			1-51	51	RO	SU	
S-SU-TA	4,792	51	19			1-51	51	SU	TA	
T-TA-TW	3,450	6	19			1-6	6	TA	TW	FIELD INSTALLED
T-TA-TX	6,000	6	19			1-6	6	TA	TX	
T-TA-TY	8,600	6	19			1-6	6	TA	TY	
T-TA-TZ	5,200	6	19			1-6	6	TA	TZ	
S-CH-ZZ-1	7,000	16	19	1-11	11	12-16	5	CH	ZZ	
S-GE-XX-1	15,500	16	19	1-6	6	7-16	10	GE	XX	
S-GE-XX-2	15,500	16	19	1-6	6	7-16	10	GE	XX	

CABLE LENGTHS ABOVE ARE SCALED DISTANCES + 15%

LEGEND

- 6 PR-19 GA SUBMARINE SIGNAL CABLE NON-LOADED
- [illegible] PR-19 GA SUBMARINE SIGNAL CABLE LOADED
- 51 PR-19 GA DIRECT BURIAL SIGNAL CABLE NON LOADED
- ISLANDS CONNECTED WITH CAUSEWAY

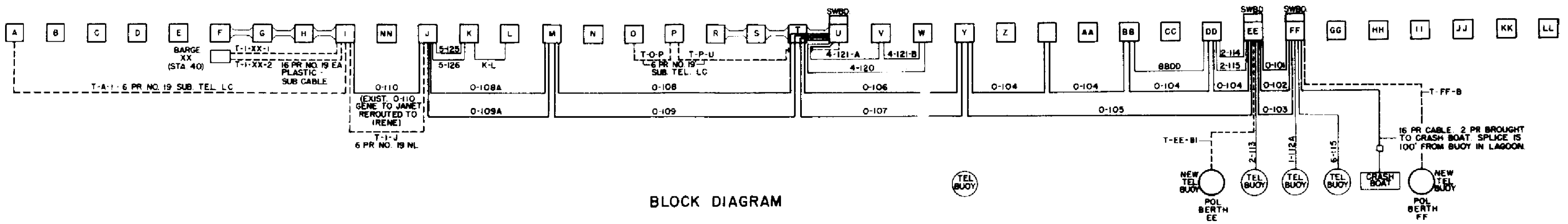
Figure 2-227. Bikini Signal Block System Diagram

DESIG. JOB 884	ALICE	BELLE	CLARA	DAISY	EDNA	FLORA	GENE	HELEN	IRENE
IVY DESIGNATION	ALICE	BELLE	CLARA	DAISY	EDNA	FLORA	GENE	HELEN	IRENE
GREENHOUSE DESIG.	F	U					Q		W
ISLAND NAME	BOGAL-LUA	BOGOM-BOGO	RUCHI	COCHITI	SANIL-DEFENSO	ELUG-ELAB	TEITEIR-IPUCCHI	BOGA-IRIKK	BOGON
CABLE TERMINAL	STA.73.02								S.T. 3.4
TEL EXCHANGE									
SWITCHBOARD									
EXIST PR TO									
REROUTED PR TO	OL,5NL								12L,14NL
PROPOSE PR TO	(1) 6 PR 4L, 2NL					(2) 16 PR 12L,20NL			OL,6NL
TOTAL PR TO	4L, 7NL					12L,20NL			12L,20NL
PR NEEDED TO	OL, 7NL					3L,17NL			3L,19NL

DESIG. JOB 884	NOAH	JANET	KATE	LUCY	MARY	NANCY	OLIVE	PEARL	RUBY	SALLY
IVY DESIGNATION	NOAH	JANET	KATE	LUCY	MARY	NANCY	OLIVE	PEARL	RUBY	SALLY
GREENHOUSE DESIG.		E	S	T	P				V	D
ISLAND NAME		ENGEBI	MUZIN	KIRINIAN	BOKONA-ARAPPU	YEIRI	AITSU	RUJORU	EBERIRU	AOMON
CABLE TERMINAL		STA. 72.01 EXIST. 69			ST 4.1		STA.103	FST		
TEL EXCHANGE										
SWITCHBOARD										
EXIST PR TO		23L,28NL	12NL	6NL						
REROUTED PR TO										
PROPOSE PR TO							6NL	6NL		
TOTAL PR TO		22L,25NL	12NL	6NL						
PR NEEDED TO		5L,20NL								

DESIG. JOB 884	TILDA	URSULA	VERA	WILMA	YVONNE	ZONA	SAND	ALVIN	BRUCE	CLYDE
IVY DESIGNATION	TILDA	URSULA	VERA	WILMA	YVONNE	ZONA		ALVIN	BRUCE	CLYDE
GREENHOUSE DESIG.	D	D	R	N	C	M			K	
ISLAND NAME	BIJIRI	ROJOA	AARAAN-SIRU	PIIRAAI	RUNIT	"M"		CHINI-EERO	ANI-YAANII	CHINIMI
CABLE TERMINAL		STA.72.02 EXIST. 69			STA.72.03 EXIST. 69		FST		FST	
TEL EXCHANGE		STA.72.02 EXIST. 69								
SWITCHBOARD		NO. 6								
EXIST PR TO	24L,27NL				22L,25NL					
REROUTED PR TO										
PROPOSE PR TO										
TOTAL PR TO	22L,25NL				22L,25NL					
PR NEEDED TO	5L,20NL				5L,20NL					

DESIG. JOB 884	DAVID	ELMER	FRED	GLENN	HENRY	IRWIN	JAMES	KEITH	LEROY
IVY DESIGNATION	DAVID	ELMER	FRED	GLENN	HENRY	IRWIN	JAMES	KEITH	LEROY
GREENHOUSE DESIG.	L	B	A	Z					
ISLAND NAME	JAPTAN	PARRY	ENI-WETOK	IGURIN	MUI	POKON	RIBAION	GIRI-INIEN	RIGILI
CABLE TERMINAL	FST								
TEL EXCHANGE		BLDG.206							
SWITCHBOARD		NO. 1	NO. 2						
EXIST PR TO			36L,10NL						
REROUTED PR TO									
PROPOSE PR TO									
TOTAL PR TO									
PR NEEDED TO									



BLOCK DIAGRAM

EXISTING SUBMARINE TELEPHONE CABLE DATA

CABLE NO.	LENGTH IN FEET	CABLE SIZE		LOADED PAIRS		NON LOADED PAIRS		FROM	TO	USABLE PAIRS	
		PRS	GA	PR COUNT	NO. PRS	PR COUNT	NO. PRS			L	NL
0-101	23,640	16	19	1-12	12	13-16	4	EE	FF	12	3
0-102	24,960	16	19	1-12	12	13-16	4	EE	FF	12	4
0-103	22,980	16	19	1-12	12	13-16	4	EE	FF	12	3
0-104	19,120	16	19	1-12	12	13-16	4	EE	DD	12	4
0-104	17,600	16	19	1-12	12	13-16	4	DD	BB	12	4
0-104	12,629	16	19	1-12	12	13-16	4	BB	SAND	12	4
0-104	35,590	16	19	1-12	12	13-16	4	SAND	Y	11	4
0-105	54,022	16	19	1-12	12	13-16	4	EE	Y	11	3
0-106	40,140	16	19	1-12	12	13-16	4	Y	U	12	4
0-107	42,000	16	19	1-12	12	13-16	4	Y	U	12	3
0-108	30,432	16	19	1-12	12	13-16	4	U	M	12	4
0-108A	26,670	16	19	1-12	12	13-16	4	M	J	11	4
0-109	30,552	16	19	1-12	12	13-16	4	U	M	12	4
0-109A	26,670	16	19	1-12	12	13-16	4	M	J	12	4
1-112A	9,544	6	19					FF	TEL. BUOY		5
2-113	8,653	5	14					EE	TEL. BUOY		5
2-114	15,300	6	19					EE	DD		6
2-115	15,180	6	19					EE	DD		6
8BDD	17,600	6	19					DD	BB		6
4-120	12,672	6	19					U	W		6
4-121A	6,360	6	19					U	V		6
4-121B	9,960	6	19					V	W		6
6-115	5,740	6	19					FF	TEL BUOY		6
CRASH BOAT	1,250	16	19	1-12	12	13-16	4	FF	CRASH BOAT	2	
0-110	14,100	16	19	1-12	12	13-16	4	I	J	12	4
5-125	6,960	6	19			1-6	6	J	K		6
5-126	9,000	6	19			1-6	6	J	K		6
K-L	2,800	6	19			1-6	6	K	L		6

NEW TELEPHONE CABLE DATA (+ 15% ADDED)

CABLE NO.	LENGTH IN FEET	CABLE SIZE		TYPE	LOADED PAIRS		NON LOADED PAIRS		FROM	TO	REMARKS
		PRS	GA		PR COUNT	NO. PRS	PR COUNT	NO. PRS			
T-EE-B1	1,050	6	19	SUBMARINE			1-6	6	EE	B1	POL BUOY - EE
T-FF-B2	1,625	6	19	SUBMARINE			1-6	6	FF	B2	POL BUOY - FF
T-A-1	32,400	6	19	SUBMARINE	1-4	4	5-6	2	A	I	NEW CABLE
T-I-XX-1	10,100	16	19	PLASTIC	1-6	6	7-16	10	I	XX	BARGE CABLE
T-I-XX-2	10,100	16	19	PLASTIC	1-6	6	7-16	10	I	XX	BARGE CABLE
T-O-P	5,200	6	19	SUBMARINE			1-6	6	O	P	
T-P-U	14,800	6	19	SUBMARINE			1-6	6	P	U	
T-I-J	14,100	6	19	SUBMARINE			1-6	6	I	J	

EXISTING TELEPHONE SWITCHBOARDS

NO.	LOCATION	DESCRIPTION	COMMON BATTERY POSITIONS	MAGNETIC POSITIONS
1	EXISTING ON ELMER	KELLOGG MASTERBUILT JUNIOR TWO POSITION SWITCHBOARD	220	30
2	EXISTING ON FRED	KELLOGG MASTERBUILT JUNIOR TWO POSITION SWITCHBOARD	230	30
3	EXISTING ON TARE	KELLOGG MASTERBUILT JUNIOR SINGLE POSITION SWITCHBOARD	60	10
4	IN ELMER STOCK TO BE LOCATED ON NAN	KELLOGG MASTERBUILT JUNIOR SINGLE POSITION SWITCHBOARD	60	10
5	IN EE STOCK - PROPOSE TO LOCATE AT EE EXCHANGE	KELLOGG K-100 JUNIOR PBX SWITCHBOARD	100	–
6	EXISTING ON URSULA	KELLOGG MASTERBUILT SINGLE POSITION SWITCHBOARD	60	10

LEGEND

- ——— 16 PR - 19 GA SUBMARINE TELEPHONE CABLE, 12 PR LOADED
- ——— 6 PR - 19 GA SUBMARINE TELEPHONE CABLE, NOT LOADED
- - - - NEW TELEPHONE CABLE - SIZE AND TYPE AS NOTED
- ISLANDS CONNECTED WITH CAUSEWAY
- NL NOT LOADED
- L LOADED
- FST CABLE TERMINAL

Figure 2-228. Eniwetok Telephone Block System Diagram

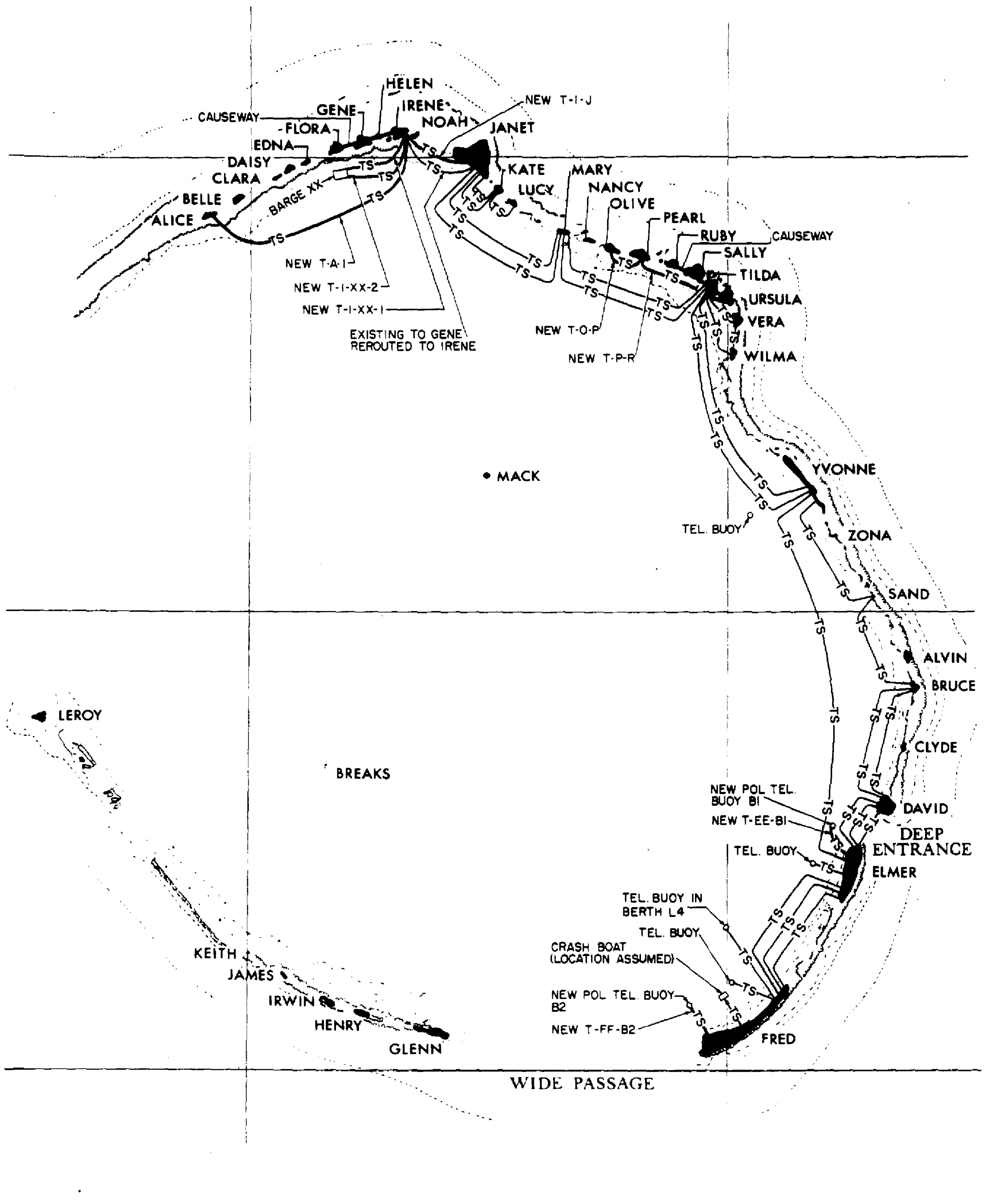


Figure 2-228A. Telephone Cable Layout - Eniwetok Atoll

Figure 2-229. Men Laying Submarine Cables on Reefs

ally laid in shallow water instead of deep water. (2) Single systems were used for telephone and signal or control instead of the dual systems used formerly. (3) Concrete terminal housing was provided for protective purposes. Figure 2-230 notes typical Station completed with earth

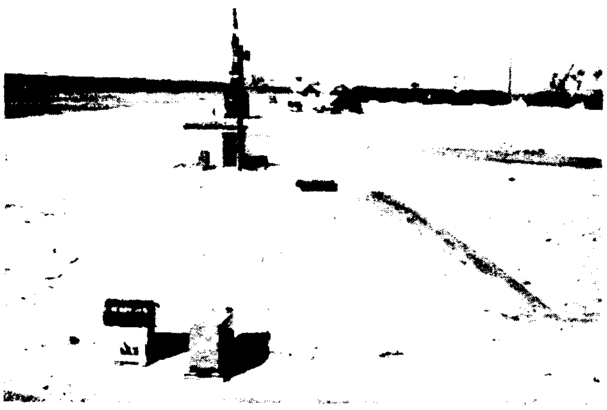


Figure 2-200. S. T. Station - Completed Typical

covering. (4) Plastic insulated and jacketed cable was used in addition to lead armored cable. (5) The mechanics of laying cable were simplified by use of a specially fitted cable-laying boat.

Difficulty was experienced in failure of the submarine signal cable terminal connection on Station 90 when this Station was moored in the Station 20 crater. This was caused by excessive pull of the cable on the terminal connections. The cable was originally laid in the form of a catenary from the lagoon bottom to the barge terminal. Due to the heavy seas prevailing there was some movement of the barge and a shifting of the crater bottom causing a tightening of the catenary with the resultant excessive strain on the terminal connections. This condition was rectified by re-laying the cable with sufficient length so that it laid entirely on the bottom from the terminal on shore to directly under the barge, at which point considerable slack was provided. Cable basket clamps were then used to secure the cable to the barge and thereby relieve the strain from the terminal connections.

The submarine cable for Station 30 was laid to its approximate terminal location in the lagoon and buoyed prior to the BRAVO event, as Station 30 was scheduled to be used after this event. But due to the unexpected results of the BRAVO detonation the ROMEO test (Station 90) was next fired in the Charlie crater. As a result of this detonation the buoy marking Station 30 cable sank and the cable was considerably damaged. It was necessary to renew approximately 6,000 feet of this cable to prepare Station 30 for use.

ENIWETOK ATOLL

A dual interisland cable system for telephone and signal or control circuits had been laid for previous test Operations in Eniwetok Atoll and it was necessary only to adapt these systems to the needs of OPERATION CASTLE. Routine testing of these cables had revealed that as a result of the MIKE detonation of the IVY OPERATION the cables leading westward from Janet to Gene and from Janet to Alice were damaged. However, there was sufficient usable cable, both telephone and signal, in the Janet - Gene line to permit re-routing this line from Janet to Irene as required for CASTLE OPERATION. The line to site Alice was re-routed to site Belle. To accomplish this it was necessary to splice in approximately 1000 feet of cable to replace the damaged portion. At sites Irene and Mary terminal housing in concrete vaults was provided which was similar to that used for the Bikini installation. This provided protection against blast effects and a means of ready access for all terminals except the one on site Belle which was considered expendable.

The telephone submarine cable system and the signal and control systems at Eniwetok Atoll as modified for OPERATION CASTLE are indicated in Figure 2-228 and Figure 4-13 (Chapter IV) respectively.

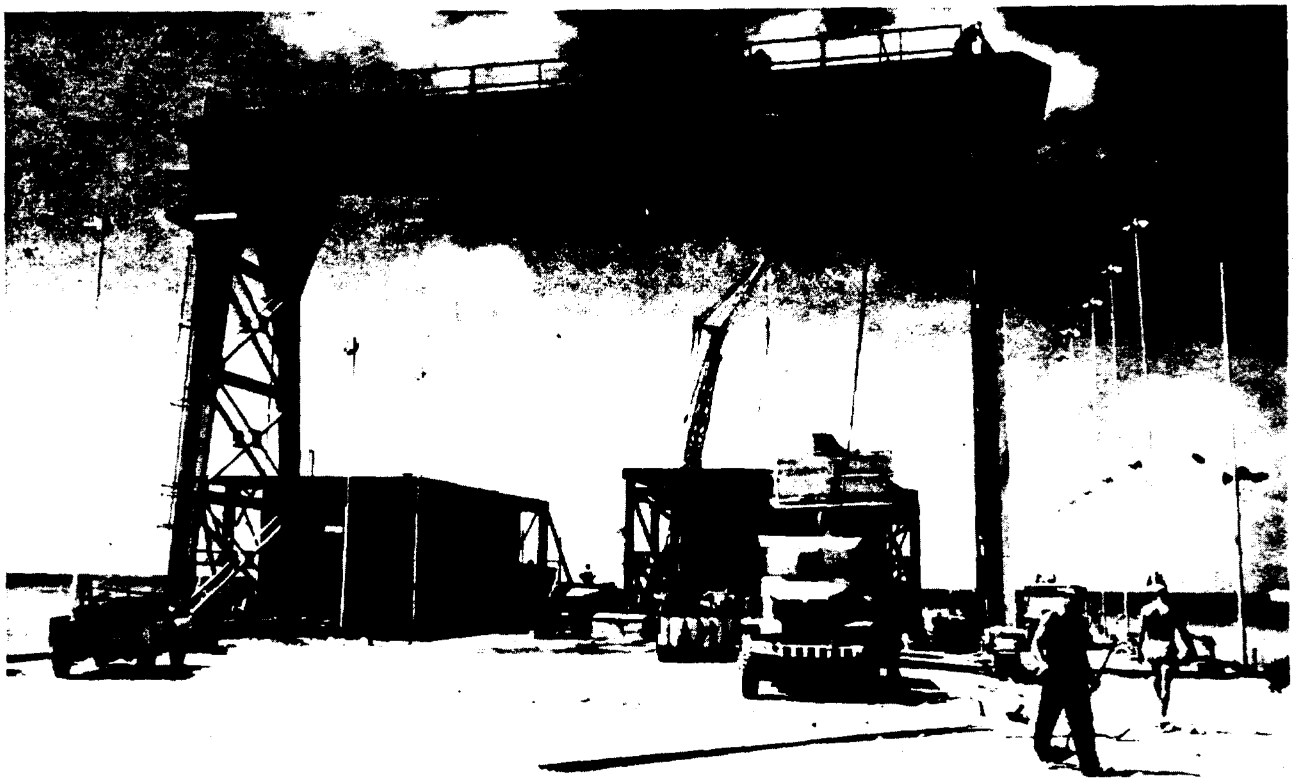


Figure 2-231. 25 Ton Gantry Crane - Barge Slip - Assembly Area - Site Elmer

Figure 2-232. Engineering Field Office - Site Elmer

CHAPTER III
MANAGEMENT AND ADMINISTRATION

SECTION I
MANAGEMENT

The Holmes & Narver General Manager, through the Heads of five Home Office Departments supervised and executed Contract Obligations. The Home Office Organization Chart, Figure 3-1, shows this managerial arrangement, which was precisely planned to assure coordination between such relevant functions as research, design, construction, accounting, procurement and security.

In any operation of this magnitude, a large part of the work is experimental, and when the site of operations is isolated from all normal sources of supply, both personnel and material, certain inherent difficulties must be considered at the outset. Management planning was based on the realization that these difficulties would be minimized by maintaining close liaison with the Commission, the Jobsite, and the Home Office. Close liaison was likewise essential between the various participants, including Military, Scientific, and transportation agencies. Examples of the essential inter-relation between the H&N Management and other agencies are borne out in the manner in which overseas communications and transportation of men and materiel were handled.

Transportation activities were closely coordinated through a system of advance estimates which were periodically revised to meet changing conditions. The Contractor's representatives at Travis Air Force Base, the Naval Supply Center in Oakland, and at Hickam Field in Honolulu were in close contact with Task Group representatives as well as with shipping agency officials.

This closely integrated liaison greatly assisted in the orderly flow of air freight shipments which, at times, far exceeded advance estimates, particularly in those instances where last-minute revisions in Scientific Stations required the expeditious supply of material, the requirements for which had not been previously indicated.

In addition to the close liaison maintained by Management, Home Office supervisory personnel were alerted to the need for the immediate transmission of information to the field forces at the Proving Ground. Critical information was normally transmitted via teletype over Military networks or by AEC teletype circuits; less critical information was sent by written memorandums.

Discussions were the most beneficial media for the maintenance of complete understanding of developments and criteria constantly undergoing revision, and were an organizational policy established near the close of OPERATION IVY, and continued throughout OPERATION CASTLE, i. e., the rotational assignments of certain supervisory personnel between the Jobsite and Home Office. It was found that an interchange of key individuals in these categories (at approximately three-month intervals) broadened their knowledge of the over-all job relevant to current developments in the Continental United States, and minimized the fatigue which occurred after prolonged duty at the Proving Ground.

The Contract made provisions for the widest possible latitude to the Commission in the scope and location of work. As the engineering and construction work progressed, various modifications to the Contract were received. New items were added, others were increased in scope, and still others were reduced or deleted entirely. Modifications to certain Scientific Stations presented particular difficulties because of the short period of time allocated for their completion. While some of these modifications were not unexpected by Management, they imposed frequent changes in the distribution of supervisory personnel at the Jobsite, and in some cases in the Home Office as well, particularly in such functions as purchasing, expediting, and transportation.

The General Manager delegated to the Manager of Construction-Operations the authority to coordinate all activities affecting the construction and operation of all features of the project. The Chief of Operations in the Home Office represented the overseas Project Manager in coordinating the various Home Office departments in matters pertaining to Jobsite operations. Part of this coordinating activity included the summarizing of all information necessary for scheduling design, procurement, and construction in order to meet the Commission's program requirements.

After schedules were formulated, they were checked frequently against various reports and appropriate purchase orders to determine which items would require special handling to meet completion dates. Inventories and long supply reports were checked for the possible substitution or interchangeability of items, or for determining the need for a change in stock levels. The Chief of Operations was also responsible for the issuance of all requisitions based on advance material estimates and bills of materials as furnished by Engineering, plus those items ordered by the field forces. All requisitions were checked to ascertain that the materials on order were justifiable and that such items were being purchased in accordance with Commission and Contractor policies.

The Project Engineer was in charge of all engineering phases of the project, such as funneling the engineering requirements into the proper channels within the H&N organization, and acting as final source of engineering information for both AEC and H&N management personnel. He specified the materials and equipment to be incorporated into structures and systems, except minor items normally carried in stock or items required for construction which were designed and built in the field.

The Project Manager, assisted by the Resident Manager, supervised operations in the field, including the maintenance of all PPG facilities. Since this entailed a busy schedule for these two men, and due to concurrent operations being performed on two widely-separated atolls, an Assistant Resident Manager was assigned for Bikini Atoll. The supervision for all this activity was controlled through six division heads, shown in the Jobsite Organization Chart, Figure 3-2.

Detailed description of the mechanics of administrative control covering the Accounting, Estimating, Industrial Relations, Procurement, Security, and Office Service Departments is related in succeeding sections of this chapter.

SECTION 2
ACCOUNTING

For accounting purposes, Operation IVY ended on 31 December 1952, and Operation CASTLE was initiated on 1 January 1953.

The terms and conditions of Contract AT-(29-2)-20, Article VIII, detailed the Accounting Department's requirements and responsibilities. Briefly, these terms and conditions decreed that accounting records, books of account, system of accounting, internal control, and auditing were to conform to generally accepted principles which were satisfactory to the Commission, and that the Contractor would furnish reports and financial statements as the Commission required.

Due to geographic separation, it was necessary to divide the Accounting Section into two groups - Home Office and Jobsite. Jobsite accounting operations were administered by the Resident Controller, who reported to the Project Manager, but were carried out in accordance with the basic accounting policies established and issued by the Home Office Controller. The field office prepared and audited all basic timekeeping, cost distribution data, material issues, token payments, travel advances, cashiering, inventory records, etc., for transmittal to the Home Office.

Except for revisions and additional reports required by the Commission, the accounting statements and reports were submitted and records were maintained throughout Operation CASTLE in accordance with the applicable requirements of the USAEC Controller's Manual. Functional accounting activities in the Home Office were segregated as shown by the following headings.

BUDGETS. Fiscal-year budgeting operations commenced approximately sixteen months prior to the beginning of the fiscal year when a general scope of operations and the estimated costs were outlined. As various budget factors became more firm, changes were written into the original outline. Refinement of plans, based on decisions of the Commission, were forwarded to the Budget Section for recording and coordination.

Approximately three months prior to the beginning of a fiscal year, the AEC Field Manager's office requested detailed explanations of the intended application of funds estimated for each operational phase. Approximately fifty individual items were involved, each covering a particular scope. At this time, the needs and requests of Holmes & Narver divisions responsible for Contract performance were correlated and interpolated into the respective monetary requirements of the AEC budget format. After being reviewed by the Commission, the Holmes & Narver budget presentation became an approved finance plan. This plan constituted the monetary framework within which operational costs had to be contained, and the Budget Section reviewed constantly all costs to ascertain that budgeted amounts were not being exceeded. In the event costs approached budgeted max-

HOLMES & NARVER, INC.

ENGINEERS CONSTRUCTORS

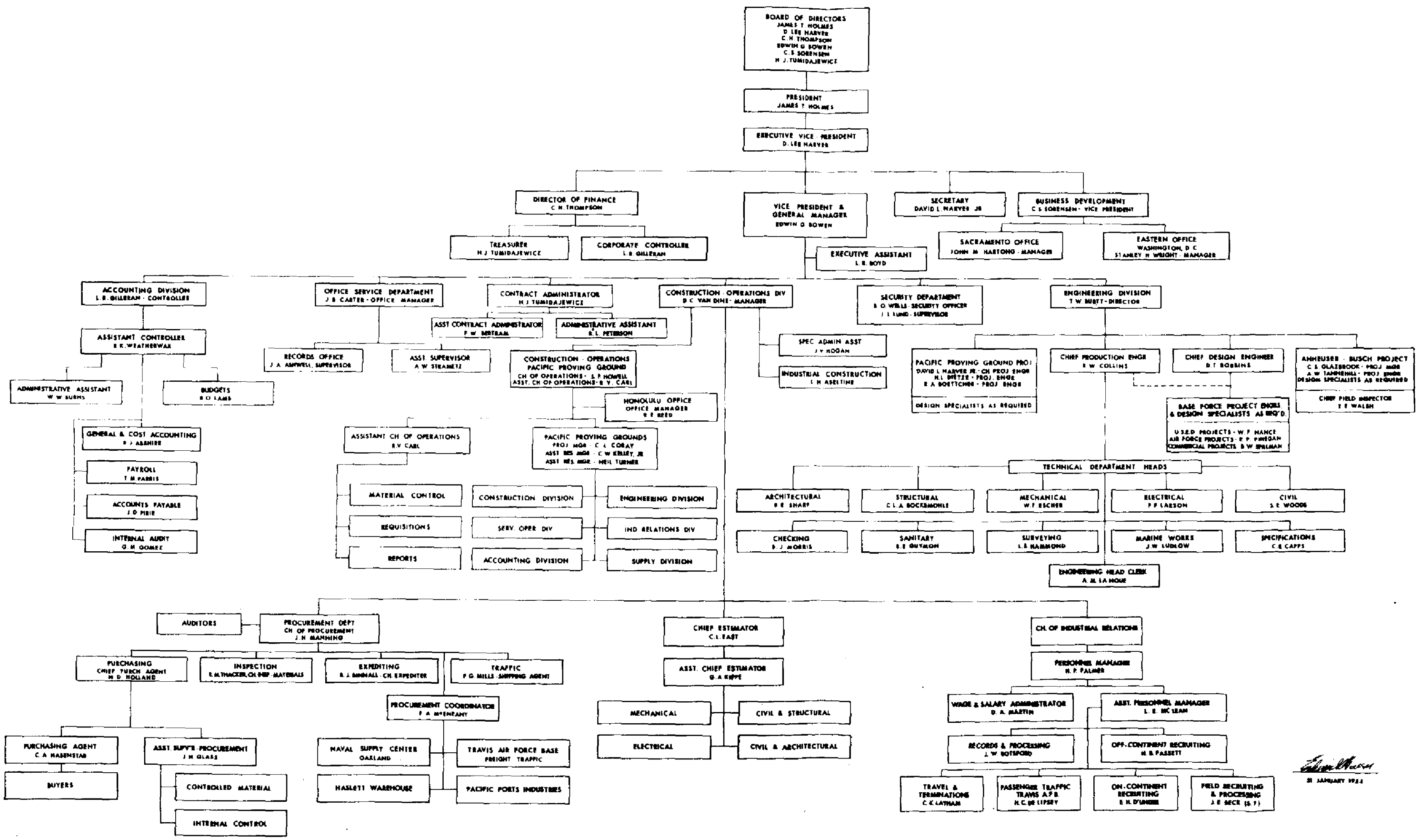


Figure 3-1. Home Office Organization Chart

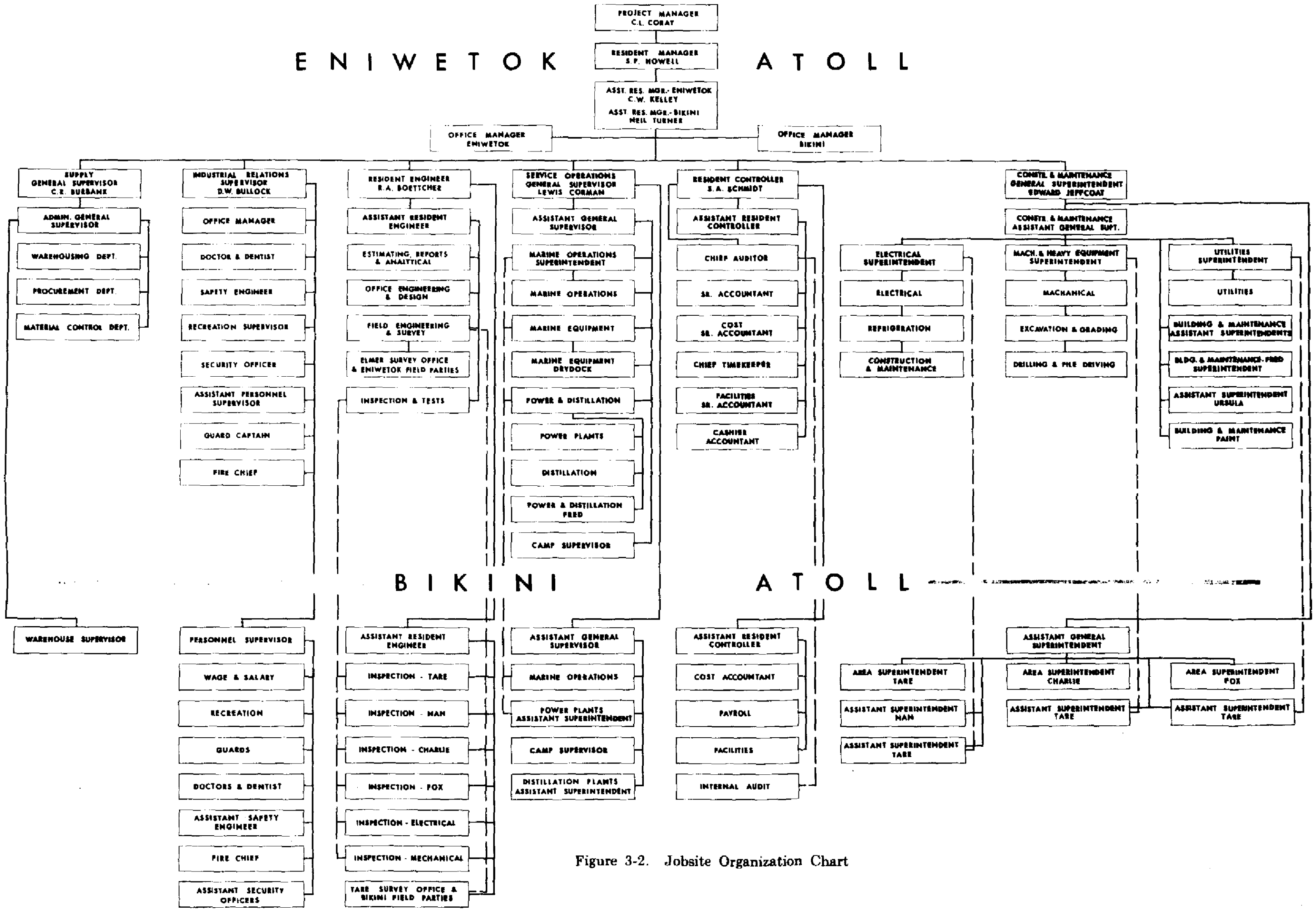


Figure 3-2. Jobsite Organization Chart

imum, H&N Management was notified by the Controller; if additional amounts appeared justified, the Commission was notified. (Due to the nature of contractual operations, requirements frequently changed as work progressed, and these changes had to be recognized and reflected in the budget.) The budget was resubmitted semi-annually in a formalized "Mid-Year Review," and at that time a thorough inspection was made of the forecast requirements, and necessary adjustments were accomplished.

The Budget Section also coordinated the preparation and submission of reports covering such relevant items as manpower requirements, messing, communications, housing, automobile assignment, camp operations, etc.

GENERAL COST AND ACCOUNTING. This Section maintained the complete accounting records required by the Commission and H&N Management. For cost distribution of contractual expenditures, cost accounting procedures were established for the preparation and provision of AEC cost budget reports, JTF costs reports, and Management cost reports.

On 1 March 1953, Controller's Bulletin No. 12-1 (Chart of Accounts), superseding a previous bulletin (No. 25), was issued wherein all changes and amendments applicable to the then current scope of work were noted, except a work order framework at the project site which was covered by separate releases.

Scientific Structures Program - Job I (Contract Item 27) Work in Progress Subsidiary Accounts included a detailed account for each Scientific Structure together with the appropriate Joint Task Force SEVEN Cost Code. Construction services were rendered to the various Governmental Agencies and/or Task Groups, which included three JTF SEVEN Task Groups and six Task Units together with 19 Scientific Programs and 53 Scientific Projects applicable thereto. Under this scope of work, 269 structures were constructed.

Support Services - Job IV Subsidiary Accounts included a detailed account for support services rendered to the various Using Agencies and Task Groups, which included five JTF SEVEN Task Groups and 12 Task Units, together with 20 Scientific Programs and 65 Scientific Projects applicable thereto. There were approximately 2700 approved work orders authorizing specialized services to be accomplished by Contractor personnel.

The monthly JTF Cost Report was compiled for cumulative cost distribution. This report segregated all costs incurred and classified by the AEC Chart of Accounts as either Atomic Energy Commission or Department of Defense scope of work. In some instances, certain Scientific Structure charges were reported under both the AEC construction classification and as DOD (Department of Defense) construction, depending upon the amount of DOD participation in the over-all program costs. These reports were revised and submitted in accordance with current revisions to AEC and JTF Directives.

Additional periodic reports supplied to the Commission covered such pertinent items as the status of obligated funds, and financial statements and supporting schedules.

PAYROLLS AND TIMEKEEPING. Weekly payrolls were prepared by this Section in accordance with established wage classifications and rates as outlined in the Contract. (Overseas employees worked under the terms of Employment Agreements.)

Payroll activities were divided into two separate functions - Home Office and Jobsite. The Home Office payroll was prepared immediately and paychecks were distributed on the second day following the close of the pay period. In processing the overseas payroll, the policy of completing the payroll and issuing the paychecks within five days after close of the weekly pay period was continued from Operation IVY. In order to accomplish this prompt payment, the wage for the regularly scheduled work week was paid currently. The time lag between the close of a pay period at Eniwetok or Bikini, and receipt of time cards in the Home Office, was approximately ten days. When received, time card hours were compared with hours previously paid and adjustments for the irregular hours worked were effected on the current paycheck.

In addition to the normal payroll records and deductions, special deductions were made for the return travel fund*, subsistence, token payments, etc. The net payroll earnings were forwarded by check to the designated allottee. Paycheck stubs, reflecting regular and overtime hours credited, specific deductions and amounts, and the net amount of the payroll check, were transmitted overseas for distribution to employees.

As of November 1953 the payroll operation, served a peak of 356 on-continent and 2364 overseas employees. The total number of paychecks processed for the period 1 January 1953 through 2 May 1954 was 138,339; their cash value amounted to approximately $20,761,427.

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*Return Travel Fund deductions were made in the amount of $385.00 for Stateside hires and $200.00 for Territory of Hawaii hires. This feature was included in the employee's overseas contract to insure a sufficient return travel fund for an employee who did not complete his contract. This withheld money, however, was returned to the employee upon the successful completion of his contract.

ACCOUNTS PAYABLE. Personnel in this Section processed and were responsible for paying all accounts payable and travel expense items, with the exception of employees' travel expenses for journeying to Jobsite under Employment Agreements. The policies and procedures followed were predicated upon the experience gained under prior operations, and complied with the requirements of the Commission's General Accounting Office in the post-audit of expenditure of Government Funds.

Inasmuch as most purchases were shipped by the vendor to Oakland, California, for transshipment or repackaging and transshipment, it was mandatory that receiving reports from the packer be received promptly to insure recovery of cash discounts. When materials arrived in Oakland, receiving reports were immediately prepared by the packer and transmitted to the Accounts Payable Section for processing and payment of vendors' invoices. From 1 January 1953 through 2 May 1954, this Section processed and paid vendor invoices totaling approximately $14,782,000 (after deductions of discounts in excess of $65,900).

The procedures and methods used in processing per diem and travel expense payments were in accordance with established Company policy and complied with the provisions and requirements of Appendix "B" of the Contract. From the effective date of Operation CASTLE (1 January 1953) through 2 May 1954, a total of 3257 Travel Orders were processed covering single and multiple movement of personnel. Travel expenses in the approximate amount of $390,000 were processed and paid through both the Home and Jobsite offices. A total of 18,407 checks were processed during the period for payment of travel expenses and vendors' invoices.

PROPERTY. Functions of Property and Materials Section were carefully synchronized with receiving and warehousing operations. Changes in Jobsite or Home Office receiving and warehousing procedures were drafted in concurrence with property and material accounting procedures in order that adequate accounting controls could be maintained at all times, and vendors' invoices were processed in the same manner as detailed under "Accounts Payable."

For items in transit to overseas locations, accounting control was maintained through the "Inventory in Transit" Accounts, and upon receipt at Eniwetok, these items were cleared from the in-transit accounts by appropriately charging them to either the proper warehouse inventory account, or to the work order number applicable to the particular feature of work. While recording equipment to the in-transit account, equipment record cards were prepared and filed in a suspense file. On receipt of the Jobsite monthly report listing additions to and retirements from the account, the equipment cards at the Home Office were reconciled accordingly. Periodically, complete inventory equipment listings originated at the project site were reconciled with Home Office equipment records. Copies of the monthly listings to and retirements from equipment inventories, the periodic complete listing of equipment perpetual inventory, and the periodic physical inventories were required by the Commission. Copies of all invoices were furnished the overseas Property and Materials Accounting Section for their use in pricing and clearing from the "Inventory in Transit" Accounts all items received and transferred to work in progress or warehouse inventories.

Receipt of materials at Eniwetok Atoll was consistently good. Practically all adjustments of claims against vendors and on-continent carriers, resulting from over and under shipments or damage in transit, were accomplished in a satisfactory manner.

Materials and equipment expended at the PPG by loss, destruction, or normal wear and tear, were cleared from accountability records by means of survey reports which contained full information as to the circumstances under which the items were expended. These reports supported inventory adjustments and entries on retirement work orders as appropriate. Other reports covered specific items such as motor vehicles, machine tools, and excess and personnel property.

SECTION 3
ESTIMATING

In addition to the Home Office Estimating organization, a supplemental estimating group was established at the Pacific Proving Ground to assemble cost estimate on basic field designs. The Home Office group comprised an average of three civil and/or architectural engineers, three structural engineers, two electrical engineers, two mechanical engineers, two statisticians and four clerks, all of whom functioned under the supervision of the Chief Estimator and the Assistant Chief Estimator. The field estimating group was comprised of personnel in the Jobsite Engineering Department, and included two experienced cost estimators, one progress engineer, and one property records engineer. This group was supervised by a Principal Engineer working directly under the H&N Resident Engineer's supervision.

Estimating functions performed for Operation CASTLE entailed such activities as: (1) the preparation of preliminary estimates which reflected the total cost of anticipated construction, engineering, camp operations, maintenance, support services and roll-up services; (2) original estimates, prepared after engineering design was authorized and formally submitted to the Field Manager; and (3) current estimates, which included the cost of any and all changes that deviated from the preliminary design. The estimated construction cost, when approved, became the official cost used to determine the Contractor's fee for approved construction.

When authorized changes in design occurred after release of the current estimate, a revised current estimate was issued which included the cost of any additions or deletions from the original design. This estimate superseded the previously issued current cost estimate in its entirety. Special studies were also prepared to supply general information or comparative data for the proper determination of design, manpower requirements, or construction schedules.

A copy of all estimates was supplied to the Jobsite for use and reference in reporting progress, and for preparing monthly completion estimates where it was found that the latest current cost estimate deviated from the field estimate "to complete" by ten per cent. This information was included in each monthly cost statement of work in progress.

Data originated or assembled by Estimating was used in work performed by various other Departments. These important departmental functions included such activities as Contract Administration, Budget and Accounting, Industrial Relations, Procurement, and Engineering at both the Home Office and in the field.

All cost estimates prepared during Operation CASTLE followed an established pattern, which detailed or segregated the relevant elements as follows:

1. The items of direct labor, direct material, equipment usage, and batch and aggregate plant production were considered as direct costs and were estimated for each job on the basis of similar work in the Zone of the Interior.
2. In accordance with previous experience at the Pacific Proving Ground, other expenses were estimated as follows:
   a. Indirect as 65% of combined direct labor and direct material.
   b. Operations as $4.50 per man-hour of the estimated direct labor.
   c. Field Engineering as 4.75% of total estimated construction cost of each project.
   d. Engineering design as 4.00% of total estimated construction cost of each project.

The following compilation, which totals 2173 estimates, represents approximately 300% more than the number of approved estimates incorporated into the Contract. This over-all total was due principally to the fact that many estimates required complete processing through the preliminary and original estimate phases prior to the preparation of approved current estimates.

Type of Estimate	Number of Estimates	Gross Dollar Value	Net Dollar Value
Cost studies	110	$ 17,089,295	$ 17,089,295
Budget forecasts	82	43,000,000	43,000,000
Preliminary Cost Estimates	99	35,669,940	30,792,964
Original Cost Estimates	741	23,290,854	21,285,104
Current Cost Estimates	1,141	47,707,600	43,505,820
Total - All Types	2,173	$166,757,689	$155,623,183

An "Estimated Operations Schedule," reflecting the scheduling of engineering, procurement and construcion for each item of authorized construction, was issued and reviewed periodically by the Manager, Construction-Operations Division, his staff, and the Project Engineer. This provided the means for coordinating the work of the various Departments involved. Immediately following the review and issuance of this schedule, a complete catalogue of Scientific Stations was issued which provided a brief description of the construction involved, site locations, and User requirements, and served to coordinate the User's needs with Jobsite construction.

Monthly statistics, showing the estimated accumulated percentages of physical completion of Contract items, were compiled and presented in the form of a bar chart. The Jobsite determined the weight of each construction feature under a Contract item by dividing each feature's direct labor by the total direct labor of the Contract item as reflected in the original cost estimate. Estimated percentages of physical completion were determined by visual inspection, and the weighted percentage of completion was determined by multiplying the established weight by the estimated physical completion.

Further, completion estimates were prepared for each Contract item (of current construction) by the Jobsite Resident Engineer whenever it was evident that the actual construction costs would vary from the estimated construction costs. The basis for comparison was the current cost estimates. If such estimates were not available, an original (or the latest) cost estimate was substituted. When this comparison revealed that actual field construction costs would not be within 10% of the estimated costs, or $10,000, which ever was the lesser, the Jobsite prepared a completion cost estimate to reflect the total estimated cost in excess of, or less than, the current cost estimate. This supplemental estimate was submitted to the Home Office. If, however, completion estimates were not reveived in Los Angeles by the tenth of the month, it was assumed that the latest cost estimate was within the allowable variance.

The over-all percentage or completion, as determined above, was supplied monthly to the Holmes & Narver Contract Administrator and the AEC Field Manager for the accurate evaluation of earned Contract fees.

SECTION 4
INDUSTRIAL RELATIONS

OFF-CONTINENT RECRUITING

An extensive recruiting program was outlined in April 1953, and early in May the hiring program for overseas personnel began. Help-wanted advertisements were placed immediately in Los Angeles metropolitan newspapers, and a recruiting program was also inaugurated on 25 May in San Francisco and the Bay cities. A similar program was initiated in the San Diego area during the third week in June.

Because office space in the Home Office was insufficient to handle the persons responding to the expanded recruiting, the California State Employment Service (CSES) granted the use of their facilities at Eleventh and Flower Streets, Los Angeles. For the San Francisco area recruiting, the CSES office at 1400 Howard Street, San Francisco, was used. Complete mechanical processing, i. e., physical examination, photo identification, and finger-printing of prospective Jobsite employees was established in the bay area.

Seattle, Portland, Salt Lake City and Denver were also surveyed for possible personnel but were eliminated from the program due to the limited number of skilled construction men available in those areas at the time. Surveys in the Bakersfield, Ventura and Fresno areas revealed a source of skilled labor, and recruiting was undertaken in these cities for generating and distillation plant operators, apprentice engineers, and electricians. A similar survey in the San Diego area disclosed a surplus of manpower in all crafts, and a recruiting program was opened in that area, using CSES facilities. Complete processing of applicants was handled in this location on the same basis as was used in Los Angeles and San Francisco. Recruiting started in San Diego on 22 June 1953 and continued through 30 September, except for the period between 1 August and 17 August. Figure 3-3 shows the total number of applicants interviewed and hired from the over-all recruiting program.

"P" approval clearances were received during the week of 7 July 1953 on the first applicants submitted in the initial phase of the recruiting program at Los Angeles; for the San Francisco and San Diego recruiting programs, the first "P" approvals were received during the week of 3 August. (Approximately eight to nine weeks elapsed between the time an applicant was accepted, processed, and submitted for clearance before the actual clearance was received.)

By July 1953 firm commitments were being made to "P" approved applicants in the San Francisco area, and overseas Employment Agreements, allotments and hiring slips were completed at the Home Office and forwarded to San Francisco for execution. The Holmes & Narver personnel representatives at San Francisco coordinated travel orders with the H&N representative at Travis Air Force Base and the Home Office Travel Section. This method of handling applicants replaced the previous arrangements by which applicants were brought to Los Angeles for processing, and resulted in the elimination of the customary round-trip

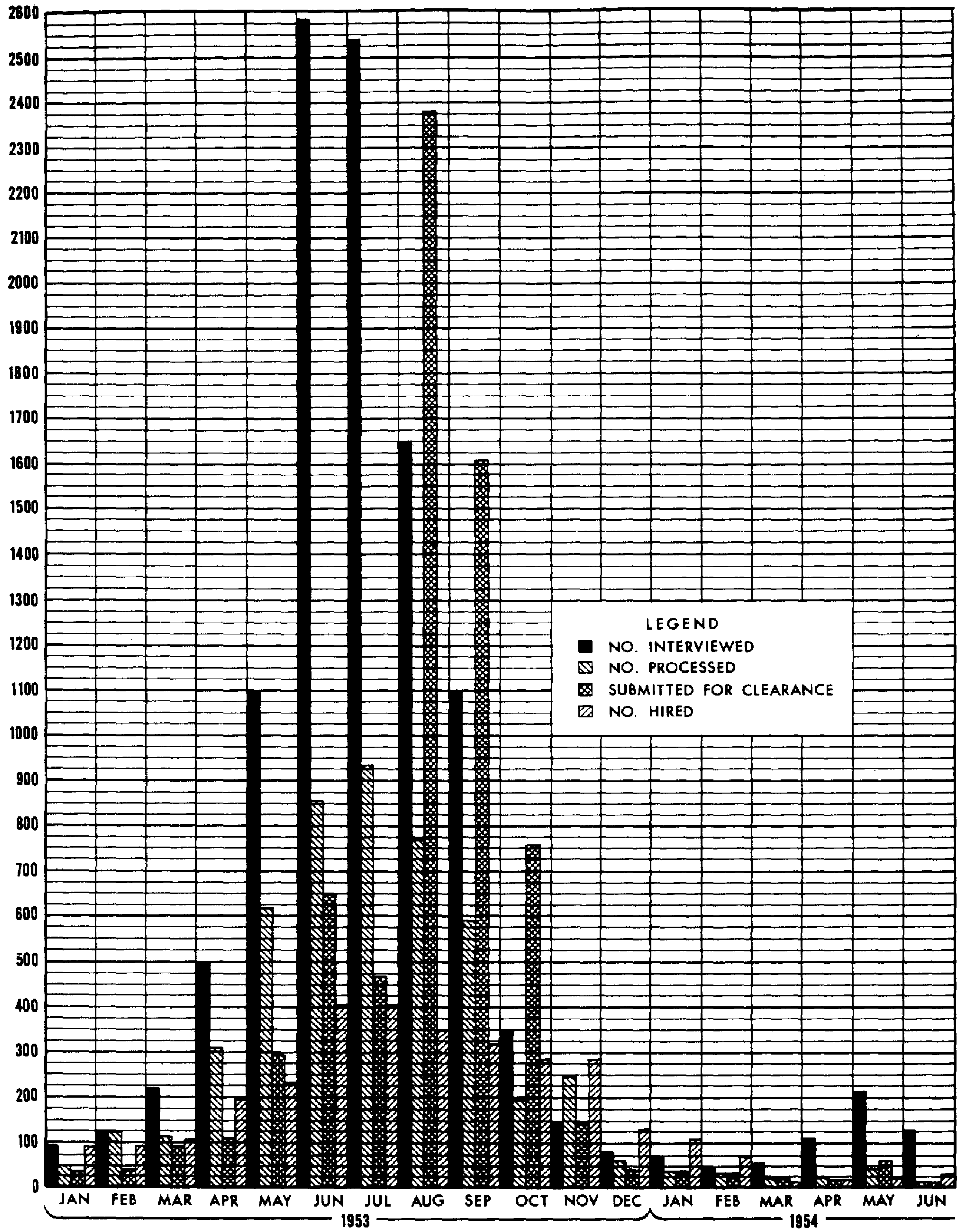

Figure 3-3. Off-Continent Recruiting

fare, per diem, and two days' salary on all San Francisco hires. This system effected a savings of approximately $103.00 per each new employee from that area during the period from 25 May through 31 December 1953.

TRANSPORTATION

Prior to the inauguration of the accelerated recruiting program, Holmes & Narver employees going to Eniwetok were transported by commercial airlines from Los Angeles to San Francisco and then by chartered commercial bus or Navy bus to Travis Air Force Base. However, on 16 June 1953, chartered aircraft, flying directly to Travis Air Force Base, were started from Los Angeles, thereby eliminating the intermediate bus service from San Francisco to the Base. Each plane had a capacity of 44 passengers and was chartered only when a minimum of 25 passengers was available. During the peak of the hiring program, two chartered flights per week were used, with each flight averaging 35 men. The last chartered flight departed Los Angeles on 2 December 1953. In all, 27 flights from Los Angeles to Travis Air Force Base at $819.00 each were chartered to carry a total of 958 men. This amounted to $22,113.00 as compared to the cost of equivalent commercial service (958 fares at $25.36) in the amount of $24,294.88. By flying directly to Travis, bus fares (from San Francisco to Travis) were eliminated resulting in a further savings of $1,858.52 (958 fares at $1.94).

A temporary group leader was appointed from within each group going overseas who was personally responsible for carrying the group's collective personnel records to Jobsite. Each member of a group was given a $25.00 advance on his Jobsite salary prior to leaving the Home Office. Travel was by MATS aircraft from Travis to Eniwetok via Hickam Field, Honolulu, and Kwajalein. Upon arrival at Travis and again at Hickam Field, the men were met by an H&N representative who escorted them through the MATS procedures.

The flow of personnel was reversed in the demobilization incident to the end of the Operation. San Francisco hires were returned to their point of hire by chartered bus after arriving at Travis Air Force Base; Los Angeles hires were furnished air transportation from the San Francisco airport. In the event chartered buses or aircraft were not warranted due to the small number of returnees involved in a group, the men were instructed to travel by commercial means and were reimbursed for this service. Figure 3-4 shows the monthly totals of men transported to and from Jobsite.

OFF-CONTINENT TERMINATIONS

The records and paper work required for off-continent termination settlements did not necessitate an increase in the Industrial Relations Department staff because the increase in termination near the close of the Operation coincided with a decrease in employment of new men. Terminations began to increase late in November 1953 due to the limiting date on "Q" clearances for Jobsite employees. This situation was brought about by the fact that "P" approved employees had been permitted to work in certain locations at the Jobsite up to a critical security date. When it became apparent that "Q" clearances on recent hires would not be received prior to the limiting date, these men were declared surplus and terminated.

Off-continent terminations (for all reasons) during November totaled 164. By February 1954, 894 terminations had been processed. San Francisco returnees were processed at the California State Employment Services office. This processing included termination physical examinations and security clearances; final processing was completed at the Home Office.

The Industrial Relations and Accounting Departments maintained close contact to avoid any delays in the terminating employees' payoff commitments. Pay-off procedures for the San Francisco terminations were modified somewhat to allow for the delay in receipt of preliminary paper work relevant to these terminations. Travel reserve checks were airmailed to San Francisco on the same day the Jobsite "employee departure wire" was received in the Home Office. This arrangement, in most cases, provided immediate funds for employees terminating at San Francisco. However, unavoidable delays were experienced in the Honolulu payoffs due to the time lapse involved in overseas mail service.

From 1 June 1953 through 30 June 1954, a total of 3,749 off-continent employees were processed and terminated; this total included 839 Honolulu terminations and 186 San Francisco terminations.

ON-CONTINENT RECRUITING

Recruiting methods for on-continent employees were essentially the same as for off-continent employees, i. e., by newspaper advertisements and CSES facilities, and by use of three private agencies. Home Office applicants were screened by a local police check, security checks, and the checking of three local references.

JOBSITE PERSONNEL

Site Elmer at Eniwetok continued to be used as the personnel headquarters and, although individual records were maintained on Bikini Atoll at site Tare for all employees permanently assigned to any one of the camp sites in that area, all permanent personnel records were initiated and maintained at Elmer. All

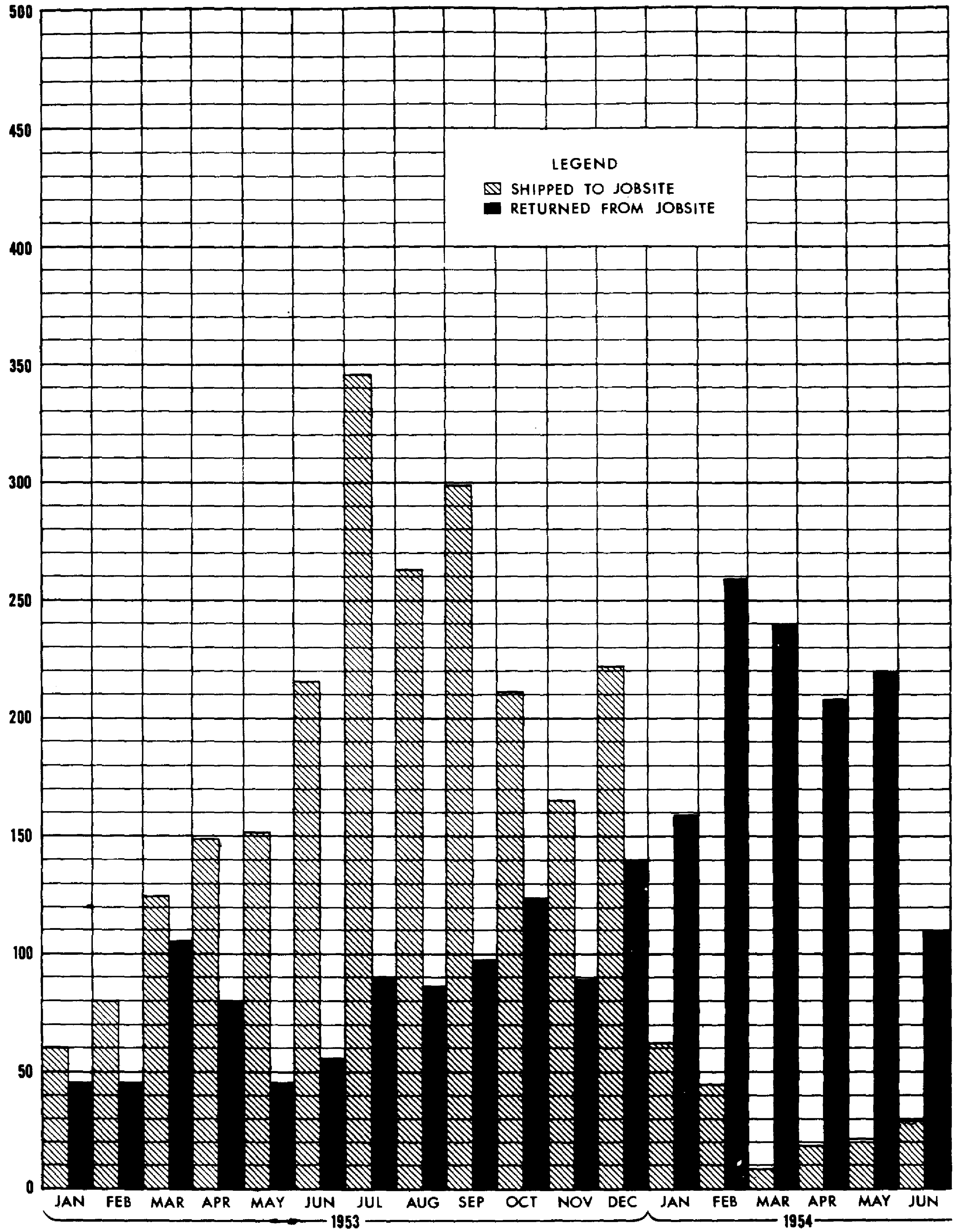

Figure 3-4. Movement of Personnel To and From Jobsite

arriving and departing employees cleared through this office for processing.

About the time that a camp was established at site Tare on Bikini Atoll, the Proving Ground in general experienced an over-all curtailment of activities occasioned by the completion of Operation IVY, resulting in a Jobsite personnel decrease of 475 men from October to December 1952.

To plan personnel strength requirements, a manpower control chart was prepared in November 1952 and projected over a three-months period. All Divisions were requested to forecast personnel requisitions three months in advance to allow sufficient time to recruit, process (including security clearance), and transport to Jobsite the necessary additions or replacements. In order to plan replacement needs, a form was sent to each Jobsite employee three months prior to his normal contract completion date, which provided space for the employee to indicate his desire to extend his contract, terminate and return in 30 days, or terminate and not return.

In April 1953, construction, engineering and support services requirements necessitated an intensive build-up in personnel, particularly in the Construction-Maintenance Division. This build-up continued until a peak population of 2,300 was attained on 7 December 1953, as indicated in Figure 3-5.

The total peak population (H&N supported), including all sites and all groups, was reached on 28 February 1954, with a total of 3,398. The breakdown of this figure, by groups, is as follows:

Holmes & Narver (Permanent)	1,804
Holmes & Narver (TDY)	11
Insurance Representative	1
Task Group 7.1	1,010
Task Group 7.2	244
Task Group 7.3	88
Task Group 7.4	88
Task Group 7.5	19
JTF SEVEN	133
Total	3,398

With the majority of construction requirements met, return of personnel to point of hire was begun in early January 1954, which resulted in the net population loss as indicated in Figure 3-5. However, additional men were still needed in the Service Operations Division, and when possible these positions were filled by transferring employees who were then surplus to the needs of other Divisions.

A cut-off date of 24 January 1954 was established for receipt of "Q" clearance. All employees who did not have a "Q" clearance by that date were given completed contracts and returned to their point of hire. An exception was made for 25 critically needed individuals in this category who were allowed to remain on site Fred and continue working until their "Q" clearance processing was completed; this exception was granted by the Field Manager, EFO, AEC. Most of the men returned to their points of hire due to non-receipt of "Q" clearances were employees of the Camp Department, and this exodus resulted in a temporary shortage of mess hall personnel at the time the Jobsite was approaching its total peak population of all Task Groups.

The following tabulation reflects the ratio of voluntary terminations and discharges during each month of the Operation:

	Average Jobsite Population	Voluntary Terminations	Discharges
October 1952	1,144	18	0
November 1952	957	4	2
December 1952	840	3	0
January 1953	802	1	0
February 1953	816	8	1
March 1953	822	9	1
April 1953	861	7	0
May 1953	999	5	1
June 1953	1,187	5	1
July 1953	1,441	13	0
August 1953	1,712	18	0
September 1953	1,935	19	4
October 1953	2,103	24	2
November 1953	2,236	22	4
December 1953	2,255	34	1
January 1954	2,141	17	2
February 1954	1,937	7	0
March 1954	1,511	5	3

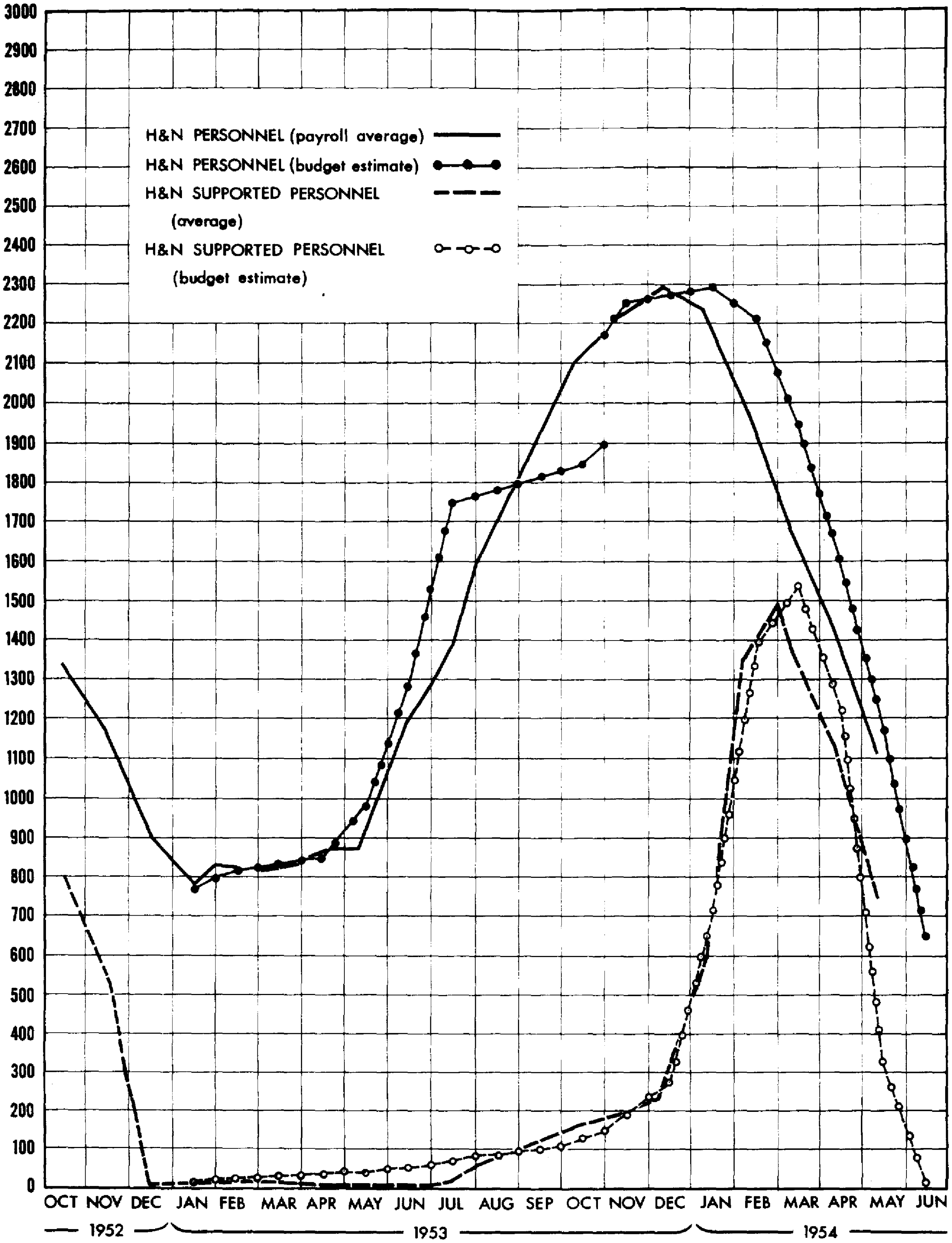

Figure 3-5. Jobsite Personnel Chart - Eniwetok and Bikini Atolls

Several of the individuals shown above as voluntary terminations left because of emergencies such as death and serious illnesses in their immediate families, and returned to the Jobsite in approximately 30 days on an "Emergency Leave of Absence" basis. After thorough investigation as to the cause of voluntary terminations, it was determined that approximately 15% were due to environmental dissatisfaction, and the other 85% for personal reasons.

Enforcement of camp rules and regulations for the conduct of employees after working hours rested with the Industrial Relations Supervisor and/or Personnel Supervisor. Through the medium of official reports from the Guard Captain, the Personnel Supervisor was advised of infractions and, after consultation with the appropriate Division Head, determined any necessary disciplinary action. Such disciplinary action normally was in the form of an official reprimand, restriction of bar privileges, limitation of work week hours, or discharge for cause.

WAGES AND SALARIES

A Wage and Salary Section was formed in June 1953 to establish and maintain a stable and balanced wage program, and to handle grievances and claims involving wages. Job descriptions were written, and the stateside and off-continent wage structures schedule was revised after consultations were held with such organizations as the Associated General Contractors of America, The Merchants and Manufacturers Association, the Engineers and Architects Association, and the Los Angeles County and California State Personnel Boards.

There were 39 wage claims filed by overseas employees; 13 claims were granted and 26 were denied. Determination as to wether or not a wage claim should be granted or denied was made on the basis of Jobsite investigation of the claim. Home Office settled wage claims on Jobsite's recommendations in each individual instance.

The number of Jobsite changes of status processed due to reclassifications or merit increases averaged approximately 40 per week. The investigation and processing of these changes constituted a major portion of the routine duties of the Wage and Salary Section.

A major revision of wage schedules became effective on 17 August 1953. The general effect of the revision was an approximate 5% increase for non-manual and supervisory-administrative classifications, and a more workable and equitable classification system for all field personnel. Further amendments to the wage and salary schedules were made on 28 September 1953 and 1 February 1954, in accordance with A. G. C. revision of rates and Jobsite needs. The merit review procedure was revised to eliminate the 30 and 45-day adjustment periods which had been in effect under Wage Stabilization rules. The latest merit review system was based upon the concept that a meritorious wage increase could be granted after a four-months service period.

Processed changes of status, wage claim investigations and recommendations, and related wage and salary matters were forwarded to the Home Office Industrial Department for consideration and action with due regard to the Company's contractual obligations, established Company procedures, and sound business practices.

MEDICAL DENTAL

Medical and dental care was predicated on two considerations: (1) adequate care for emergencies, including accidents and disaster; and (2) preventative measures through sanitation and medical treatment to keep personnel in good health and on a productive basis. The dental service accomplished these ends by handling dental emergencies and by providing care over and above emergencies compatible with maintaining the Jobsite employees in a working condition. The medical service accomplished its mission through maintaining regularly scheduled sick calls, caring for immediate emergencies, maintaining frequent sanitary inspections of all camp messing and housing facilities, consulting with concerned Departments in disaster planning, and furnishing reports and advise as necessary on over-all problems. The medical service also handled reports to the insurance carrier, made disability evaluations, and determined when Zone of the Interior care was necessary for individuals and whether they were physically qualified to carry out Jobsite duties. Close liaison was maintained with Army medical facilities, and a free exchange of services was maintained at all times. All medical service was made available to supported groups as well as to Holmes & Narver employees.

During the Operation there were four deaths - three Holmes & Narver employees and one Task Group 7.1 employee. In October 1952, a death occurred from coronary heart failure. This contract employee had been treated for congestive heart failure and was awaiting transportation home when he developed a coronary thrombosis and expired after 36 hours of intensive treatment. In November 1953, an employee was discovered deceased in his barracks; autopsy at St. Francis Hospital in Honolulu disclosed a ruptured aortic aneurysm, abdominal. In February 1954, an employee was admitted to the Army Hospital and died within a few hours from a massive coronary infarction confirmed by autopsy at St. Francis Hospital. In the same month, a Task Group 7.1 employee died from electrical shock when he shorted across a piece of electronic equipment at an offshore site. The three Holmes & Narver deaths were all cardiac deaths and no other deaths due to injury or occupational hazard occurred at Jobsite during this period. One Holmes & Narver employee died at Queen's Hospital in Honolulu following evacuation from Jobsite.

Medical statistics are as follows:

Men returned as Completed Contract - Injury	25
Men returned as Physically Unqualified	102
Patient visits made at Elmer Dispensary	25,178
Patient visits made at Bikini Dispensaries	11,541
Days lost due to illness	2,694

There was no incidence of unusual occupational or epidemic illnesses, nor any unusual frequency of ordinary illnesses usually encountered. Skin conditions, upper respiratory infections, and gastric complaints accounted for most of the patient visits. No regional or communicable "tropical" diseases were encountered during this Operation. Otomycosis, as well as dermatomycosis pedis continued to account for a good number of visits, but the incidence per one thousand population did not appear to be much higher than in the Continental United States. Minor lacerations and abrasions accounted for the major portion of the injuries, with sunburn and corneal foreign bodies appearing next in order; injury fractures were a very minor part of the dispensary activity. One case of an infectious disease (chicken-pox) occurred in a User employee, but there were no contact cases resulting. One positive and one suspect case of tuberculosis occurred and tuberculin test and X-ray surveys were carried out with no contact cases showing. Hemorrhages from active peptic ulcers, both in H&N and in User and AEC employees, contributed to the medical problem for about three months. Several basilar skull fractures and jaw fractures occurred during this period but did not present an over-all high incidence. Except in one case in which actual contusion occurred, no neurologic complications were encountered.

Those vaccines which needed refrigeration were the subject of a special procedure. Permission to purchase all refrigerated items from Honolulu was obtained. A standard stock of 500 points of smallpox vaccine was established as a minimum safe level. A narcotic handling procedure was written, accepted, and made a part of standard procedures.

RECREATION

Provision for recreation was made as a coordinated program under a Recreation Director and his assistants. The facilities and activities varied somewhat with the size of each camp, but in general the objective was to provide outlets for leisure time. The programs provided movies; church services; organized shell hunting and fishing; horseshoe pitching; tournaments in chess, billiards and other games; softball, basketball and volleyball leagues; bingo games; rebroadcasts of sports events; libraries with newspapers and magazines; a mimeographed newspaper; and carnivals and other special events.

SAFETY.

A continuous safety program was maintained to guard the health of employees and those User groups for whom Holmes & Narver had support responsibility, and to prevent accidents through elimination or control of conditions capable of causing personal injuries, occupational diseases, fires, or damage to equipment property and material.

Safety operations encompassing two atolls and seven separate campsites were covered by a Safety Engineer at Eniwetok and an Assistant Safety Engineer at Bikini Atoll. Constant contact was maintained by correspondence, and radio was used in cases of urgency.

Safety education was promoted by utilization of signs and posters, and insertions were published in the daily newspaper, designating hazardous locations, speed limitations, off-the-job safety, use of protective equipment and similar safety material. Hazardous conditions and practices found were discussed with the supervisors, recommendations were made, and corrective action was initiated.

The "Manual of Accident Prevention in Construction" issued by the Associated General Contractors of America, Inc., was the accepted basis for Jobsite safety requirements with additional specific guidance from applicable bulletins issued by the AEC Santa Fe Operations Office. Additional safety rules and regulations as set forth by the Contractor's Management were published in the form of procedures and safety bulletins.

All injury cases were reviewed and investigated in order to determine the cause factors and to make recommendations which would minimize the possibility of reoccurence. Engineering plans and designs were reviewed to effect maximum application of safety engineering standards and practices. All new arrivals at Jobsite attended safety orientation discussions which outlined established procedures with regard to swimming, shell hunting, exposure to the sun, transportation, personal hygiene, and protective equipment and clothing.

Reports required by the AEC and Holmes & Narver Management were prepared and submitted, together with supporting data relevant thereto. Separate monthly narrative reports were sent to the AEC and H&N Management.

Experience figures shown below for the Contractor's portion of Operation CASTLE are based on the American Standards Association Z-16.1 code, titled "Method of Compiling Industrial Injury Rates," and conform to applicable AEC bulletins.

Average number of Employees	1,442	
Total Man hours Worked	6,524,954	
Number of Lost Time Injuries	33	
Frequency Rate	5.06	
Total Days Lost	2,180	
Severity Rate	.33	
		Direct Cost
Number of Motor Vehicle Accidents	11	$ 673.50
Number of Property Damage Accidents	8	2,469.00
Number of Fires	15	3,692.00

Of the 33 lost time accidents reported, there were four resulting in permanent partial disability, which accounted for a total of 1,600 days lost time. All were caused primarily by carelessness in unusual circumstances on the part of the employee concerned. The most serious of these, involving a lost time charge of 1,000 days, resulted in the partial amputation of three fingers on an employee's left hand. In other documented cases, there were no industrial fatalities and no cases of permanent, partial or total disability. A comparison with other SFO Contractors' injury experience is shown in Figure 3-6.

Two property damage accidents amounting to $485.00 and $890.00 respectively, resulted when a Tournapull with defective brakes struck the side of a building while making a turn, and when an excessive dynamite charge threw rock and debris which damaged a building.

The major fire losses were the result of two fires with total incurred loss of $3,327.00.

In matters of safety, fire protection, and health, extensive liaison with AEC and Task Group officials was necessary in coordination of test site activities with Holmes & Narver operations. Representative of the operations so coordinated were Dewar or RTD movements, rocket and explosives operations, special handling of cylinders containing highly corrosive and poisonous materials, and dissemination of information relating to emergency signals. All war-time unexploded missiles and projectiles found were reported to the Safety Department for removal and disposal. Whenever available, the cooperation of the Military disposal unit was secured for such operations.

RAD-SAFE

Rad-Safe indoctrination was given all new arrivals at Jobsite in an initial safety orientation talk. Written information was also furnished personnel at the point of hire and in safety lectures presented at the Jobsite. Radiological problems were set up in the Operations plans as a responsibility of TU 7, under the direction of the Military during test periods and under an AEC representative during non-operational periods. In compliance with CJTF instructions and through close liaison with the Rad-Safe group, the Safety Department assisted in establishing and activating routines for the control of H&N employee movement into forward areas, and for local evacuation should exposure so justify, and aided coordination of H&N operations involving radiological safety. During the test period, an attempt was made to maintain by the Rad-Safe office up-to-date records of all H&N employees with accumulated exposures in excess of 2.5r. This information was kept immediately available to assist supervision in the efficient utilization of personnel in recovery, decontamination and other supporting operations.

FIRE PROTECTION AND PREVENTION

Through the period, sufficient fire apparatus was made available by the AEC and through loan from Military sources to provide a minimum of one unit at each camp. At the peak of the Operations, AEC-owned and Contractor-operated apparatus consisted of:

Two Chevrolets with 500 GMP Center Mount Pump

One Ford with 500 GPM Center Mount Pump

One Maxim with 750 GPM Center Mount Pump

On loan from the military were:

One Chevrolet with 100 GPM Fron Mount Pump

One GMC with 500 GPM Front Mount Pump

One LaFrance with a Bean High Pressure Center Mount Pump

One International with Bean High Pressure Center Mount Pump

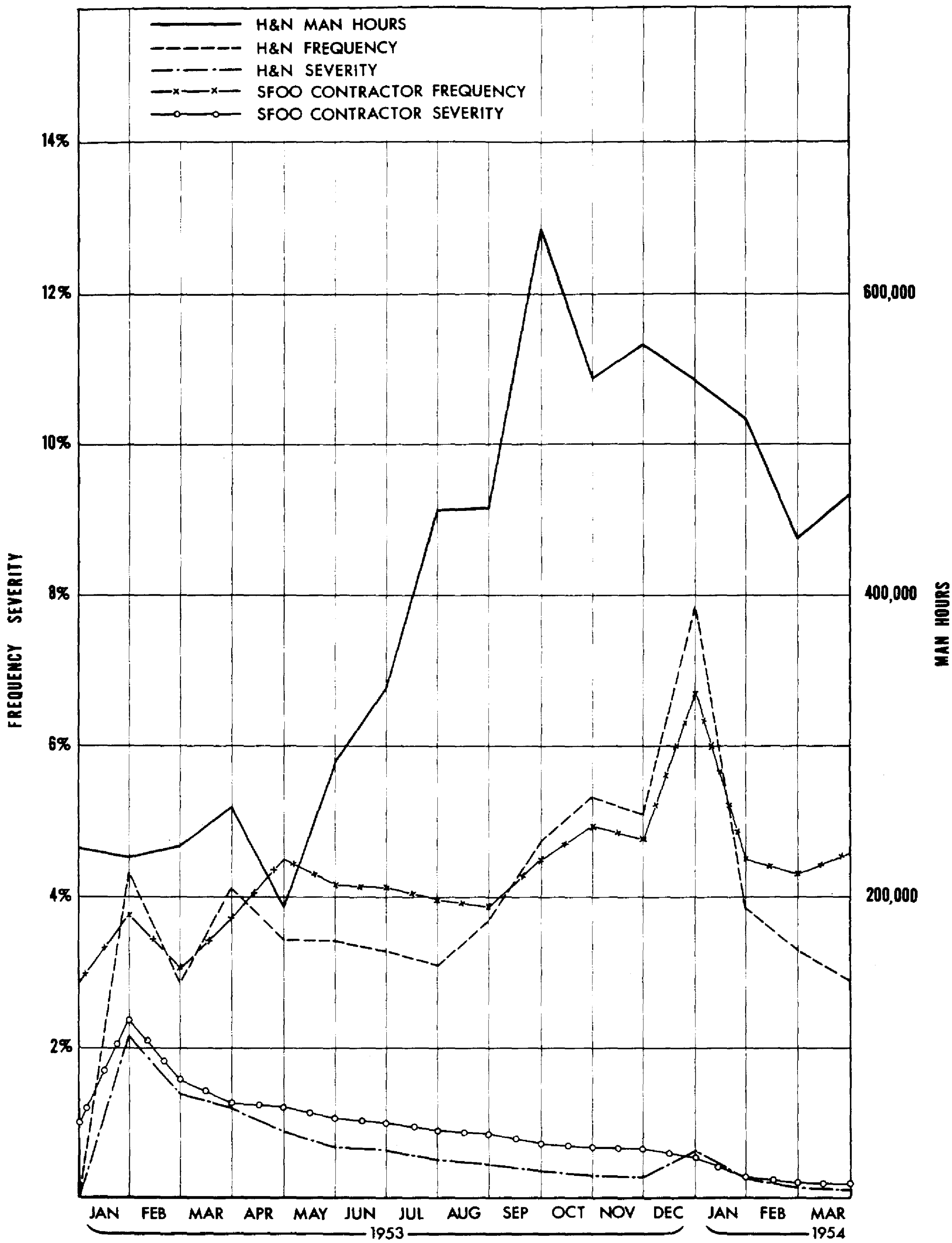

Figure 3-6. Personal Injury Experience - A Comparision With Other SFOO Contractors

Assignment of this equipment was as follows:

On Eniwetok Atoll the Maxim, LaFrance and Bean High Pressure units were retained at site Elmer where the principal warehousing, shop, office and User facilities indicated the need of the most equipment. One Chevrolet 500 GPM unit was located at site Ursula.

At site Fred (Eniwetok Island), coverage was provided for all Operations by the Military fire organization.

At Bikini Atoll, under Contractor operation, Chevrolet, Ford and GMC 500 GPM units and a Chevrolet 100 GPM unit were assigned for coverage at the four camps, with the specific responsibility for allocation of apparatus to each site being delegated to the Fire Chief in charge at that atoll. In addition to the above, a Military organization, with equipment, was furnished for coverage of the airstrip at Bikini. This group was coordinated with the Holmes & Narver camp Fire Department for joint help in event of emergency. Water for fire protection at sites Charlie, Fox and Tare was supplied from the elevated storage tanks and at Nan from a 300 GPM pump at the distillation plant. While these sources of supply were limited, they were found to be sufficient for the needs that arose. After the individual tests, Fire Department apparatus and manpower were used to great advantage in decontamination operations.

At site Elmer a perforated casing type well was adopted at the Assembly Area after the buried cube type proved unsatisfactory. Water for future camps and storage areas can be economically obtained through the use of this type well.

With the withdrawal of equipment from the Bikini location to site Elmer at Eniwetok, action was initiated for the renovation and return of apparatus on loan from the Military.

The maximum number of professional firefighers during the Operation reached a total of seven, which included two chiefs and five firefighters. While this figure was not constant, it did remain at a level which permitted assignment of one trained employee to each camp as it was established, and two at the main location on site Elmer. Manpower, in addition to the fireman for manning equipment, was dependent upon volunteers recruited from other Departments.

Since the principal storage, shop and User facilities were located on Elmer site, arrangements were made for members of the guard force on night duty to make three inspections nightly of the inside of the storage and shop buildings, and to maintain a watch for incipient fires while on jeep patrol through the area. Similar practice was followed at the Bikini locations with the exception that available personnel did not permit coverage by patrol during the later part of the night. Guards were instructed in the proper use of hand extinguishers.

The water supply for fire fighting was adequate for normal demands, and fire hydrants were regularily tested. Because the Marine Department had fire hazards peculiar to their operations, a close liaison was maintained with the resultant safe operation of sea craft.

In view of the high valuation of equipment and material involved in the Pacific Proving Ground operations, an exceptionally small total fire loss was experienced.

SANITATION

The control of insects on both Atolls was a continuing program. Changes in spray schedules and composition of the spray formula were made as required to overcome recurring insect infestation and to provide better coverage. Regular spray applications were maintained at all sites using fog smoke for entire coverage of each site and a liquid residual spray to critical areas. Hand spraying was routine in the mess halls and other buildings. Additional clearing of ground cover served to reduce a serious gnat infestion originally found prevalent at Bikini sites.

Small rodent problems were normally controlled by the use of traps, but on a few occasions it was necessary to use a rigidly supervised supplementary program of poisoned bait.

Periodic routine sanitation inspections were made and sub-standard conditions and practices were immediately referred to functional organizations with recommendations as to corrective action. Periodic checks of swimming areas were made by the use of dye markers and water sample analyses to make certain there was no contamination by sewerage.

SECTION 5
PROCUREMENT AND SUPPLY

Procurement procedures at the beginning of Operation CASTLE were, in essence a carry-over from Operation IVY, and no immediate increase in procurement personnel was necessary since the IVY demobilization level was adequate for the opening phase of CASTLE.

All procurement of subsistence supplies to be shipped overseas was covered by strict specifications arranged between the Jobsite and the Home Office Procurement Department. All branches of the food industry were, after close inspection of their plants and service facilities had been made, canvassed for bids for the supply of Holmes & Narver requirements. A thirty-day lead time was established after receipt of requisitions to request bids, assure delivery by vendors, receive, inspect and make final shipment. This cycle was completed every thirty days. Better methods of packing were conceived to ship highly perishable vegetables and fruits without undue loss. Green-leaf vegetables were delivered at Jobsite in a fresh condition up to five weeks after the date of purchase. Strict inspection of fresh meats and adherence to specifications resulted in shipment of quality products at minimum cost.

It had been determined, through advance engineering estimates, that cement would be in heavy demand. Past experience proved successful in negotiating the purchase of lumber on a blanket purchase order, and it was decided to use this same type of purchase order to fulfill cement requirements. This decision eliminated a large amount of paper work and detail involved in unit purchasing.

On 23 June 1953, a request was received from the Jobsite for 450,000 gallons of bitumuls, and delivery was required by 15 September. On 1 July, advice was received in the Home Office that a sizeable quantity of the bitumuls would be required in Honolulu not later than 21 July for transshipment in a Navy tanker. This presented a Stateside-to-Honolulu transportation problem since the Navy had no continental coastwise tankers available at the time, and commercial tankers are limited to their ability to carry this type of commodity because most ship bottoms are utilized for their own fuel supply or for fresh water. Through close cooperation between the Contractor and various oil and steamship companies, the problem was solved. Negotiations were concluded over the Fourth of July week end for space aboard the tanker Hawaiian Forrester, whose Captain agreed to take on additional fuel at Honolulu after the bitumuls were transferred to the Navy tanker. The balance of this bitumuls order was shipped directly from Wilmington, California aboard a Navy tanker on a direct sailing schedule to Eniwetok.

The transocean movement of four 585-ton barges from California to Eniwetok was an interesting accomplishment. The barges were released by JTF SEVEN, Washington, D. C. from a remote section of the marine storage activity at Rio Vista, California, and were towed by the U. S. Army from the fresh water Mayberry Slough to the Army base in the San Francisco Bay, where the barges were specially outfitted for the long haul to the Marshall Islands. From the Bay Army base, Navy tugs USS Tawasa and USS Munsee each towed two barges to Pearl Harbor; at Pearl Harbor the Navy Tugs USS Mectobi and USS Hitchiti took over and towed the barges to Eniwetok Atoll. The entire water movement was accomplished without damage or delay.

EXPORTING AND PACKING

Packing of material and equipment for export was a function of the Procurement Department's Traffic Section. Where export packing was not provided by the vendor, it was accomplished either under a contract with Pacific Ports Industries, Oakland, California, or by the Holmes & Narver warehouse personnel in Los Angeles. The methods and procedures used in handling the exporting and packing coincided as nearly as possible with customary methods established by the Bureau of Foreign and Domestic Commerce - U. S. Department of Commerce.

Scheduling of all shipments began with the receipt of requisitions. A requisition received in the Home Office was first directed to the Chief of Operations' office to determine the most feasible means of transportation. The purchase order was then written as determined by the Material Control Section. In many cases during the program in which the purchase order called for water shipment, a change had to be made to air freight due to the urgency of the work involved.

Material scheduled for transshipment to the Proving Ground via water was delivered by the vendor to the Naval Supply Center(NSC) in Oakland where it was manifested and held for loading aboard cargo vessels. The Western Sea Frontier allocated space aboard the vessels according to the amount of Holmes & Narver material to be shipped. A Contractor representative was stationed at NSC to receive and schedule all water shipments. If the material was to be shipped by air freight, a priority permit was required. All materials received at NSC or Travis were checked for proper packing and marking for shipment to Jobsite.

TRANSPORTATION

AIR SHIPMENTS. During the period from 1 January 1953 to 30 April 1954, air freight shipments amounted to 603,205 lbs. The two peak months were November and December 1953, when air freight shipments reached 98,198 and 89,184 lbs. resepctively. The shipment of such large quantities of air freight was accomplised through close cooperation between Holmes & Narver representatives and Air Force Base personnel. However, temporary delays of air shipments from Travis occurred in a few instances due to the higher priorities given to Military material. Refer to Figure 3-7.

WATER SHIPMENTS. During this same period, 1 January 1953 through 30 April 1954, water shipments amounted to 33,695.6 long tons of cargo. The two peak months were June and July 1953 with shipments of 5,447.1 long tons and 5,270.6 long tons respectively. Refer to Figure 3-8.

SCHEDULING. Cargo for transshipment by water was allocated space aboard a cargo vessel or refrigerated ship (reefer) by Naval authorities at the Naval Supply Center, Oakland. On receipt of notification concerning vessel availability, preparations were made for receiving as much material as possible for loading. Where perishable commodities were concerned, Jobsite requirements for any particular month determined the amount of space allocated aboard ship. As a general rule, shipboard space was allocated for H&N use on one cargo vessel and one reefer ship per month. During some of the peak periods, two cargo vessels a month were assigned to transport materials and supplies to both Eniwetok and Bikini Atolls. (Materials were scheduled for air freight when requirements at the PPG were such that this faster method of transshipment were essential.)

RECORDS, INVOICES, CLAIMS

Basic records covering the transportation of materials included the U. S. Navy Ship's Manifest, which was prepared by Naval Agencies and then forwarded to the Contractor's Home Office. An air manifest covering air freight shipments was prepared by the H&N representative at Travis Air Force Base and forwarded daily to the Home Office. Copies of all manifests and supporting documents were dispatched to the Jobsite forces for advance information.

Claims for damaged and lost materials were initiated and processed by the Traffic Section and then referred to the Home Offfice Accounting Department for disposition.

STORAGE

When non-perishable material or equipment was received at either the warehouse in Oakland or the Holmes & Narver warehouse in Los Angeles, it was immediately inspected for quantity and description as set forth in the applicable purchase order. The necessary papers (the Receiving and Inspection Report and the Over, Short or Damage Reports) were executed by the receiving warehouse. In most cases, the material was immediately processed for export packing and shipping. Very little storage was required in either the Contractor's warehouse or the export packer's warehouse during this Contract; the received materials were loaded on carriers for transfer to NSC or Travis within a few days. All perishable goods were delivered by the vendor directly to the Haslett Warehouse Company in Oakland. This firm was under contract to Holmes & Narver for receiving, storing and delivering perishable cargo to NSC Oakland. Perishable materials were stored in either refrigerated or ventilated rooms (as required); storage periods were brief.

SHIPPING

Most materials and supplies requisitioned by Jobsite were purchased from Los Angeles and San Francisco Bay area vendors in most cases, the shipment from these vendors to the export packers or the Naval Supply Center was accomplished by truck lines. However, in a great many instances, a prime vendor reordered from a subvendor whose material had to be shipped from the east or midwest. This caused many and varied expediting and transportation problems in meeting overseas schedules. Due to the proximity of the Pacific Ports Industries plant to the point of water or air loading, shipment from the packing plant to the port was made by rail and truck lines only; no air freight was required. For perishable commodities, shipment was made from the Haslett Warehouse Company in Oakland to the point of loading by either refrigerated truck or refrigerated rail car, depending upon the size of the shipment.

All packages were stencilled on at least two surfaces with the consignee designator (such as FOGS-H&N-AP-304-EE). Added to the designator was the requisition number, purchase order number, and a lot number. A blue "X", indicating Holmes & Narver, was placed on all visible surfaces. Labels were attached as cargo designators as follows: blue for general cargo; red for flammable liquids; white for acids and corrosives; and yellow for flammable solids and oxidizing materials. The gross weight, gross cube, and dimensions of each container were indicated. One packing list in a water proof container was stapled to the outside of the box or crate, and one packing list was placed inside the package.

All documents pertaining to purchase orders and transportation (including receiving reports, inspection reports, vendor packing lists, and Jobsite receiving reports) were kept in a numerical purchase order file in the Home Office Traffic Section. Documents were checked to determine if the applicable purchase order had been completed; if completed, the documents were consolidated into one file containing a complete record of purchasing activity from the requisition through the Jobsite receiving report.

INSPECTION

On-continent inspection functions were performed by the Procurement Department's Inspection Section. Inspection was required on

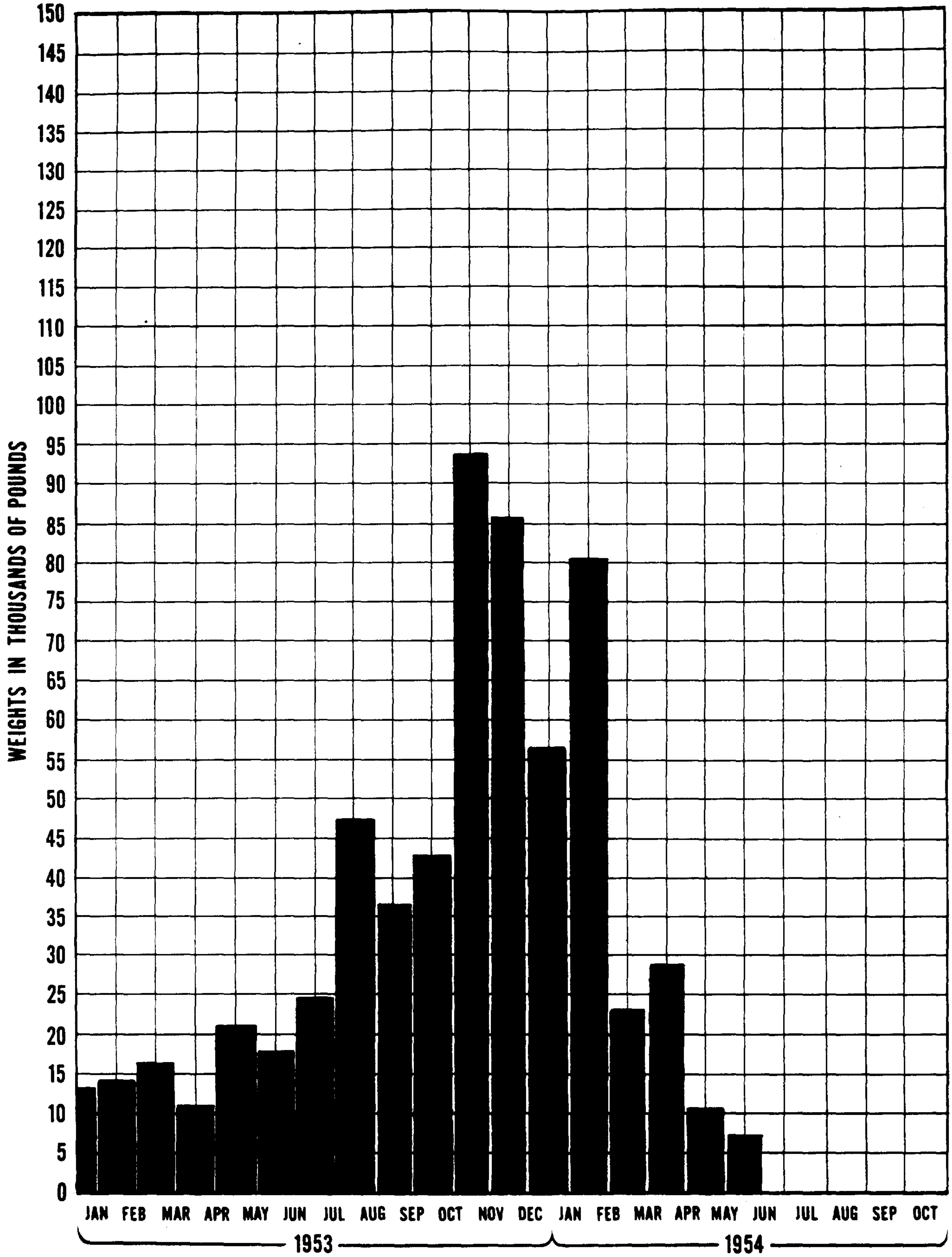

Figure 3-7. Monthly Air Shipments

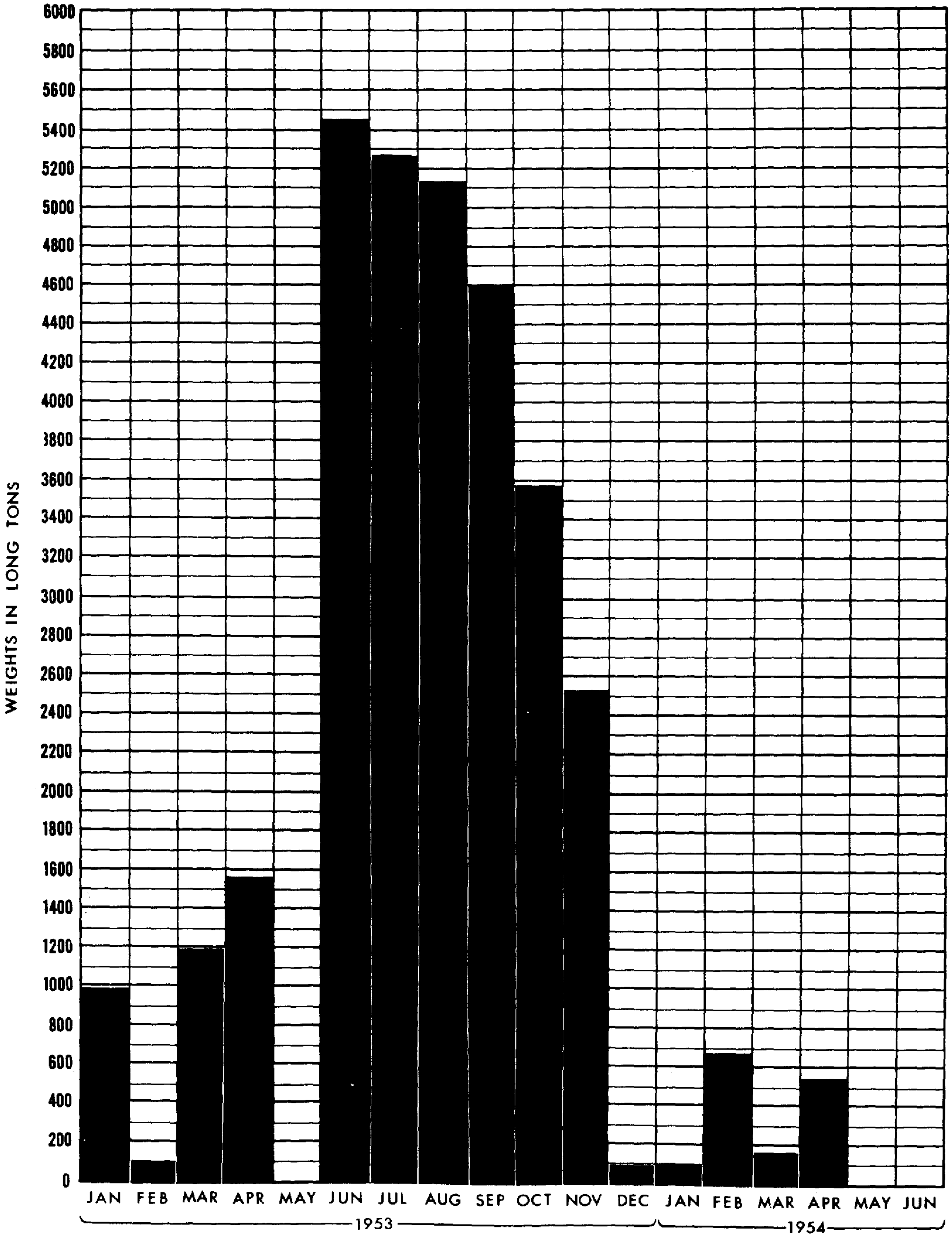

Figure 3-8. Monthly Water Shipments (Long Tons)

practically all fabricated structures, equipment, materials and goods shipped to the Proving Ground. These were generally divided into four main categories: specially designed and fabricated structures, electrical equipment, replacement parts, and subsistence supplies. The U. S. Department of Agriculture Inspection Service aided in the inspection of subsistence supplies. Inspectors activities were carried out on a daily assignment basis, and reports were made out and filed on each inspection action.

An extensive inspection activity was required early in the Program on a large quantity of 8-inch O. D. spiral-welded pipe during fabrication in the vendor's plant at Berkeley, California. The order had been placed by the University of California, which had requested that inspection of the pipe be made by Holmes & Narver. Since the pipe had a relatively thin wall and was furnished in 40-foot lengths, special wooden crates were built to insure delivery of the pipe without deformation. Practically all lumber used in the crates was designed to be salvable at Eniwetok.

Whenever construction schedules permitted, special and custom electrical fabrications and devices were operated and tested under simulated loads to insure that only top-quality operable equipment would reach the Jobsite.

The inspectors exercised particular care on replacement parts to make certain that no substitutions by vendors were made. In order to provide rapid identification at Eniwetok, all such parts were marked to show the item and part number; like parts were individually tagged and bagged.

INTERNAL CONTROL

The following statistics cover the periodfrom 1 January 1953 through 31 April 1954:

MONTH	REQUISITIONS RECEIVED	PURCHASE ORDERS ISSUED	VALUE
January	407	225	$ 431,980.12
February	496	413	391,843.91
March	446	480	509,634.12
April	416	483	1,226,633.48
May	777	468	981,843.15
June	686	727	1,745,205.46
July	849	895	1,370,630.73
August	689	964	1,504,580.57
September	787	836	1,014,275.96
October	763	847	1,339,083.00
November	675	786	568,851.00
December	722	744	608,615.00
January	534	651	352,927.44
February	389	501	257,214.97
March	282	405	197,981.74
April	197	168	85,946.58
	9,115	9,593	$12,587,247.23

Petty cash transactions for this period amounted to 1,276 actions, with a dollar amount of $11,545.76.

The following reports were prepared in compliance with AEC procurement procedures:

REPORT NUMBER	TYPE OF REPORT
AEC-328	Procurement Action of $25,000 or more.
AEC-329	Procurement Actions of Subcontractors of $25,000 or more.
AEC-330	Summary of Procurement Actions.
Quarterly Small Business Report	Percentage of business placed with small business firms.

In order to maintain required deliveries, it was necessary in some cases to ask for priority assistance from the Defense Requirements Branch, Supply Division, AEC, Albuquerque. In a few instances, a directive was placed on the vendors and manufacturers.

JOBSITE WAREHOUSING AND MATERIAL CONTROL

Original planning for OPERATION CASTLE contemplated that all incoming materials, supplies, refrigerated cargo and bulk fuel would first be off-loaded at Elmer on Eniwetok Atoll and from there transshipped to Bikini Atoll as needed. With the expansion of the program from its original concept, the need for direct off-loading at Bikini Atoll for some cargo became apparent. This was accomplished with the arrival of the USNS Lt. Robert Craig in June 1953 with general cargo. Figure 3-9 shows the unloading of a fire crash truck from the USS Craig, anchored in the Bikini Lagoon to the deck of a "T" boat. Figure 3-10 likewise shows the method of off-loading in the Bikini Lagoon. In this latter figure, T. G. 7.1 equipment is being transferred from an LST to a "T" boat. The USS Arequippa off-loaded at Bikini in September 1953 with refrigerated cargo, and the USS Natchong in September 1953 with bulk fuel. Figure 3-11 shows method of shipping two Camco trailers in the midship hold of the USS Craig. Figure 3-12 shows the unloading of these trailers in the Eniwetok Lagoon.

At Bikini Atoll, cargo vessels were off-loaded by stevedore gangs organized from Holmes & Narver constructive personnel. The vessels anchored in the lagoon and the freight was ferried by landing craft from ship side to the beach. To lessen the time that refrigerated cargo would be out of refrigerated spaces during the unloading operations, DUWKs were placed in LCM boats and loaded with the refrigerated cargo. As soon as the LCM beached, the loaded DUWKs were driven directly to the cold storage area.

At Eniwetok Atoll, stevedoring on shipboard was performed by U. S. Army personnel provided by Task Group 7.2. Vessels anchored in the lagoon and landing craft were used to ferry the cargo to the cargo pier at Elmer. The

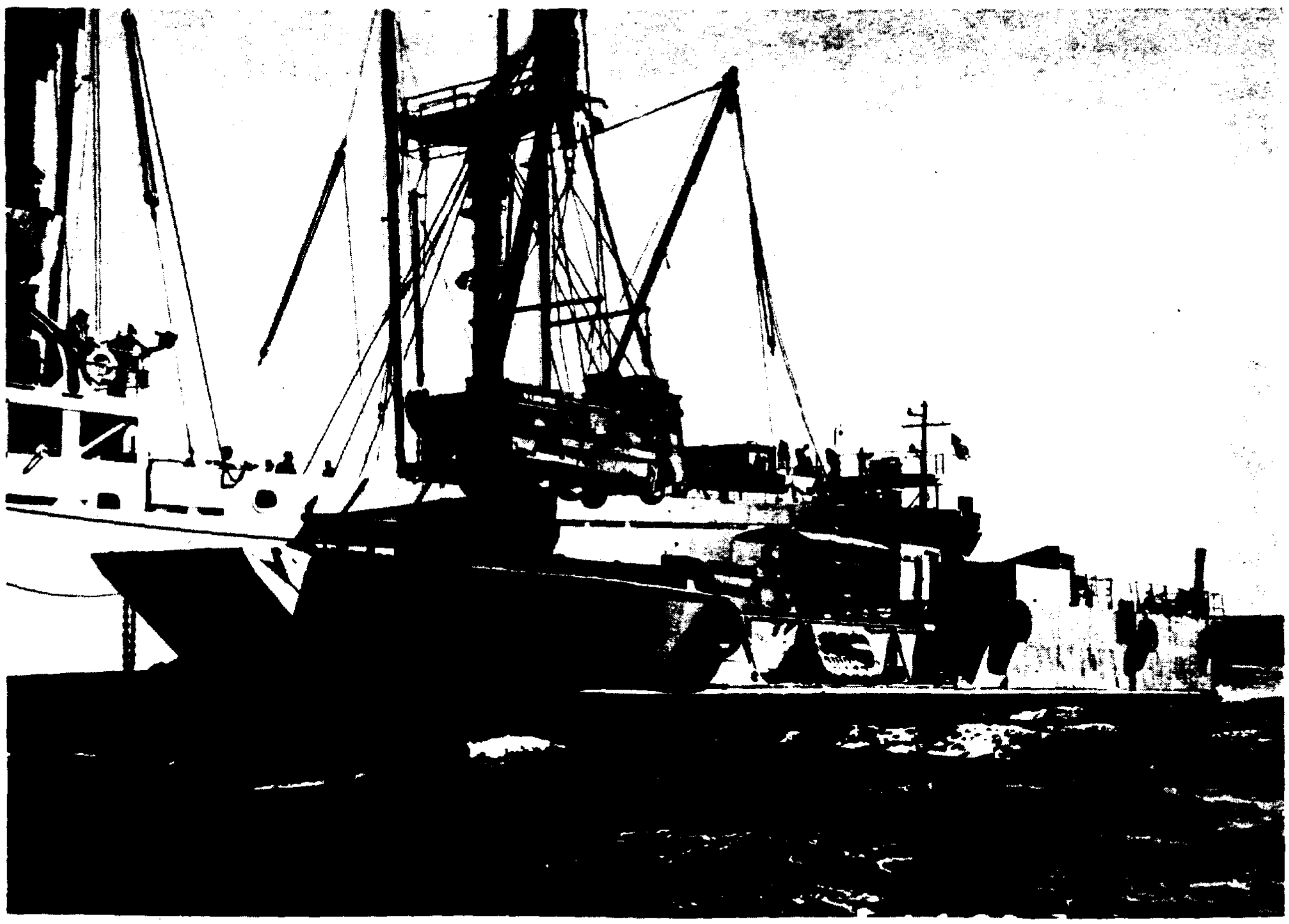

Figure 3-9. Unloading Fire Crash Truck from USS Craig

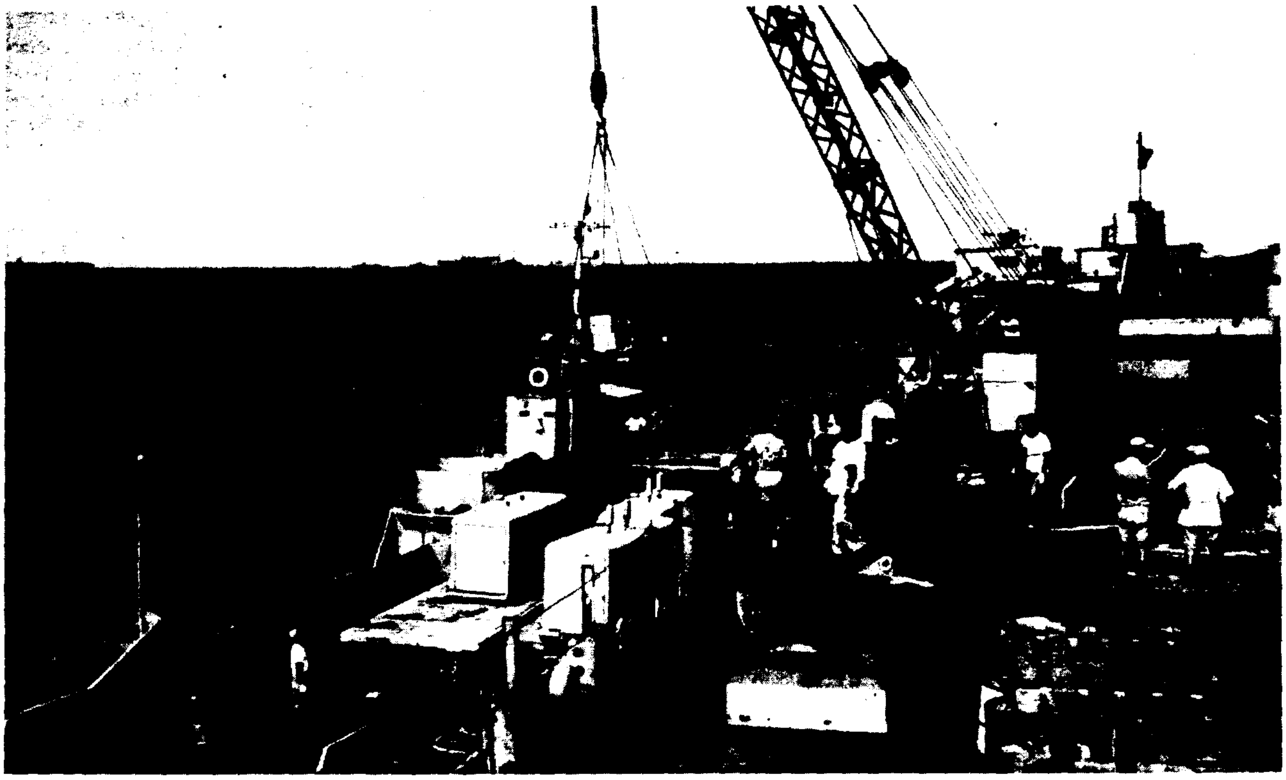

Figure 3-10. Method of Off-Loading in Bikini Lagoon

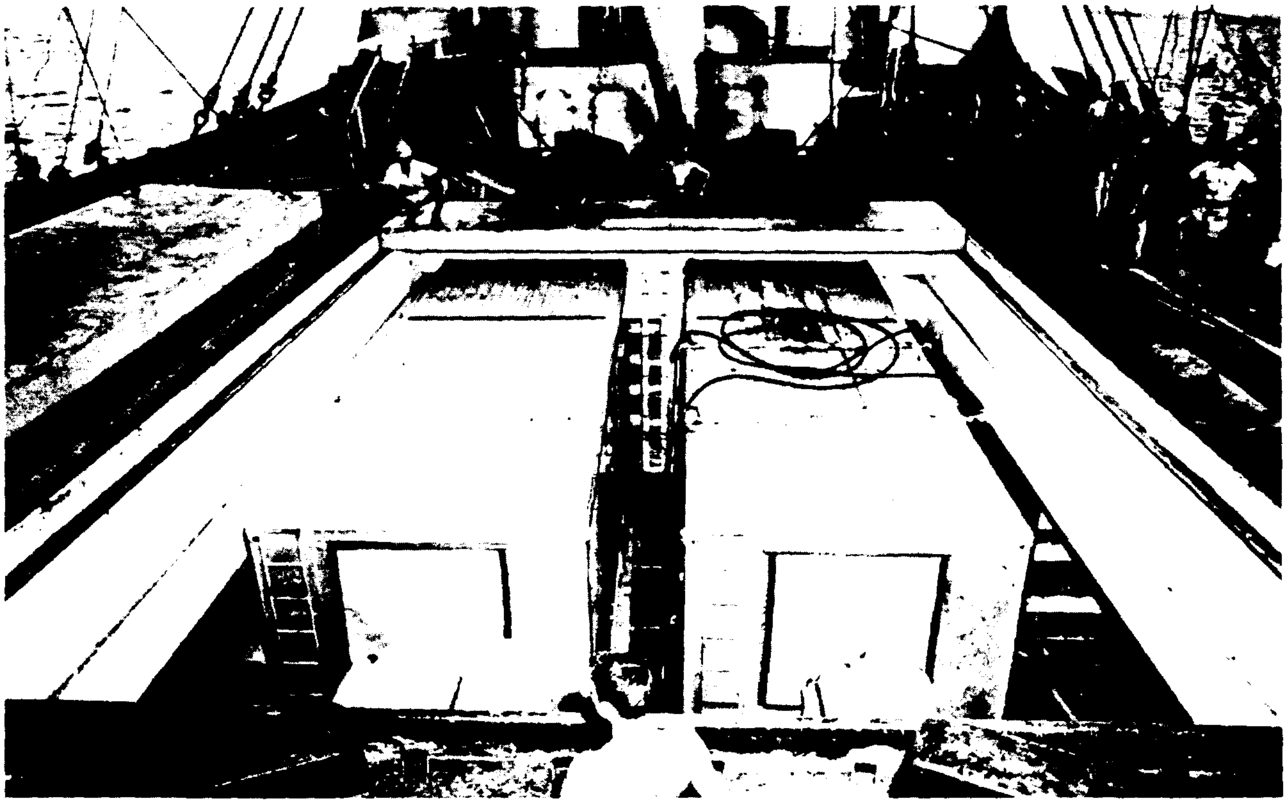

Figure 3-11. Camco Trailers in Midship Hold of USS Craig

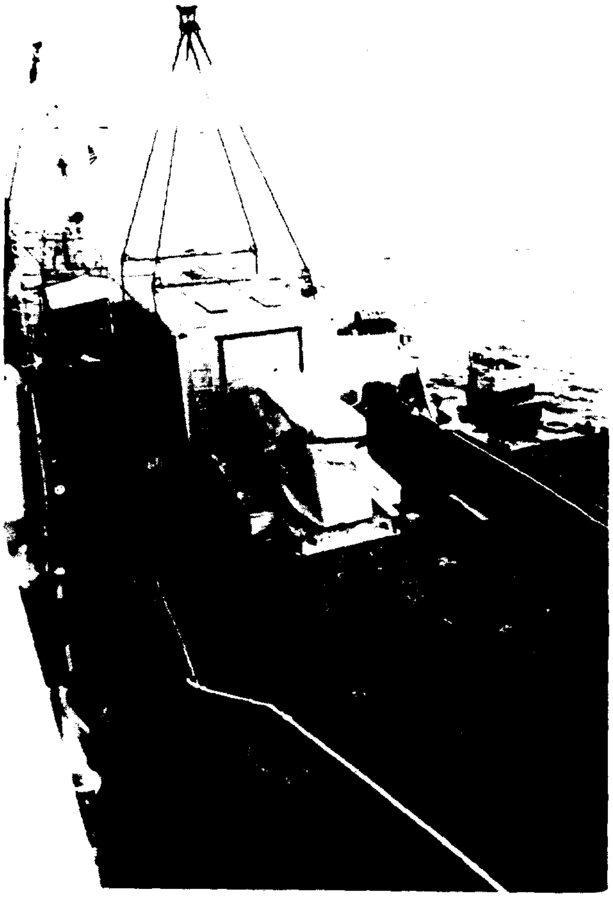

Figure 3-12. Unloading Camco Trailers, Eniwetok Lagoon

direct movement of refrigerated cargo from the pier to the cold storage area was accomplished by mobile forklifts.

Bulk fuel was delivered to the tank farms located on sites Elmer, Fred and Sugar through submarine piping systems. Tankers tied-up to the POL mooring buoys which were located off-shore at each tank farm. The submarine lines terminated in hose which was connected by chain to a third buoy. This chain was used to pick up and relay the hose for all fueling operations.

Six warehouses, each 24' x 60' were constructed at Bikini Atoll for OPERATION CASTLE. Four of these were located at site Tare and one each at site Fox and site Charlie. Of the four at site Tare, two were used for general stores and two for subsistence stores. The warehouses at sites Fox and Charlie were used for general stores. At site Nan, part of the electrical shop was utilized for general storage. Since the more remote camps drew their stores directly from Tare, no subsistence warehouses were erected at the other sites. However, each of the off-island camps was provided with an 8-man tent for use as the Commissary issue room and for storage space. There was 63,374 square feet of floor space in various warehouse structures at Elmer, and 512 square feet at Ursula. Figure 3-13 shows warehouses Nos. 501, 502 and 503 on site Elmer, which were constructed under project 3028, Item A-38-A, and completed in January 1953. Figure 3-14 shows the bin arrangement in the Plumbing Warehouse, Building No. 502.

Outside storage areas were provided as follows:

Site Tare	50,000 sq. ft.
Site Charlie	15,000 sq. ft.
Site Fox	15,000 sq. ft.
Site Nan	5,000 sq. ft.
Site Elmer	368,670 sq. ft.
" " (Classification yard	53,000 sq. ft.
Site Ursula	6,340 sq. ft.

The outside storage area at Nan is shown in Figure 3-15.

All incoming cargo was checked upon arrival on shore, and the storage destination was designated. Upon arrival at the storage area, all boxes or containers were opened and contents were checked against the packing list. If discrepancies appeared, an Over, Short or Damage Report was initiated.

The Superintendent of Supply was furnished a list of the personnel who were authorized to sign stores requisitions and shipping requests. To withdraw material from a warehouse, it was necessary to present a stores requisition signed by an authorized person. For interatoll or intra-atoll cargo movement, a shipping request was initiated indicating the use feature at destination. Interatoll scheduled shipments were generally made via LST, but, regardless of the type of vessel, every interatoll ship movement necessary for any reason was utilized to the maximum extent for carrying cargo between atolls. The interatoll shipment of cargo is depicted graphically in Figure 3-16.

JOBSITE MATERIAL AND PROPERTY CONTROL

During the Operation, requisitions were screened through Kardex records before materials were issued, to insure that allocated materials were not being used for other purposes or, if the materials were released for use, that adequate replacements or substitutions were available or procured. Allocations of materials were made against specific or general construction commitments until such time as definite requirements were known, at which time they were posted to use features. Reviews were made of stock levels against established re-order points, and maintenance stock replacement requisitions were subsequently initiated for items

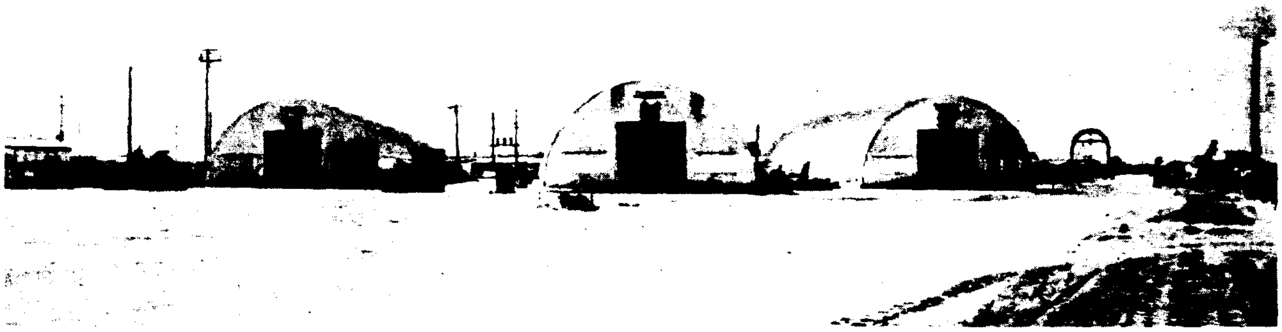

Figure 3-13. Warehouses 501, 502 and 503 on Site Elmer

Figure 3-14. Bin Arrangement, Plumbing Warehouse 502

Figure 3-15. Outside Storage, Site Nan

which were of a standard stock nature. Cards were flagged, as prescribed, to indicate the actions taken.

Stock records reflected in detail the unit and total costs of items in stock. The dollar values supported the Accounting General Ledger and were in turn supported by proper documents on file. A monetary control ledger was maintained in which was recorded current balances by commodity groupings essentially similar to those listed in AEC Bulletin SF-ACC-8 (SN193), and by subgroupings by warehouse sites and by classification as construction or maintenance stocks.

Physical inventories of all commodities were taken and applicable adjustments were made to records at least twice during the Operation. These inventories were audited, and the findings were used in establishing better physical and documentary control of stores. Property items were allocated, issued and controlled in a similar manner, except that they were recorded by individual equipment numbers and were permanently tagged. Upon retirement, a survey report was processed, and the permanent property card was so noted. Continuing location cards were maintained on capital equipment, and two physical inventories of all such equipment were accomplished during the Operation.

EXCESS MATERIAL AND PROPERTY

A program was initiated early in the Operation for reporting and utilizing materials which were in excess of normal maintenance requirements or which remained at Jobsite from previous Operations. Experience usage records on stock items were established with revisions being made as usage changed. Long Supply Reports were prepared quarterly and distributed at the Jobsite as well as the Home Office. Wherever possible, items in long supply were used in engineering design in preference to procuring new items. The Santa Fe Operations Office was requested for advice as to the disposition of those materials for which no possible usage was anticipated. The excess materials reporting program, as presently in force, was not adopted until the Fall of 1953, but these materials were included previously in Long Supply Reports.

The basic reporting program included reporting as excess all items for which no use was known or anticipated. All other items not allocated or committed for construction which were in excess of one year's maintenance requirements were reported in long supply. Reports were made on a cycle basis and were subject to approval by the Project Manager and to audit by the Resident Controller.

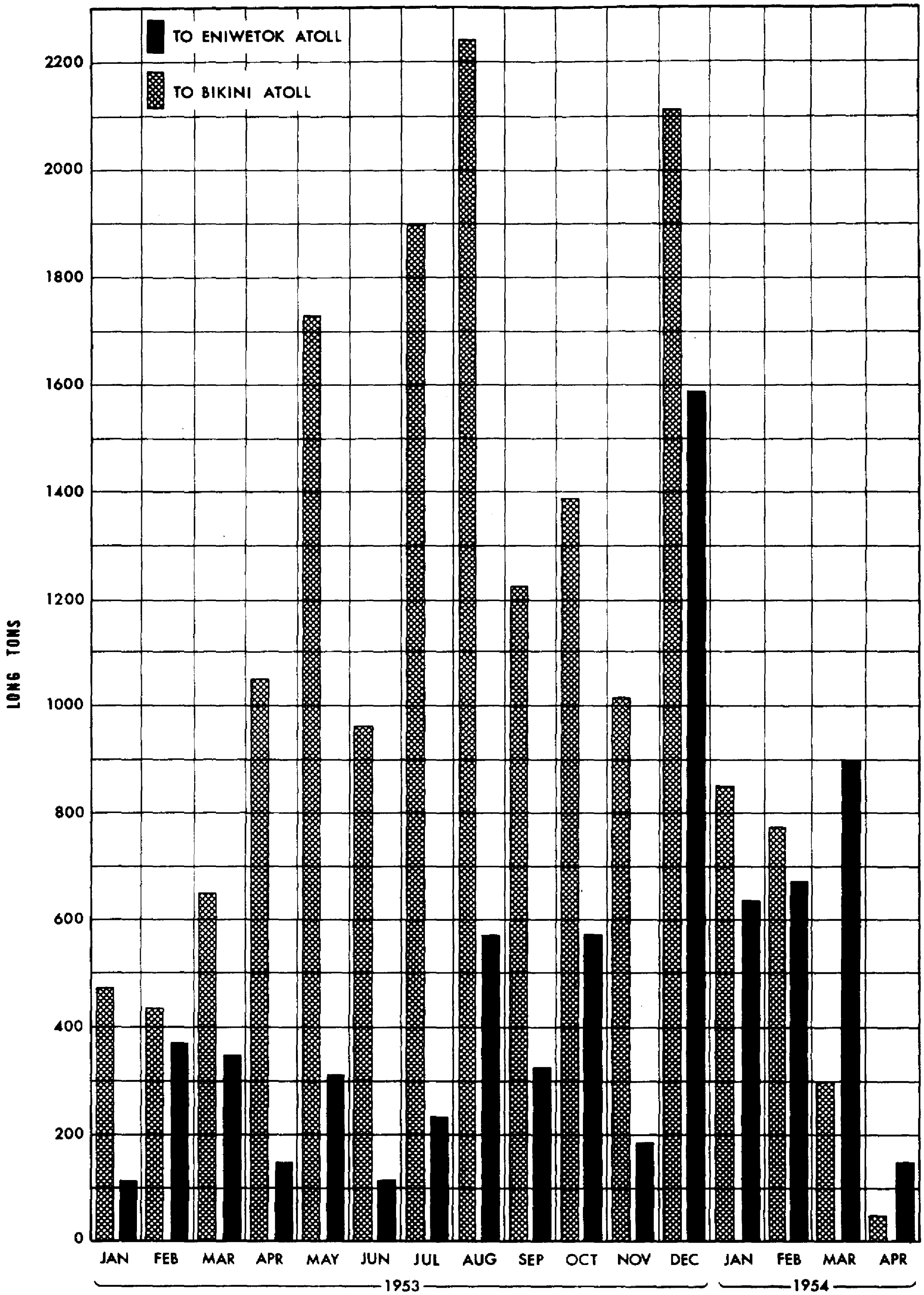

Figure 3-16. Interatoll Cargo Shipments

SECTION 6
SECURITY

GENERAL

The security requirements for OPERATION CASTLE were essentially the same as those established for OPERATIONS GREENHOUSE and IVY. The Contractor's Security Department was responsible for formulating policies and implementing procedures on a company-wide basis to insure compliance with existing Atomic Energy Commission security directives, and for safeguarding the mission of the Proving Ground by educating employees in security consciousness.

Reporting to the General Manager, the Holmes & Narver Chief Security Officer was responsibile for all phases of the security program, both in the Home Office and at Jobsite, and was aided in carrying out this responsibility by an Assistant Security Officer.

A full-time Holmes & Narver Security Officer, reporting functionally to the Project Manager, and technically to the Chief Security Officer, was assigned to the Pacific Proving Ground and was responsibile for the security of all Holmes & Narver activities at the forward area. The Chief Security Officer, however, was responsible for selecting qualified Security personnel, properly indoctrinating them, and providing complete and comprehensive material relative to Security procedures and processes. As the Operation progressed, two Assistant Security Officers were assigned to the Jobsite Security Officer; one at Bikini Atoll and one at Eniwetok Atoll.

The Honolulu Office Manager was selected as the Security Representative for Hawaiian Island activities. Although he reported to the Chief of Operations, technical guidance in security matters was provided by the Security Officer and his staff.

All personnel clearances were processed and all identification media were produced in the Home Office Security Department. Every applicant processed was photographed and fingerprinted. The Security Department prepared all identification forms, cards, and badges as well as requests to the Port Control Director, Long Beach Naval Station, for the issuance of Government travel orders. Pre-employment information, provided by the Industrial Relations Department, was used as a basis for obtaining a limited non-governmental background investigation. In addition, Security was responsible for maintaining, coding, and disseminating all derogatory information received, and for preparing all papers which accompanied the Personnel Security Questionaires submitted to the Atomic Energy Commission, Los Angeles Security Branch, for security clearances.

Liaison with governmental agencies, both local and national, resulted in the execution of a tighter security program than would otherwise have been possible. Information secured from these various sources proved to be of special value in the personnel security program. The favorable security record maintained by contractual people during the Operation was attributable in large measure to the expeditious processing and broad cooperation afforded to Holmes & Narver by the Los Angeles Security Branch of the Atomic Energy Commission. Operational security arrangements in existence prior to the commencement of OPERATION CASTLE provided that AEC's Los Angeles Security Branch undertake the responsibility of processing all Holmes & Narver employment applicants under the personnel clearance program. The Los Angeles AEC Security Branch also provided the Eniwetok Field Office with security surveys of the various facilities and premises of the Holmes & Narver Home Office.

PERSONNEL SECURITY

Because security is one of the most important considerations in conducting an Operation, every effort was made to employ only those individuals who could be trusted not to disclose classified information to unauthorized persons. To accomplish this, each applicant was processed in accordance with AEC standards. There were two basic types of clearances: the "P" Approval, which authorized access up to and including Secret-Defense Information, Non-Restricted Data; and the "Q" Clearance, which authorized access to information classified Restricted Data, as defined in the Atomic Energy Act of 1946. The "P" Approval was predicated upon the results of a name and fingerprint check of the files of the Federal Bureau of Investigation and other national agencies, as applicable. The "Q" Clearance was granted upon the results of an exhaustive background investigation which was conducted by either the FBI or the Civil Service Commission.

There were a few deviations from basic clearance mechanics. Where little, if any, access to classified information would be had by a potential employee, and where his services were so urgently needed that the Operation would suffer without them, provisions were made to grant the applicant either a Local "P" Approval or a "Q" Emergency Clearance. The Local "P" Approval was based on the results of a name check of local law enforcement and Federal Agencies and could be obtained only if the applicant resided in the local area for at least the last ten years. The "QE" also was based upon the results of a local and sometimes a national check by agencies. Both types of clearances were strictly temporary, and the prior approval of the Field Manager, Eniwetok Field Office, had to be secured before processing could be started. Simultaneously with the request for either the Local "P" or the "QE" Clearance, a formal request was made for the conventional "P" or "Q." Where the applicant had previously been granted a "Q" Clearance with another activity and his "Q" Clearance had lapsed, a "Q" Reinstatement was requested.

At the inception of OPERATION CASTLE, each employee was required to have at least a "P" Approval before he was authorized to enter the Pacific Proving Ground. During May, 1953, the Eniwetok Field Office notified Holmes & Narver that, subsequent to 1 January 1954, no individual would be allowed to enter the Pacific Proving Ground nor remain at the PPG without a "Q" Clearance. To plan for compliance with this directive, it was decided that requests for "Q" Clearances should be made prior to 1 September 1953 for employees who would be at the Pacific Proving Ground subsequent to the cut-off date. Accordingly in only a few instances of emergency were individuals allowed to proceed to the PPG after 1 September 1953 if they had not been placed in process for a "Q" Clearance prior to that date.

All security papers necessary for obtaining clearances were submitted to the Atomic Energy Commission's Los Angeles Security Branch. Prior to the submission of security papers each applicant was screened from a professional and character standpoint to determine his eligibility for further processing. This screening was accomplished not only by contacting previous employers and personal references, but also by utilizing two national private investigative agencies. As a result of information received from these sources, approximately 11% of the applicants were removed from security processing. Information obtained from local law enforcement and Federal Agencies in the area was helpful in weeding out those individuals who could not meet established security requirements. Of the 4,293 requests for "P" Approvals, 2,979 were granted; of the 4,288 requests for "Q" Clearances, 1,329 were granted. Of the 450 requests for "Q" Reinstatements, 444 were received; 425 requests for Local "P" Approvals were requested and received. The average time required for AEC processing of "P" Approvals was 36.03 days; for "Q" Clearances, 101.72 days; for "Q" Reinstatements, 18.82 days; and for Local "P" Approvals, 4.5 days.

A meeting was held 9 April 1953, attended by representatives of the H&N Security Department, AEC Security representatives from the Santa Fe Operations Office, and from the AEC Los Angeles Security Branch, wherein it was decided that all clearances would be cancelled by the AEC Los Angeles Security Branch ninety days after the date of granting unless the individual had been placed on the Holmes & Narver payroll by that time. A similar provision pertained to terminating employees; their clearances lapsed unless they were re-hired within ninety days. In order to affect this procedure a form was prepared for each hired applicant, setting forth the individual's full name, his AEC number, his next of kin and address of next of kin, and the individual's type of clearance. This form was transmitted to the AEC Los Angeles Security Branch, the Eniwetok Field Office Security Representative at the Pacific Proving Ground, and the Eniwetok Field Office, Albuquerque, New Mexico. The form served not only to notify all concerned that H&N was employing the applicant, but also to notify the Department of State of the overseas travel of an individual. Upon hiring of an individual, either in the Home Office or at Jobsite, his clearance status was made known to his supervisor.

Entry into the Pacific Proving Ground was controlled by the Commander-in Chief of the Pacific Fleet, and in order to gain entry, an individual had to be certified as a good security risk. The Port Control Director, Long Beach Naval Station, was the Military representative authorized to sign all overseas identification cards and all travel orders for individuals traveling to the Pacific Proving Ground.

In May 1953, when H&N was advised that any employees who would be at the Pacific Proving Ground subsequent to 1 January 1954 would require a "Q" clearance, the Security Department requested the AEC to commence processing applicants for "Q" clearances. However, requests for "Q" clearance processing on applicants was suspended until "P" approvals were received, thus precluding a costly "Q" clearance processing on those individuals who would not be granted a "P" approval.

It was decided that all employees signing one year contracts after 1 June 1953 would be placed in process for "Q" clearances. By 15 June 1953, the Jobsite had selected those "P" approved personnel who were desired after the "cut-off" date, and they were placed in process for "Q" clearances. After 15 August 1953, all applicants whose services were required after the "cut-off" date were placed in process for a "QP" clearance.

The date 1 September 1953 had been established early in the Operation as the "limiting date," after which an individual normally could not proceed to the Pacific Proving Ground unless he was in process for a "Q" clearance. Changes in the planning during August 1953 made this date unrealistic because the personnel requirement was increased from 1,850 to 2,500. The result was that a considerable number of individuals who were not in process for a "Q" clearance by 1 September 1953 were sent to the Jobsite with the understanding on the part of Management that the employee would not be allowed to remain at the Pacific Proving Ground after the "cut-off" date if his clearance had not been received by that date.

As the "cut-off" date approached, lists of uncleared employees were transmitted to the Atomic Energy Commission so that the Civil Service Commission and the FBI which individuals in process should be afforded preferential handling. During the latter part of December 1953, the Eniwetok Field Office extended the "cut-off' date to 24 January 1954; this extension relieved the clearance situation to some extent. As of the "cut-off" date, there were approximately 32 individuals who had not yet received their "Q" clearances. Twenty of these employees were allowed to remain in the forward area due to the fact that their services were urgently required on Eniwetok Island after the "cut-off' date.

PHYSICAL SECURITY

All physical security measures were implemented as directed by the Commission's General Manager, the Manager, Santa Fe Operations, and the Field Manager, Eniwetok Field Office. The responsibility to protect classified matter extended to every location in which Holmes & Narver had a security interest.

At the start of the Operation, the Home Offices were located at 816 and 824-828 South Figueroa Street, Los Angeles 17, California. On 24 July 1953, the offices at 816 South Figueroa Street were moved to 751 South Figueroa Street.

At the outset, one limited area located at 824-828 South Figueroa Street was devoted exclusively to the drafting and engineering activities related to the Operation. Access to this area was controlled by an armed, "Q" cleared guard. On 25 January 1954, this limited area was altered to a controlled area, thus allowing access to "P" approved personnel. With the changing of the area from a limited to a controlled area, all Restricted Data was transferred to the Central Files Section at 751 South Figueroa Street. Specific security areas at the 816 address were the Teletype Sigtot Room, which was established as an exclusive area, and the Central Files Section, which was established as a limited area. Access to the Sigtot Room was restricted to only those "Q" cleared employees authorized to enter. All individuals entering the area were required to sign a register. After the move to the 751 address, these areas were protected security-wise as they had been while at 816 South Figueroa Street.

Due to the number of employees who were in various stages of security processing, badges were utilized as a media of identification for entry into the various areas. No visitors were allowed access to classified information unless Holmes & Narver had been given full advance details concerning the visit by the AEC. Upon entry to a controlled, limited, or exclusive area, the visitor was required to sign the visitor's register, and all visitors were escorted while in the security areas. Visitors who were "Q" cleared were issued one type of visitor badge; non-"Q" cleared visitors were issued another type.

The Home Office was also responsible for the production and preparation of I. D. cards for overseas employees. These cards, in addition to the individual's photo and other information, carried the signature of the Port Control Director.

At both Home Office locations, guard service was provided on a 24 hour basis. Guards were armed, "Q" cleared, and trained in security procedures and fire detection. Hourly patrols were made during non-working hours. All repositories were checked on each patrol, as well as all areas of access to the buildings. In addition, an electronic photo-electric cell was installed to span the entrance to the offices in the 751 South Figueroa Street building.

At the Pacific Proving Ground, physical security was maintained by the Holmes & Narver Guard Force. During non-working hours, hourly patrols were made, repositories checked, and classified areas patrolled to guard against unauthorized entry. Guards continued the security checks for the entire Operation except during shot periods when the Military assumed this responsibility. With the great number of personnel involved, maintaining exact personnel clearance information became extremely important. The Security Officer at Jobsite maintained records on each employee arriving at the PPG. Individuals were issued badges according to the type of their clearance, their need for access, and the areas to which they were permitted in order to accomplish their assigned duties. All but a very limited number of employees (those assigned to site Fred where a "Q" Clearance was not required) were granted "Q" type clearances.

Classified documents arriving at or originated by the Honolulu Office were stored at Hickam Air Force Base, Honolulu. A moderate number of Confidental Defense Information, Non-Restricted Data documents were stored in the approved repository at Holmes & Narver's Honolulu offices.

Midway during the Operation, the President of the United States in his Executive Order 10,501 abolished one of the four security classifications: "Restricted." This left three classes

- Top Secret, Secret, and Confidential. Undisturbed in this order was the classification of Defense Information (known as Restricted Data) as defined in the Atomic Energy Act of 1946. The only immediate effect this order had on H&N security procedures was the requirement that all Confidential, Defense Information be registered when transmitted by U. S. Mail.

INFORMATION SECURITY

The scope of the activities of Holmes & Narver during the Operation, the numbers of personnel who required access to classified information, and the necessity for transferring voluminous classified documents between the Los Angeles Home Office and the Pacific Proving Ground dictated that uniform procedures and practices must be followed to insure that all classified information remained in the possession of authorized recipients.

All classified mail received in the Home Office was directed to Central Files. Papers were logged in and then delivered by messengers appropriately cleared and approved. Classified documents were delivered to the Pacific Proving Ground by "Q" cleared employees acting as couriers. For transmittals between the Home Office and AEC's Los Angeles Security Branch, the services of a "Q" cleared armed guard were used.

At both the Pacific Proving Ground and the Home Office, documents no longer required were destroyed in accordance with AEC security procedures.

The Field Manager, Eniwetok Field Office, delegated authority to the General Manager of Holmes & Narver to classify documents originated by H&N, and empowered him to redelegate to key personnel within the organization.

In addition to the foregoing, the informational control program included the establishment of practices and procedures to insure that all cleared personnel were aware of their continuing responsibility to the United States Government not to divulge classified information to unauthorized personnel. Each employee at the Home Office was given a security interview upon receiving his clearance, at which time the broad scope of the security program, was outlined, and examples were cited to point up the necessity for constant vigilance. Employees assigned to the Pacific Proving Ground were cautioned prior to departure, not to discuss anything concerning their job with their family, friends, or other individuals. A comprehensive security lecture was deferred until the employee arrived at the Jobsite. After having the lecture at the PPG, each employee took a written test. If the employee failed in the test, he was required to take it a second time. Top H&N management personnel were given a special lecture in addition to the over-all lecture delivered to general employees, and were required to sign a document acknowledging their security responsibility as management personnel.

In the Home Office, all terminating employees were given a security lecture and were required to execute and have witnessed by the Security Department a security termination statement, Form AEC-136, which included Section 10(b) of the Atomic Energy Act of 1946, The Internal Security Act of 1950, and Title 18, U. S. Code, Section 794. Jobsite employees were given a security lecture prior to their departure for their place of hire and were requested to sign the AEC Form 136. Upon arrival, whether it was at Honolulu, San Francisco, or Los Angeles, each terminating employee was again given a comprehensive security lecture, was again requested to sign the AEC Form-136, and was reminded of his responsibility to notify the Commission of any anticipated foreign travel. For those employees anticipating foreign travel, Holmes & Narver prepared Form AEC-290 and submitted it to the AEC, Los Angeles Security Branch.

SECTION 7
OFFICE SERVICES

To provide more efficient workability, the Office Services Department in the Home Office underwent a reorganization early in June 1953, and an Office Manager was placed in charge. The central file room, mail room, teletype room, telephone facilities, reproductions (except Ozalid prints), warehousing and records, stores issue, AEC car pool, furniture and equipment allocations, all maintenance work, and inter-office messenger service were assigned to this department.

The mail room handled approximately 2,500 lbs. of incoming mail per month, and an equivalent amount of outgoing mail. All mail was logged in and out by cleared personnel; mail was delivered within the Home Office by messengers runs daily.

The reproduction work required for Operation CASTLE, such as Multilith, Ditto, Mimeograph and Autostat, was produced by the Office Services facilities, and averaged 50,000 sheets per month (including the reproduction work requested by the Honolulu Office).

RECORDS CENTER

The AEC Records Program was inaugurated in May, 1952 on a part-time basis. By 1 July 1953, 56 records schedules had been forwarded to the Santa Fe Operations Office for approval; 415 cubic feet of records were forwarded to less expensive storage facilities; 220 cubic feet of records were transferred to the AEC Records Service Center at Los Alamos, New Mexico; and 149 cubic feet of records were destroyed. A full-time Records Officer was appointed on 1 July 1953, at which time the H&N Records Center started operating on a full-time basis. By the end of 1953, the Records Center holdings totaled 861 cubic feet, or double the amount reported for the preceding six months.

Reference services furnished from Records Center to the Home Office amounted to 83 in 1952, and 1,086 in 1953. The monthly average of reference services from 1 July 1953 to the end of the year was 166. In 1954, a peak of 994 was reached during the month of April, then gradually decreased to 161 in June 1954.

Investigations and studies regarding the possibility of microfilming all vital records were made. However, the space-saving advantage gained through the use of microfilm did not warrant the over-all cost of this undertaking in view of the fact that storage of vital records, by contractual agreement, need not exceed seven years.

COMMUNICATIONS

TELEPHONE. On 24 July 1953, the 120-position PBX in the Home Office was replaced with a 160-position board. Approximately 558 long distance calls a month were made over a seven-month period, including the peak period, and approximately 44,000 local calls were made for the same period.

TELETYPE. Teletype communications between the Home Office and Eniwetok were effected by means of the radio teletype facilities installed at the AEC Communications Center at Los Alamos and Eniwetok. All classified and unclassified messages were sent over this means by TWX to Los Alamos, thence over the radio teletype circuit direct to Eniwetok. Incoming teletypes were relayed by this same means to Los Alamos, and then in turn relayed on to Holmes & Narver, Los Angeles, by TWX collect.

During Operation IVY, classified messages to Eniwetok were encoded in the Contractor's Home Office, then transmitted to Los Alamos. Los Alamos decoded and re-encoded the messages for relay to the Task Group Communications Center at Eniwetok Atoll. In October 1952, prior to the commencement of CASTLE, a cryptographic system was issued for the Contractor's use in Los Angeles, and for the Communications Center at Eniwetok. This system enabled H&N to send and receive messages classified Restricted, Confidential, and Secret without the delay involved in having Los Alamos decode and re-encode these messages.

"Back-up" communication circuits were available in the event of failure of the radio teletype circuit. The "back-up" circuit operated from Los Alamos to the AEC Communications Center, Sandia; from there messages were sent over Military circuits to Fort Sam Houston, Texas, thence through the Sixth Army Headquarters at San Francisco. From San Francisco, messages were sent by Military radio teletype to the Communications Center at Oahu and from there to Eniwetok.

In July 1953, due to continued adverse atmospheric conditions resulting in the failure of the radio teletype circuit between Los Alamos and Eniwetok, Holmes & Narver was advised to file unclassified messages with the Army Communications Center in Los Angeles. These messages were then relayed to the Sixth Army Headquarters Communications Center, San Francisco, where they were sent by Military radio teletype to Oahu, and thence to Eniwetok and/or to H&N's office in Honolulu.

In March 1953, the Holmes & Narver Message Center in the Home Office was officially recognized by the Military as a "trained TWK tributary station of the Los Angeles Communications Center." As a result of this recognition, H&N was furnished Military Procedure Publications which enabled the Message Center to operate efficiently and in accord with other units of the circuit.

The Army Communications Center at Los Angeles was unable to accept Holmes & Narver classified messages prior to 5 April 1954 due to Military regulations governing encoded messages sent over TWX equipment. This equipment was, until that date, the type of equipment installed at the Home Office. The filing of classified messages continued through Los Alamos. However, after 5 April 1954 new equipment, formally known as an AKAN circuit, was installed at the Holmes & Narver Home Office, and encoded messages were permitted via a leased line to the Army Communications Center in Los Angeles.

To expedite procurement, teletype facilities were also employed between the Contractor and commercial companies within the United States.

The peak in H&N's teletype traffic was established during the months of August and September. A monthly breakdown of the teletype traffic transmitted and received for the period 1 January 1953 through 31 December 1953 follows:

	SENT	RECEIVED	TOTAL
January	232	439	725
February	254	521	775
March	272	617	889
April	344	687	1,031
May	376	713	1,089
June	367	731	1,098
July	462	895	1,357
August	476	940	1,416
September	493	949	1,442
October	466	894	1,360
November	434	819	1,253
December	406	731	1,137

CHAPTER IV
SERVICE OPERATIONS

SECTION I
CAMP OPERATIONS

GENERAL

The engineering and construction effort was self-sustaining during the entire period of facilities development for OPERATION CASTLE at the Pacific Proving Ground. Quarters, living facilities, and camp services were operated by the Contractor to house and sustain all personnel of Joint Task Force SEVEN, except those men living in Naval Vessels, or at Site Fred, which was the Eniwetok military garrison. The peak supported population of 3398 was reached in February 1954. Life on the atolls was subject to many restrictions due to security regulations and the geography. The absence of women, the minimum community, and the sustained tension of a tight construction schedule combined to give the area the atmosphere of a military combat mission. Under such conditions, the quality of the basic essentials of subsistence assumes great importance and has a profound effect on group morale. Consequently, every effort was made to provide the highest practicable housing and messing standards. Termination interviews with departing contractual employees and Task Force personnel revealed that, in general, these services were considered to be highly satisfactory.

It was necessary to establish for OPERATION CASTLE, in addition to the permanent camps at Elmer and Fred, temporary camps at sites Tare, Fox, Charlie and Nan at Bikini Atoll and at site Ursula on Eniwetok Atoll. For short periods, small camps with minimum facilities were set up on sites Able and How at Bikini Atoll. Three houseboats were used, two at Bikini Atoll and one at Eniwetok Atoll. After the Bravo event, camp operations at Bikini Atoll were conducted aboard ship, primarily in the USNS Ainsworth, since radioactive contamination made it impossible to base ashore.

The first beachhead camp for CASTLE on Bikini Atoll was established at site Tare on 6 October 1952, and consisted of a portable kitchen, one 150-cubic foot reefer and essential housing and other facilities to sustain 70 men. One cook and a helper were sufficient to provide meals for the first echelon. These facilities were gradually increased to accommodate 250 men by 1 November 1952. A beachhead camp was started at Charlie in April 1953, and at Fox and Nan in May of that year.

During January 1953, equipment and supplies to outfit a camp on site Ursula to serve 300 men were assembled at site Elmer at Eniwetok. The equipment and supplies were crated in numbered boxes, each with its own packing list. This "packaged camp" remained in storage until April and was then set up; actual camp operations were not begun at Ursula until sometime in June 1953, but the effectiveness of this technique was established.

In general, the pattern for the establishment of a camp was as follows: an LCU was used as a houseboat for the initial exploratory phase; a beachhead camp was established with very limited facilities (a portable galley, housing tents without flooring, portable generators, and one or two small distillation units); and when land based subsistence was established, the construction of the designed camp with all related utilities was begun.

It was realized that some camps would have to be considered expendable in the testing of nuclear devices, and, due to the short period these temporary camps would be used, they were constructed as simply and as inexpensively as possible. The possibility of damage by blast effect, and the crash requirements of evacuation, dictated the selection of the materials and equipment for these camps. Wherever practicable, the older and more obsolete camp equipment from Eniwetok was used and the newer equipment was retained in the permanent camps.

At each of the camps constructed, all facilities such as messing, housing, PX store, barber shop, postal outlet, laundry and other necessary facilities were provided. The operation of these facilities was the responsibility of H&N's Service Operations Division. Each Atoll had a camp supervisor who administered the main camps (Elmer and Tare) and supervised the operation of the other camps through an assistant camp supervisor detailed to each camp. The administration of camp operations presented some difficulties due to the fluctuating population of each camp and the varying working schedules of camp employees. Seven-day-a-week camp service was required, necessitating the use of odd and split shifts in order to keep overtime to a minimum. Extended meal hour periods were needed to provide for two seatings at each

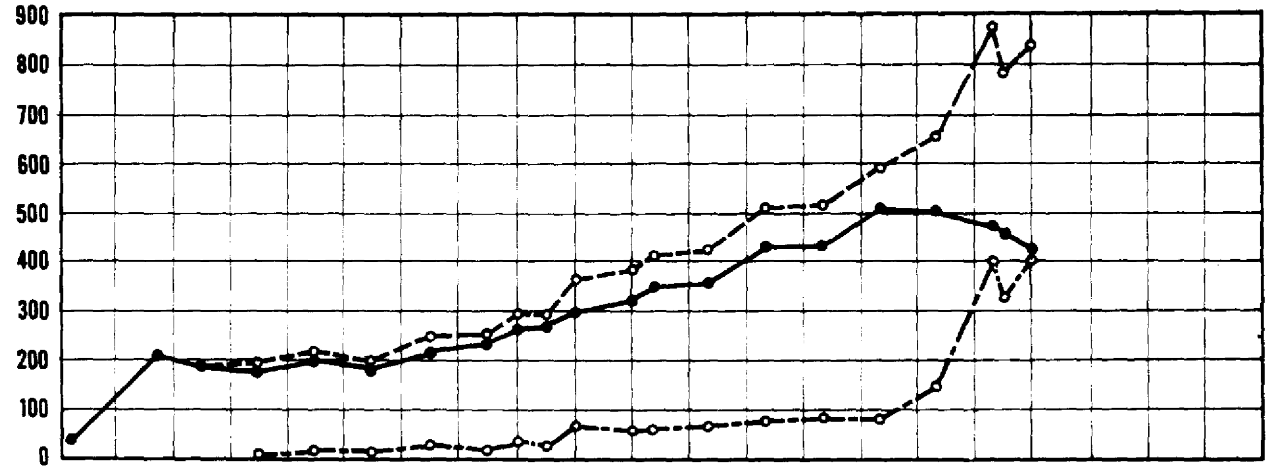

Figure 4-1. Jobsite Personnel Chart - Site Tare

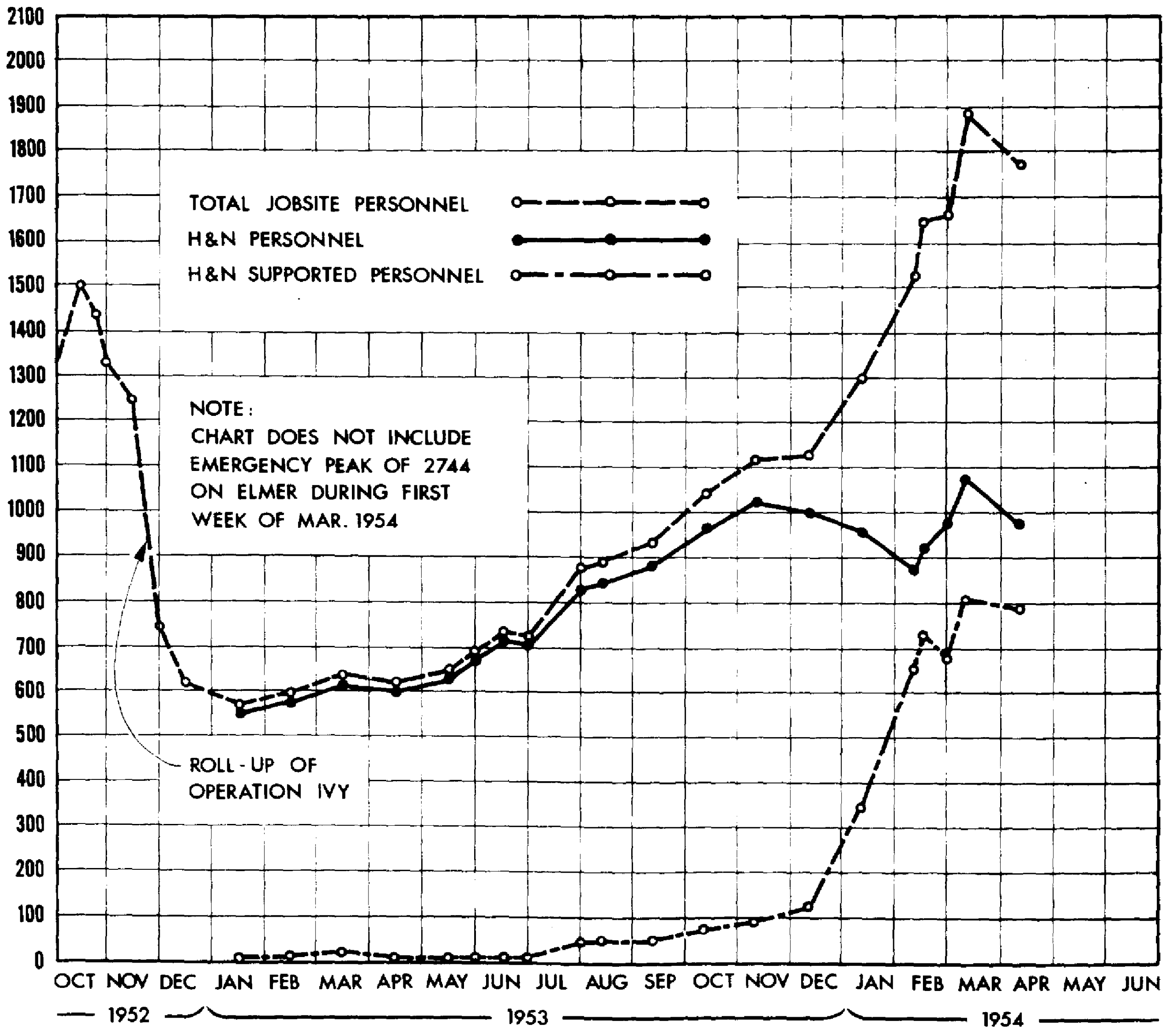

Figure 4-2. Jobsite Personnel Chart - Site Elmer

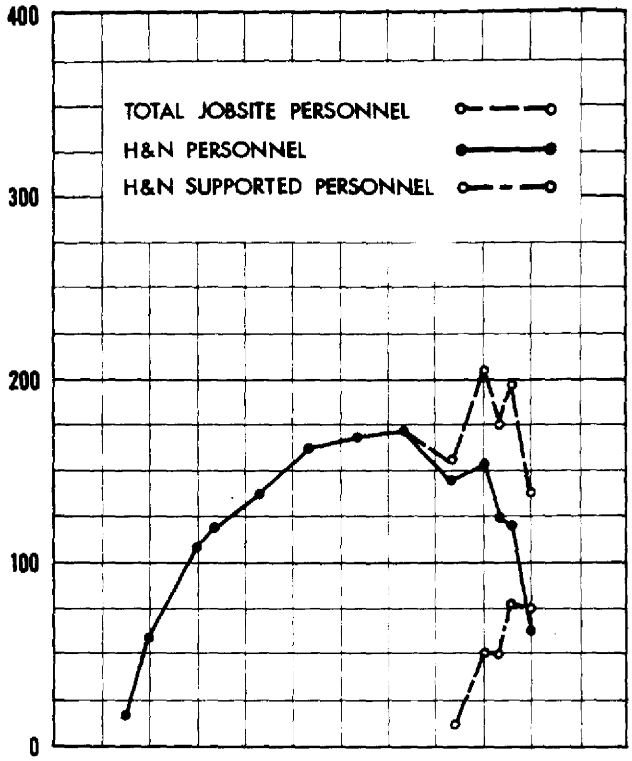

Figure 4-3. Jobsite Personnel Chart - Site Fox

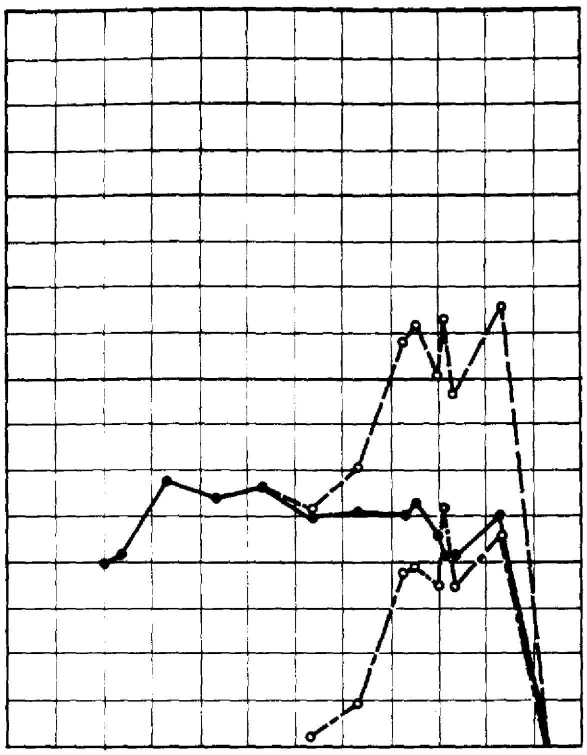

Figure 4-4. Jobsite Personnel Chart - Site Ursula

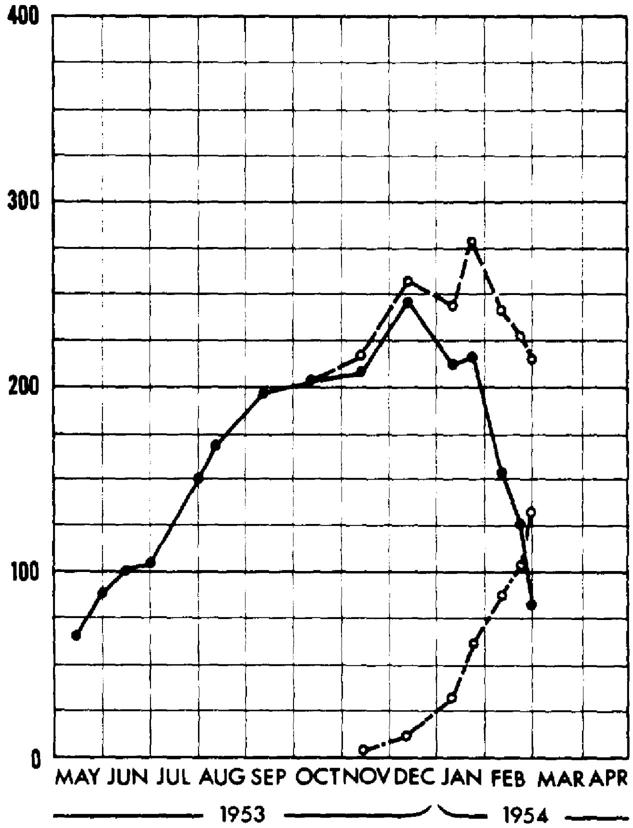

Figure 4-5. Jobsite Personnel Chart - Site Charlie

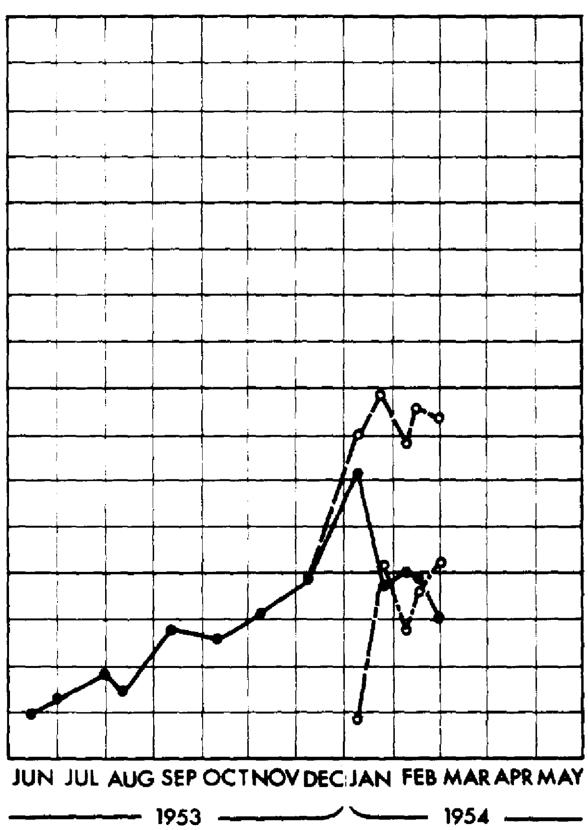

Figure 4-6. Jobsite Personnel Chart - Site Nan

meal; this required overlapping work hours of various groups in order to keep a meal shift to a three-hour working period. The frequency of changes in size of camps, due to the changing requirements of the test program, called for detailed planning in order to provide the necessary personnel, equipment and supplies. Site Nan was originally planned as a small beachhead camp but grew to a population of over 200 men; a further increase was being contemplated when the effects of the Bravo event cancelled all camp operations ashore at Bikini. Except for a short period in January and February of 1954, the number of camp operations personnel, was, as a whole, adequate and overtime was kept to a minimum. Except for a short period in January and February of 1954, the number of personnel assigned to camp operations was adequate. About 18 January, however, a number of employees were surplussed due to non-receipt of Q clearances before the established deadline date. The normal investigative and processing time involved in obtaining Q clearances was such as to prevent recruitment at that date, and resulted in some overtime and reassignments until replacements could be provided.

In preparation for the Bravo event, the camps at Bikini were placed in status as indicated below:

Charlie - Completely rolled up.

Fox - Housing reduced to sustain 75 men. Provisions, camp supplies, PX and bar stores reduced to sustain 75 men for 10 days only.

Tare - Camp left intact. Cold storage provisions reduced to sustain 1,000 men three weeks. Dry Provisions, camp supplies, PX and bar stores sufficient for 1,000 men for six weeks.

Nan - Camp left intact. Cold storage provisions to sustain 250 men three weeks. Dry provisions, camp supplies, PX and bar stores sufficient for 250 men for 6 weeks.

Precautionary measures were taken against radioactive "fallout" and blast damage. Dry stores, liquors and PX stores were restored in warehouses and covered with tarpaulins. All loose objects were secured and all items generally stored on a high level were placed on the floor. All food items, galley and dining room equipment were covered with tarpaulins or sheets. Tent sides were rolled up and all beds and other furniture were moved to the center of the tent. All windows and doors of buildings were secured in the open position. Water tanks were filled and guyed. All post office and PX money was turned in to the accounting office at Elmer, Eniwetok Atoll.

Immediately after the Bravo event, all camp operations ashore at Bikini ceased, as a result of the unexpected blast effects and radioactive contamination. Thereafter, all personnel at Bikini Atoll were housed and sustained in the vessels of Task Group 7.3. Holmes & Narver personnel were primarily based on board the USNS Ainsworth and assisted in the ships services. Sixteen contract employees were assigned to other vessels of the Task Force to assist them in providing messing services.

Experience with camp operations on board ship during OPERATION IVY indicated that men to be employed afloat must be carefully selected as to their willingness and physical adaptability to work under shipboard conditions. With this in view, volunteers for work aboard ship were requested. These volunteers were carefully screened with the net result that the problems of the camp department were kept to a minimum in supporting ship's personnel in providing the necessary services afloat.

The satisfactory conduct of camp operations on the USNS Ainsworth was considerably aided by the cooperative attitude of the officers and crew of this vessel. The ship's services and time tables were adapted to the operational convenience of those living aboard. This was reflected in harmonious working relations between the ship's officers and crew with Holmes & Narver personnel at all levels, and in added productivity.

A total of 44 Holmes & Narver personnel were assigned at first to assist the crew of the USNS Ainsworth in the preparing and serving of food. The ship's crew operated the cabin mess. Under this arrangement, the requirement of practically "around the clock" feeding was met without friction. The late workers and the early turn-to crews, which by the very nature of the operations after 1 March 1954, were in large numbers; these men were fed hot meals regardless of their working hours.

The working parties ashore were provided with bag lunches prepared by the night crew of the troop mess. These lunches varied in number from 160 to 430 (averaging around 250). For a short period, the grills at the Tare camp were reactivated to provide hot lunches for the men working at that site. After the Romeo event, hot lunches were provided only at Tare. These were prepared on the USNS Ainsworth and sent ashore in insulated 5 gallon food containers.

There was no difference in the quality of the food served in the cabin and troop messes. Cafeteria style service was used in the troop mess and individual waiter service used in the cabin mess. Class feeling due to designation as troop or cabin-feeders was non-existent. Many men designated as "cabin class" preferred taking their meals in the troop mess, particularly because they could obtain the quantity they desired with the first serving.

The main difficulty encountered in living afloat was the vast difference in comfort between cabin and troop class accommodations. Allotment to cabin spaces was made by assignment of supervisory and administrative personnel down to and including the foremen level. All remaining spaces were assigned by lottery. The bunks in the troops' spaces consisted primarily of an aluminum frame to which was laced a piece of canvas. These were set up four high with too little space between bunks. To add to the comfort of those living in these spaces, Holmes & Narver provided mattress pads. The cabin spaces were kept filled insofar as was practicable, and prior to the Yankee event, due to demobilization, all men were billeted in these spaces.

MSTS regulations required all passengers to pay for laundry, and therefore it was not possible at first to inaugurate free laundry service on board the USNS Ainsworth. This was later cleared through the vessel's chain of command, and after the end of March, all personal laundry was handled on board. To perform this service it was necessary to augment the ship's laundry personnel with six Holmes & Narver men. On 9 March, seven of the Laundromat machines were placed in operation at Tare to take care of personal and Rad-Safe laundry service. These were kept in operation until the evacuation for the Koon event, after which Rad-Safe clothing was shipped to Elmer at Eniwetok for laundering.

Postal facilities were established immediately on embarking on the USNS Ainsworth. A daily mail courier service between Eniwetok and Bikini Atolls by H&N courier provided the quick delivery; postal service was entirely satisfactory.

At the commencement of the operations afloat, the ship's store carried a fairly complete stock of essential items with the exception of clothing, candy, cigars and laundry bags; these were soon depleted. According to MSTS regulations, the ship's store could not purchase replenishment items in short supply from a private contractor. It was therefore necessary for Holmes & Narver later to establish a Post Exchange to sell those items not carried by the ship's store.

The following table indicates the personnel housed and supported on the USNS Ainsworth.

	TG 7.5					
DATE	H&N	AEC	TG 7.4	TG 7.2	TG 7.1	TOTALS
10 March	392	2	4	30	197	625
15 March	350	6	3	33	210	602
20 March	330	2	2	31	153	518
25 March	305	3	2	30	134	474
30 March	278	3	1	30	176	488
10 April	143	0	0	8	42	193
15 April	140	1	3	12	79	235
20 April	127	2	3	6	65	203
25 April	116	1	5	5	67	194

As a result of blast effects and radioactive contamination of the camp areas on Bikini Atoll, which could not be anticipated and for which, therefore, no preparation had been made, the following losses in camp services occurred.

PX	\$14,350.78
Bar stores	\$ 3,082.48
Food	\$71,918.47

Many PX items were damaged and had to be sold at reduced cost. The loss in bar stores can be attributed, to a minor degree, to pilfering. The loss in food was due primarily to the fact that at site Fox the camp was completely destroyed by the Bravo event, and at both Nan and Tare the generator breakers were opened, thus cutting off power to the reefers. Thawing of food had taken place and spoilage had set in before the generators could be placed back on the line.

All money from revenue producing facilities was deposited in the Contract Advance Fund and thereby reverted to the Commission. The total personnel supported by Holmes & Narver at each camp and atoll is shown in Figures 4-1, 4-2, 4-3, 4-4, 4-5, 4-6, 4-7 and 4-8.

MESSING

Messing facilities were operated at each established camp. The structures for messing at the temporary camps were made as simple and inexpensive as possible since they were considered to be expendable, and were to be operated only until an advanced time prior to a shot. Standard allowance of galley equipment and utensils for a 250, 500, 1,000 and 1,500-man camp were formulated. When a camp was authorized, the equipment for it was segregated, allocated and then shipped in time to permit installation during the construction of the mess

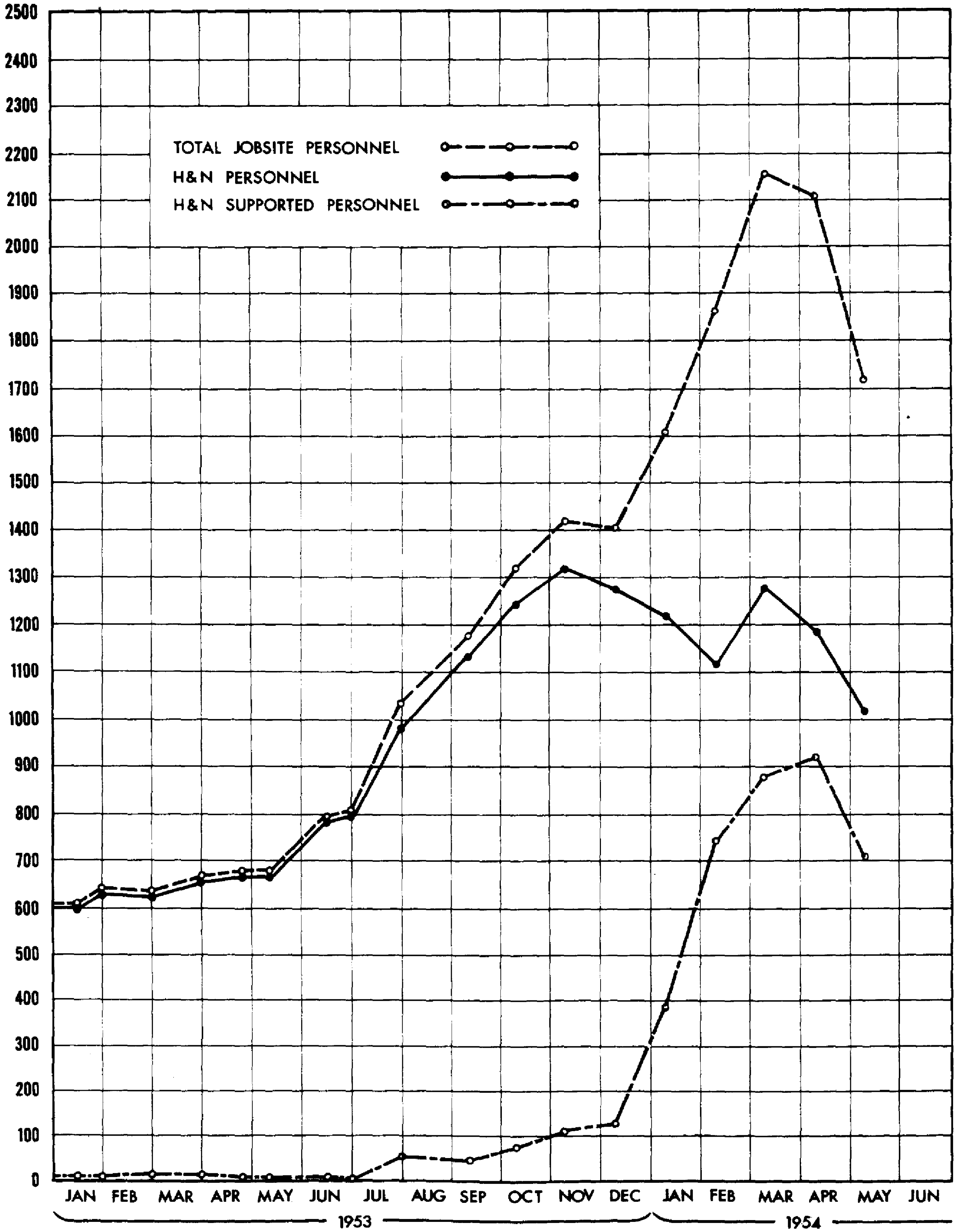

Figure 4-7. Jobsite Personnel Chart - Eniwetok Atoll

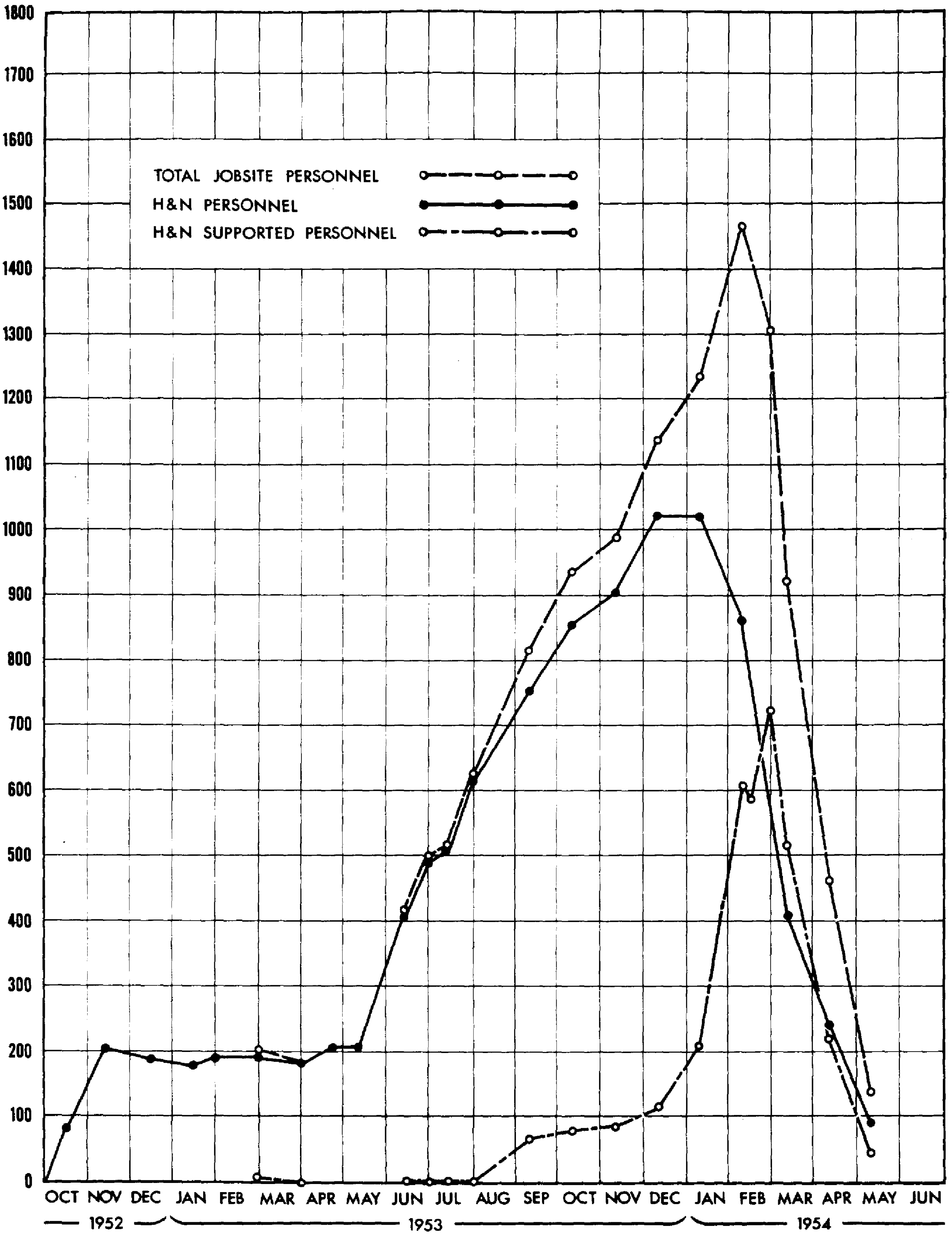

Figure 4-8. Jobsite Personnel Chart - Bikini Atoll

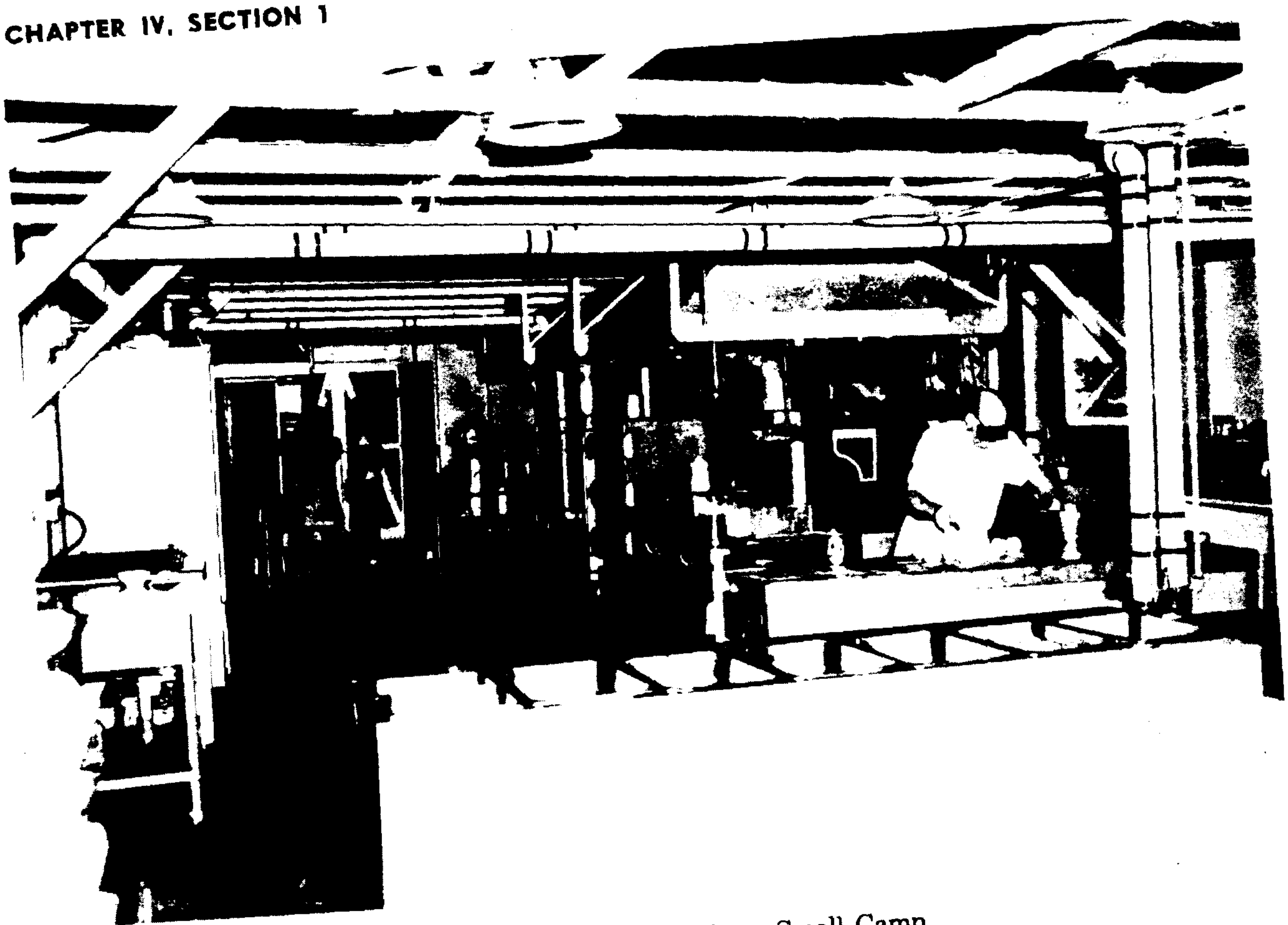

Figure 4-9. Galley for a Small Camp

Figure 4-10. Bake Shop for a Small Camp

buildings. Figure 4-9 shows a small galley, and Figure 4-10 a small bakery shop.

Menus were prepared monthly with emphasis placed on avoiding frequent repetitions. All camps were furnished the same menus, and insofar as was practicable the meals served at the various camps were alike. A typical menu for one week appears below:

BREAKFAST	LUNCH	DINNER
Monday		
Chilled Orange Juice Fresh Northern Apples Hot Oatmeal with Milk Griddle Cakes with Maple Syrup Sliced Premium Bacon Toast with Jelly English Crumb Cake Hot Coffee Fresh Milk	Soup - Puree of Navy Bean Grated Cabbage Salad, Sweet and Sour Veal Fricassee Supreme Saute Potatoes with Green Onions Fresh Lima Beans Rye Bread Chocolate Pudding Hot Coffee Iced Tea	Cottage Cheese and Pineapple Salad Roast Leg of Pork Celery Dressing - Brown Gravy Applesauce Mashed Potatoes Fresh Spinach Southern Whole Wheat Bread Gold Cake Assorted Ice Cream Hot Coffee Hot Tea
Tuesday		
Chilled Grapefruit Juice Fresh Oranges Hot Cream of Wheat with Milk Creamed Chipped Beef on Toast Soft Boiled Eggs Home Fried Potatoes Toast with Preserves Danish Pastry Hot Coffee Fresh Milk	Garden Vegetable Soup Grated Carrot and Pineapple Health Salad Grilled Chopped Steak Mushroom Sauce Lyonnaise Potatoes Boiled Navy Beans with Salt Pork Tea Biscuits Apple Pie Hot Coffee Fruit Punch	Chilled Tomatoes with Green Onions Roast Barbecued Beef, Sauce Naturale Oven Roast Potatoes Buttered Corn Saute O'Brien White Bread Tollhouse Cookies Assorted Ice Cream Hot Coffee Hot Tea
Wednesday		
Chilled Tomato Juice Fresh De Anza Pears Assorted Dry Cereal with Milk Homemade Sausage Cakes Wheat Cakes with Maple Syrup Toast with Jelly Coffee Cake Hot Coffee Fresh Milk	Puree of Green Split Pea Soup aux Croutons Red Kidney Bean Salad Grilled Baby Beef Liver with Onion Sauce Creamed Au Grautin Potatoes Fresh Carrots and Peas French Bread Cocoanut Cream Pie Hot Coffee Iced Lemonade	Cottage Cheese and Fruit Salad Southern Pan Fried Chicken Country Gravy Whipped Potatoes Yellow Wax Beans Butter Bread Chocolate Fudge Cake Vanilla Ice Cream with Pineapple Topping Hot Coffee Hot Tea
Thursday		
Chilled Pineapple Juice Fresh Oranges Hot Oatmeal with Milk Grilled Smoked Ham Cheese Omelette Toast with Marmalade Raised Donuts Hot Coffee Fresh Milk	Chicken Mulligatawny Soup Grated Cabbage and Green Pepper Salad Beef Chop Suey with Fried Noodles Dutchess Potatoes Creamed White Cabbage with Ham Julien Pan Rolls Blueberry Pie Hot Coffee Iced Tea	Chilled Fresh Relish Ensemble Roast Leg of Veal Savory Dressing - Brown Gravy - Mint Jelly Idaho Baked Potatoes Fresh Corn on the Cob in Milk Graham Bread Pound Cake Assorted Ice Cream Hot Coffee Hot Tea

BREAKFAST	LUNCH	DINNER
Friday		
Chilled Welch Grape Juice 1/2 Arizona Grapefruit Hot Cream of Wheat with Milk Sliced Choice Bacon Country Fried Eggs Toast with Jam Butter Horns Hot Coffee Fresh Milk	Philadelphia Clam Chowder Grated Cabbage and Green Pepper Salad Fried Deep Sea Scallops Sauce Tartar Baked Beef and Macaroni Spanish Style Fresh Steamed Cauliflower in Butter Vienna Bread Chilled Bartlett Pears Hot Coffee Berry Punch	Shrimp Cocktail with Lemon Baked Sugar Cured Ham with Raisin Sauce Mashed Sweet Potatoes with Grated Pineapple New Green Peas White Bread Angel Food Cake Assorted Ice Cream Hot Coffee Hot Tea
Saturday		
Chilled Vegetable V-8 Juice Fresh Oranges Hot Oatmeal with Milk Grilled Little Pig Sausages Hot Cakes with Maple Syrup Toast with Jelly Cake Donuts Hot Coffee Fresh Milk	Cream of Chicken Soup, Princess Tuna Fish and Egg with Diced Celery Brown Beef Stew with Young Vegetables Parisian Potatoes Green Cut Beans Custard Rum Pie Rye Bread Hot Coffee Iced Tea	Relish Dish with Celery, Olives and Hot Peppers Broiled Sirloin Steaks Sauce Bordelaise Saute Onions French Fried Potatoes Kernel Corn Saute Butter Crust Rolls Strawberry Shortcake Hot Coffee Hot Tea
Sunday		
Chilled Orange Juice Fresh Northern Apples Assorted Dry Cereal with Milk Grilled Smoked Ham Baked Pork and Beans Fried Eggs Hashed Brown Potatoes Toast with Preserves Hot Coffee Fresh Milk	French Onion Soup aux Grautin Mixed Chilled Relish Dish Baked Pork and Beans with Grilled Frankfurters Hot Mustard Sauce Chop Suey Vegetables White Bread Chilled Bing Cherries Hot Coffee Berry Punch	Fruit Salad Roast Northern Turkey Savory Dressing - Giblet Gravy - Cranberry Sauce Whipped Potatoes Creamed Whole Onions Whole Wheat Bread Silver Cake Vanilla Ice Cream with Chocolate Topping Hot Coffee Hot Tea

Monthly requisitions for food were prepared 90 days in advance of requirements to provide maximum reliability in shipping forecasts. The needs were estimated on a basis of manpower forecasts, "usage factors", and "proposed" menus. The "usage factor" (i. e., the quantity of a certain item to feed 100 men for one month) had been developed from experience over three years with each class of food. Ordering of food supplies was based on maintaining a minimum of a 60-day supply of dry stores, and a 30-day supply of frozen foods on hand at all times. Chill stores, which were subject to spoilage after three or four weeks storage, were ordered only to cover the periods between reefer vessel arrivals. The main difficulty with food receipts was the spoilage that took place enroute in certain fresh items such as lettuce, tomatoes, and celery. As these items constitute the main ingredients for most salads and are important dietetically, it was always necessary to maintain substitutes for them.

The original concept for OPERATION CASTLE contemplated the use of the Elmer camp at Eniwetok as the main base of food supply for all camps. As the program expanded, the need for direct shipments of cold storage items from the Zone of Interior to both Bikini and Eniwetok Atolls became evident and ordering was changed to this basis. The subsistence orders for the months of September 1953 thru February 1954 were placed so that cold storage provisions were off-loaded from the reefer ships both at Elmer and Tare. From these camps, the food was transshiped by the use of portable reefer to the off-lying island camps. A one month's supply of provisions, with replenishment weekly, was maintained at all off-island camps except Nan. Due to the limited storage facilities at this site, the camp was supplied with a week's supply of reefer items; bakery products and ice cream were supplied daily. The dry stores were housed in separate wooden warehouses, tents or in wire screened shelters at the temporary camps. Cold storage was provided by banks of portable reefers which, during the peak population in February, were located as follows:

ENIWETOK REEFER STORAGE AT PEAK POPULATION

Type (cu. ft.)	Number Units	Location	Use	Maximum cu. ft.
675	23	Elmer Warehouse	Freeze	12,650
675	3	Elmer Warehouse	Chill	1,650
675	1	Elmer Beer Hall	Beer	550
150	1	Elmer Galley	Ice Cream Freeze	140
150	1	Elmer Galley	Bake Freeze	140
Chill House	1	Elmer Warehouse	Chill	10,560
675	3	Elmer Galley	Chill	1,650
			Elmer Total	27,340
675	1	Ursula Mess Hall	Freeze	550
675	2	Ursula Mess Hall	Chill	1,100
675	1	Ursula Beer Hall	Beer	550
			Ursula Total	2,200

MOBILE UNITS

2 Units at Site Ursula when not in transit with shipments of freeze and chill from Site Elmer, Maximum Cu. ft. - 1050.

BIKINI REEFER STORAGE AT PEAK POPULATION

Type (cu. ft.)	Number Units	Location	Use	Maximum cu. ft.
675	12	Tare Warehouse	Freeze and Chill	6,600
150	1	Tare Warehouse	Butter	140
150	1	Tare Warehouse	Freeze	140
675	3	Tare Galley	Freeze and Chill	1,650
150	2	Tare Galley	Chill and Work	280
675	1	Tare Beer Hall	Beer	550
			Tare Total	9,360
675	3	Charlie	2 Freeze - 1 Chill	1,650
150	1	Charlie	Bar	140
			Charlie Total	1,790
675	2	Fox	1 Freeze - 1 Chill	1,100
150	2	Fox	1 Freeze - 1 Chill	280
150	1	Fox	Bar	140
			Fox Total	1,520
675	1	Nan	Chill and Work	550
150	2	Nan	Freeze	280
150	1	Nan	Bar	140
			Nan Total	970

MOBILE UNITS

4 Units at Site Tare when not in transit with off-base shipments of freeze and chill - maximum cu. ft. - 2100.

In the permanent Elmer dining room, family style service was used throughout the Operation. At site Tare, cafeteria style service, using the G. I. compartmented trays, was used until 20 January 1954, when a change to family style service was effected. The camp at this time was feeding approximately 800 men and the change was effected to eliminate the long waiting in line inherent in cafeteria feeding in large camps. At Fox, Charlie, Nan and Ursula, cafeteria style service was used with the diner having a choice of the G. I. compartmented aluminum tray or a plastic tray with china plateware. It was interesting to note that, where a choice in trays was permitted, over 80% of the diners preferred the compartmented metal tray. In all dining rooms, bus service was eventually initiated, thus eliminating the need for diners to carry their trays to the scullery.

The approximate number that could be seated in each dining room was as follows:

Elmer	840
Ursula	112
Nan	80
Tare	432
Charlie	112
Fox	104

Figure 4-11 shows the typical permanent type dining room which was located at site Elmer. Figure 4-12 shows a typical temporary camp dining room located at site Charlie.

The furnishing of satisfactory "takeout" meals was a difficult problem. The forces in the field away from established mess halls were so widely scattered on the many islands of the atolls that it was impracticable to furnish the regular luncheon through the use of hot food carriers. It was necessary to resort to the use of the sandwich luncheon with cold and hot drinks, fruits, salads and relishes. These meals were generally prepared by the galley night shift, packaged by groups, and picked up by a designated individual of the group prior to his depart-

Figure 4-11. Dining Room, Elmer Camp

ing for the job. Where large groups were working away from a camp, the regular hot lunch was furnished in hot containers delivered just prior to the lunch period. This procedure was advantageously used during the heavy construction period on Able.

Four portable kitchens were used for initial beachhead operations to provide mess facilities during the construction of a camp; to provide mess facilities while the regular facilities were being rolled up; and to provide mess facilities at small camps such as How. These kitchens were fairly complete, with Army-type field ranges, sinks, grills, deep freeze cabinets, and utensils. They definitely justified their construction. During the last days at the Charlie camp, as many as 200 men were supported from one of these kitchens.

LCUs fitted as houseboats were used in the first landings at all camps; to support scientific groups off Fox after the Bravo event; and as a Station vessel for Scientific Station 10. Provisions were generally furnished these houseboats on a three day basis. Future operations requiring the use of LCUs as houseboats will contemplate increasing cold storage facilities and the fresh water supply. This can be readily accomplished by the use of the standard 150 cubic foot portable reefers and converting the LCU's void space for fresh water storage.

One dollar and fifty cents per day was collected from each person subsisting in a mess operated by Holmes & Narver. Military transients regularly subsisting at Army mess at Eniwetok were charged $0.40 per meal. In the case of enlisted men, this was accomplished by monthly interchange of funds between the two messes, and in the case of officers, cash for each meal was required. Contract employees' mess bills were paid for by payroll deductions while all others were billed by the Resident Controller. The statement of meal costs covering the entire period of OPERATION CASTLE is contained in Appendix 1 of this report.

Figure 4-12. Dining Room, Charlie Camp

The following tables indicate the average daily population for each month at each camp and the average daily number of mess personnel employed:

BIKINI ATOLL

DATE		SITE TARE Avg. Pop.	SITE TARE Mess Pers.	SITE CHARLIE Avg. Pop.	SITE CHARLIE Mess Pers.	SITE FOX Avg. Pop.	SITE FOX Mess Pers.	SITE NAN Avg. Pop.	SITE NAN Mess Pers.
1952	Oct.	122	12						
	Nov.	195	19						
	Dec.	184	19						
1953	Jan.	200	20						
	Feb.	210	19						
	Mar.	217	19						
	Apr.	236	18	34	4				
	May	262	24	81	5				
	June	310	31	97	12	31	2	28	3
	July	367	33	127	11	83	9	36	4
	Aug.	395	39	173	19	119	12	56	5
	Sept.	462	47	200	18	147	15	69	11
	Oct.	511	55	216	19	165	19	71	10
	Nov.	554	66	243	26	170	19	86	10
	Dec.	624	65	251	29	165	25	134	14
1954	Jan.	764	62	246	28	167	18	173	15
	Feb.	856	65	234	25	160	18	176	15

ENIWETOK ATOLL

DATE		SITE ELMER Avg. Pop.	SITE ELMER Mess Pers.	SITE URSULA Avg. Pop.	SITE URSULA Mess Pers.
1953	Jan.	573	64		
	Feb.	593	57		
	Mar.	610	57		
	Apr.	610	54		
	May	646	56		
	June	754	58		
	July	916	66	67	10
	Aug.	960	76	102	12
	Sept.	960	80	131	13
	Oct.	1039	89	132	15
	Nov.	1124	99	125	15
	Dec.	1106	102	129	14
1954	Jan.	1345	101	184	16
	Feb.	1589	113	216	18
	Mar.	1912	126	202	19
	April	—	—		
	May	—	—		
	June	—	—		

The following table shows the average of food and labor direct costs per meal monthly:

		ENIWETOK ATOLL		BIKINI ATOLL	
	MONTH	FOOD COST PER MEAL	LABOR COST PER MEAL	FOOD COST PER MEAL	LABOR COST PER MEAL
1953	January	.6574	.5735	.7530	.5867
	February	.6667	.4873	.7830	.5854
	March	.6876	.4954	.9202	.5371
	April	.6806	.4920	.9095	.5113
	May	.6587	.4611	.7314	.5114
	June	.5989	.4696	.7295	.5140
	July	.5815	.4361	.6959	.5769
	August	.6499	.4641	.6623	.5821
	September	.6333	.5007	.6759	.5838
	October	.7137	.5004	.7564	.5648
	November	.6650	.4822	.8061	.5789
	December	.6835	.4971	.7744	.6427
1954	January	.6877	.5044	.6561	.6454
	February	.6182	.4334	.6739	.5500
	March	.5266	.4184		
	April	.6621	.4459		
	May	.5884	.4245		

Total meals served during calendar year 1953 - 1,463,048.
Total meals served from 1 January 1954 to 14 March 1954 - 758,832.
Accumulative cost of food per meal, 1953 - .6939.
Accumulative cost of labor per meal, 1953 - .5225.
Accumulative cost of food per meal, 1954 - .6323
Accumulative cost of labor per meal, 1954 - .5054.

The following table shows the date of each food inventory, total manpower on that date, total food inventory, and average value per man for the Jobsite:

DATE OF INVENTORY		TOTAL MANPOWER ON INVENTORY DATE	FOOD INVENTORY Total	FOOD INVENTORY Avg. Per Man
1953	Jan. 25	828	$195,554.70	$236.18
	Mar. 1	856	265,494.63	310.15
	Mar. 22	865	224,446.76	259.48
	Apr. 19	908	229,768.55	253.04
	May 17	1048	186,864.02	178.30
	June 21	1266	145,366.90	114.82
	July 19	1524	161,956.72	106.27
	Aug. 16	1811	162,047.26	89.50
	Sept. 13	2004	210,094.85	104.84
	Oct. 11	2265	286,750.18	126.60
	Nov. 15	2474	283,828.70	114.72
	Dec. 13	2532	283,749.44	112.06
1954	Jan. 17	2882	530,119.37	183.97
	Feb. 14	3227	529,934.40	164.22
	Mar. 14	3040	423,725.66	138.06
	Apr. 18	2352	313,903.24	133.46
	May 16	1510	269,233.78	178.30

Figure 4-13. Barracks Room, Elmer Camp

Figure 4-14. Typical Eight-Man Tent

HOUSING

At site Elmer, on Eniwetok Atoll, men were housed in aluminum barracks and tents, and at all other camps standard Army tents, with outer flies, were used. During the operational phase, blocks of housing were designated for various Task Groups' use. The assignment of quarters to each particular individual was made by the Camp Supervisor for all H&N employees and by a designated Task Group authority for all others. There were no unusual crowded conditions during this operation except after Bravo, as described below. All quarters were provided with comfortable beds, tables, camp chairs and aluminum hot lockers. Figure 4-13 shows a room in the permanent type barracks at Elmer. Figure 4-14 shows a typical 8-man tent. Linens were changed weekly and janitorial service for barracks and latrines was provided daily; every effort was made to provide pleasant living conditions. Where practicable, each individual was given a choice of roommates.

In an operation of this type there is a considerable number of personnel with duties at more than one camp, which results in retention by individuals of accommodations at more than one location. Population figures do not truly reflect the number of transients moving in and out of the various camps. This was especially true during periods of peak population or when sudden shifts of construction crews occurred. Frequent revaluation of the needs of each Task Group was required. This was particularly so with Task Groups 7.5 and 7.1, and it became necessary to change the block assignments in order to avoid crowding within each group assigned housing. The net result of all the foregoing was the need for providing more housing units than population figures indicated. On 13 February 1954 the total land-based population at Bikini Atoll was 1,463, which was the peak for this operation. At this time there was no apparent excess of housing units even though there were 1,735 beds and 759 lockers set up at the Atoll.

Authorized housing units were constructed only as the need for them became evident. The peak of housing facilities provided was reached in February 1954 and was as follows:

	Elmer	Fred*	Ursula	Tare	Charlie	Fox	Nan	Able	How
18-man barracks	17	—	—	—	—	—	—	—	—
36-man barracks	15	—	—	—	—	—	—	—	—
8-man tents	56	—	3	106	43	21	14	—	—
4-man tents	50	—	65	29	—	18	25	4	2
Bunks	2034	100	272	1003	314	230	205	30	12

*H&N employees only

With the completion of the Bravo event, a readjustment of personnel at Bikini became necessary; accordingly, the USNS Ainsworth, the USS Estes, and the USS Bairoko were sent to Eniwetok. On Bravo + 2 all Task Groups 7.5 and 7.1 personnel on these vessels were disembarked and landed on Elmer. For several days, there were more men stationed at this camp than could normally be berthed there, and emergency billets were required to accommodate them.

This situation was relieved by the subsequent return of the ships to Bikini lagoon, and by surplussing and departure of personnel.

Emergency billets were provided by arranging berthing spaces in various buildings as follows:

Shipping and Receiving Warehouse	—	96 mattresses
Day Room	—	50 cots and mattresses
Recreation Building	—	60 mattresses
Gymnasium	—	20 cots and mattresses
3 - Beach Clubs	—	75 cots and mattresses
Building 206 Annex	—	12 cots and mattresses
37 - 8-man tents	—	148 mattresses (4 each)
16 - Aluminum barracks	—	192 mattresses (12 each)

POST EXCHANGE

The Post Exchange stores were operated at each camp for the convenience of the employees and provided them, at reasonable prices, with articles of ordinary use, wear, consumption, and for recreational activities. Merchandise normally classed as luxury items was not stocked. Prices were established by the Resident Controller to cover merchandise, salaries of the PX employees and the estimated cost for overhead connected with purchasing and export packing.

Store hours were scheduled to meet the requirements of each camp. Normal opening hours were during luncheon periods and from 1715 to 1930 each day.

All PX supplies were first received at Elmer and then equitably distributed to other camp sites. Transportainers, built of heavy sheet metal and equipped for locking and lifting, were utilized for this distribution. When merchandise was so shipped, Form O/S 242 was completed in triplicate and the original sent to the Accounting Division, a copy to the consignee, and one copy retained in the files of the main store.

In the small camps it was impracticable to cover all the requirements of the customers. This was particularly true in shoes and other clothing. In these cases, requests for merchandise were supplied upon demand by shipping from the main exchanges at Tare and Elmer. Such orders were usually phoned in and were filled within one day. The PX store at Tare is shown in Figure 4-15.

Statistical Reports of the Post Exchanges follow:

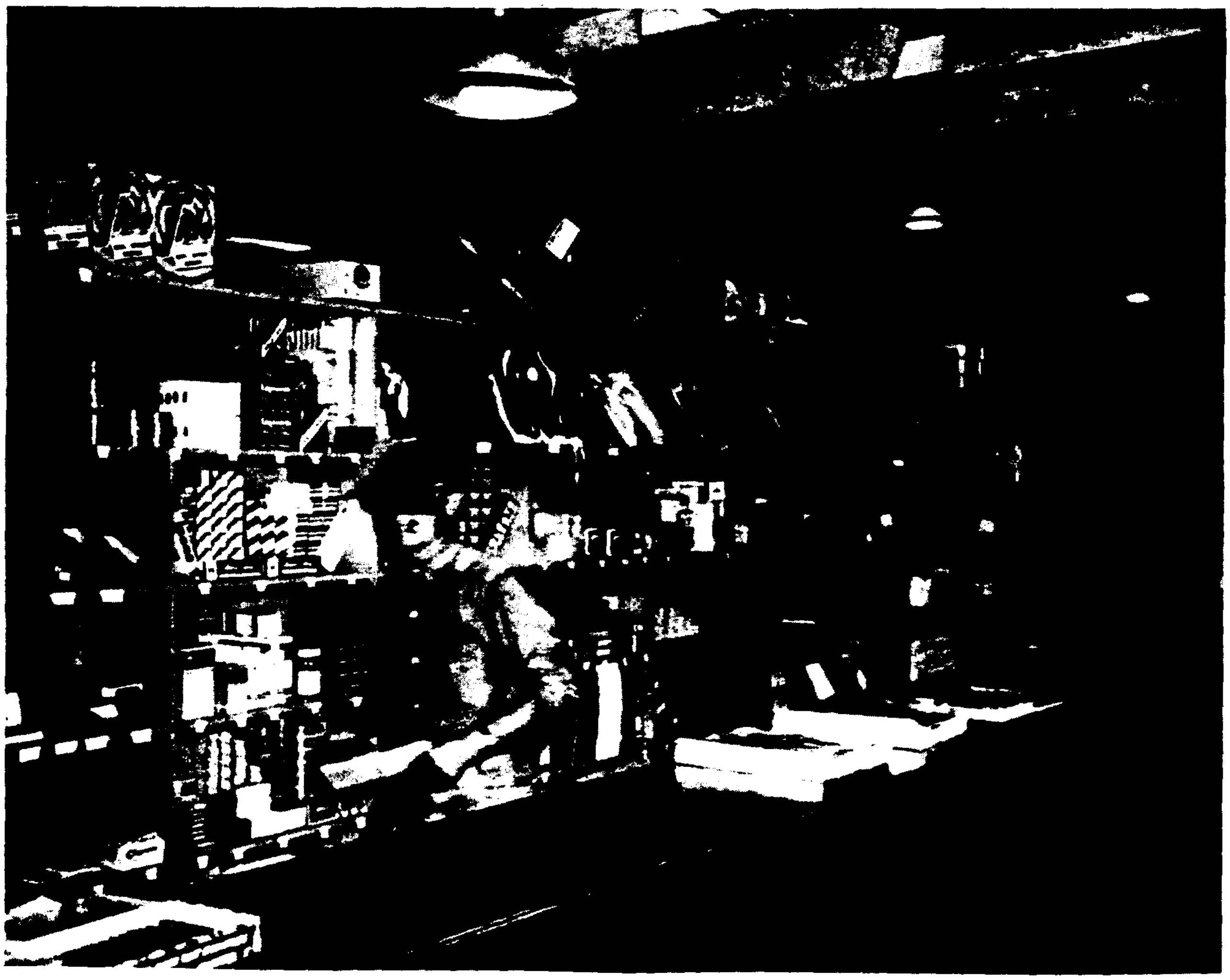

Figure 4-15. PX Store, Tare Camp

INVENTORY DATE		MANPOWER ON INVENTORY DATE	P. X. INVENTORY TOTAL VALUE	VALUE PER MAN
1953	January 25	828	$ 40,497.63	$ 48.91
	March 1	856	53,121.23	62.06
	March 22	865	46,585.17	53.86
	April 19	908	48,740.89	53.68
	May 17	1048	46,783.52	44.64
	June 21	1266	36,171.21	28.57
	July 19	1524	57,633.71	37.81
	August 16	1811	46,474.61	25.66
	September 13	2004	58,652.59	29.27
	October 11	2265	42,990.29	18.98
	November 15	2474	101,118.61	40.87
	December 13	2532	118,301.52	46.72
1954	January 17	2882	173,948.70	60.36
	February 14	3227	185,490.88	57.48
	March 14	3040	185,516.88	61.02
	April 18	2352	123,454.74	52.49
	May 16	1623	93,518.39	57.55

Monthly Report of Profit and Loss.

	MONTH	GROSS	LABOR	NET
1953	January	$ 1,910.47	$ 1,721.13	$ 189.34
	February	2,154.19	2,123.96	30.23
	March	1,646.70	1,230.49	416.21
	April	2,047.79	1,694.40	353.39
	May	2,320.87	1,744.82	576.05
	June	2,119.36	2,420.84	(301.48)
	July	4,204.58	2,349.69	1,854.89
	August	4,093.54	3,206.24	887.30
	September	4,599.66	4,327.63	272.03
	October	3,324.15	4,839.54	(1,515.39)
	November	7,629.66	7,255.79	373.87
	December	7,588.21	5,844.34	1,743.87
1954	January	9,349.02	7,499.53	1,849.49
	February	10,181.59	5,936.28	4,245.31
	March	9,345.87	5,159.83	4,186.04
	April	9,225.65	4,206.94	5,018.71
	May	6,046.37	3,454.98	2,591.39

BARS AND CLUBS

Refreshment bars were operated at all established camps. In order that the privileges for use of beer and liquor would not be abused, stringent controls were established governing the handling and sales of these beverages. Liquour and beer were sold retail across the bars only at scheduled hours. A chit system was inaugurated for supplying one bottle of liquor and one case of beer per week to personnel authorized to make such purchases by their Task Group Commanders. The last chit in the chit book authorized the purchaser to buy five bottles of liquor for his "take home" supply. This "take home" liquor was sold only on approval of an authorized representative of the individual's Task Group Commander, and only upon embarkation for the continental United States.

The Laguna and Mira Mar Beach Clubs on Elmer were operated by Holmes and Narver on week ends for sale of sandwiches, liquor and beer. All stocks of beer and liquors for these clubs were drawn from the stock of the bar on Elmer and were accounted for under that facility. The Military forces operated the Rivera Beach Club and the Officers Hut on Elmer.

All money from revenue producing facilities was deposited in the Contract Advance Fund.

Monthly Profit Statement of all Jobsite Bars

MONTH	GROSS	LABOR	NET
1953 January	$ 6,890.04	$ 2,943.81	$ 3,946.64
February	7,953.42	3,810.33	4,143.09
March	4,908.04	2,211.29	2,696.75
April	6,691.89	2,872.93	3,818.96
May	7,724.12	3,168.08	4,556.04
June	11,673.21	4,585.68	7,087.53
July	11,139.05	4,901.92	6,237.13
August	13,252.17	5,524.80	7,727.37
September	13,743.01	6,349.33	7,393.68
October	15,281.75	6,147.63	9,134.12
November	19,679.22	9,400.21	10,279.01
December	15,884.36	8,168.37	7,715.99
1954 January	22,071.42	10,213.96	11,857.46
February	17,819.83	7,522.12	10,297.71
March	12,836.97	6,455.53	6,381.44
April	12,013.99	5,120.56	6,893.43
May	8,415.67	3,398.16	5,017.51
June	6,959.74	3433.66	3,526.08

Monthly Operation of all Jobsite Bars

INVENTORY DATE	MANPOWER ON INVENTORY DATE	BEER & LIQUOR INVENTORY JOBSITE TOTAL	BEER & LIQUOR INVENTORY VALUE PER MAN
1953 January 25	828	$ 21,684.09	$ 26.19
March 1	856	27,137.87	31.70
March 22	865	21,072.11	24.36
April 19	908	43,493.48	47.90
May 17	1048	48,578.64	46.35
June 21	1266	35,579.41	28.10
July 19	1524	44,079.57	28.92
August 16	1811	53,350.82	29.46
September 13	2004	52,964.58	26.43
October 11	2265	56,592.69	24.99
November 15	2474	50,009.69	20.21
December 13	2532	67,185.16	26.53
1954 January 17	2882	143,871.79	49.92
February 14	3227	143,156.70	44.36
March 14	3041	146,983.33	48.33
April 18	2427	107,114.59	44.13
May 16	1623	80,821.99	49.79

SNACK BAR

A snack bar was operated on site Elmer for the morale and convenience of the personnel. This bar served sandwiches, light refreshments, coffee and fountain drinks. On Sundays from 0900 to 1000 late breakfast was served at reasonable prices. Retail prices were determined by the General Supervisor of Service Operations and the Resident Controller. A price list of all items sold was posted in the dining area.

Stores for snack bars were drawn from the regular mess stocks. The list of foods so issued was furnished the Accounting Division weekly. A physical inventory of all stocks in the snack bar was taken at the close of each accounting period.

During the construction phase, in order to secure the regular kitchen during night hours, night workers were fed in the snack bar. The night meal register was furnished the Accounting Division weekly. The Accounting Division was thereby able to credit the snack bar for meals provided by this facility and at the same time debit the regular mess facility for these meals.

On 16 January 1954 a "chit" system for use in the snack bar was established to replace the cash sales system which formerly had been in effect. This "chit" system insured a tighter control over cash receipts. The books were serially numbered and were issued for sale to the snack bar by the Accounting Division. Revenue from the sale of the books was turned in daily to the Accounting Division cashier. The snack bar supervisor maintained a pre-numbered register in which was registered the name of the purchaser of each "chit book."

SNACK BAR OPERATING STATEMENT

MONTH	GROSS PROFIT (Food Only)	COST OF LABOR	CREDITED FOR NIGHT MEALS (Labor Only)	CREDITED FOR SUNDAY BKFTS. (Food and Labor)	CORRECTED PROFIT OR (LOSS)
1953					
Jan.	$ 457.11	$1,736.15	$ 756.00	$ 504.00	$ (19.04)
Feb.	766.73	1,929.12	945.00	710.00	492.61
Mar.	243.07	1,101.66	567.00	334.00	42.41
Apr.	482.21	1,232.46	756.00	578.00	583.75
May	540.63	1,162.53	756.00	527.00	661.10
June	739.91	1,505.92	945.00	450.00	628.99
July	543.84	1,213.18	756.00	410.00	496.66
Aug.	588.16	1,273.55	756.00	628.00	699.11
Sep.	640.07	1,553.94	756.00	778.00	620.13
Oct.	1,456.85	1,592.20	756.00	698.00	1,318.65
Nov.	2,701.17	2,000.82	945.00	1,183.00	2,828.35
Dec.	1,952.42	1,650.81	405.00	810.00	1,516.61
1954					
Jan.	2,009.05	2,211.14	—	939.00	736.91
Feb.	1,788.92	1,652.82	—	809.00	945.10
Mar.	2,576.57	1,804.24	—	616.00	1,388.33
Apr.	2,607.77	2,550.87	—	980.00	1,036.90
May	2,065.01	1,982.32	—	1006.00	1,088.69

LAUNDRY

The original concept for this operation considered using the Elmer laundry facilities to serve all sites. Regular days for pick up and delivery were established and the entire operation placed on a scheduled basis. The service to Bikini did not prove satisfactory as transportation schedules for both air freight and LST sailings varied almost daily. It was not unusual for clean or dirty laundry to be held up three to five days. This unsatisfactory service was rectified by the installation of 9 automatic washing machines; three at Tare, and two each at Fox, Charlie and Nan.

The installation of the automatic washing machines at Bikini Atoll was simple and inexpensive. A concrete slab was roofed over by a rough board frame covered with canvas. The units were located near the water towers and little piping was required. Hot water heaters were not provided. These installations were staffed with regular laundry employees. Each person who desired to avail himself of the service provided by these facilities was required to bring and pick up the laundry. Finished laundry (ironed) was not provided. Clothes were generally delivered moist and clothes lines were provided in the camp areas for drying in the sun. Washed laundry was ready within 24 hours after receipt. This entire procedure was enthusiastically received and met with such favor that the Bikini laundry load at Elmer was reduced approximately 60%.

The services of the Elmer laundry were made available to all persons, including finished work for those men at both Eniwetok and Bikini who desired it. However due to transportation difficulties there were times when two weeks would elapse between pick up and delivery. All sheets were laundered at the Elmer laundry and to properly meet the demands of each camp a heavy supply of clean sheets was required at each camp in order to make the regular weekly change.

After the Bravo event, seven of the automatic washing machines were recovered and activated at Tare. This provided the needed service for Rad-Safe clothing and for personal laundry until this latter service was provided by ships. After the Koon event and the abandonment of Tare, it was necessary to send all Rad-Safe clothing to Elmer for washing.

In preparing for CASTLE, additional equipment and space were provided at the Elmer laundry, since a heavy work load was expected during peak population. The northern section of the building was extended 32 feet, thus providing 768 square feet for the installation of additional equipment, and a washer extractor was set up on the eastern side of the building for washing radioactive contaminated clothing.

Due to the high relative humidity of the Atoll air, a mildewed, musty odor of feather pillows resulted. A satisfactory remedy for this condition was to put the pillows through the tumblers, then through a locally designed dryer. This dryer was a wooden structure 4′ x 4′ x 7′, fitted with wire mesh trays to hold the pillows while an air current containing a disinfectant and deodorizer was circulated.

Laundry production records were maintained; the report which appears below covers the week ending 27 February 1954, which was the period of peak production.

			THIS WEEK	LAST WEEK	
1. ROUGH DRY	Day Shift:	1,094	1,933	1,721	Bundles
	Night Shift:	839			
2. FINISH	Day Shift:	1,111	1,811	1,703	Bundles
	Night Shift:	700			
3. SHIRTS PRESSED	Day Shift:	3,012	3,138	3,185	Each
	Night Shift:	126			
4. PANTS PRESSED	Day Shift:	3,621	4,146	4,063	Each
	Night Shift:	525			
5. SHEETS	Day Shift:	4,689	9,783	8,899	Each
	Night Shift:	5,094			
6. PILLOW SLIPS	Day Shift:	3,218	4,760	4,266	Each
	Night Shift:	1,542			
7. HOSPITAL	(Towels)	683	683	662	Each
8. MESS HALL	(Aprons)		130	100	Each
9. MESS HALL	(Rags)		150	175	Pounds
10. MESS HALL	(Pants)		293	242	Each
11. MESS HALL	(Caps)		21	15	Each
12. SNACK BAR	(Towels)		223	243	Each
13. PAINT SHOP	(Rags)		100	100	Pounds
14. GEN. MESS	(Jackets)		64	61	Each
15. GEN. MESS	(Pants)		39	47	Each
16. GEN. MESS	(Towels)		311	321	Each
17. GEN. MESS	(Napkins)		187	166	Each
18. GEN. MESS	(Table Clothes)		23	19	Each

Laundry production for the week of least population (January 3, 1953) follows:

	THIS WEEK	LAST WEEK	
1. ROUGH DRY	454	430	Bundles
2. FINISHED	422	426	Bundles
3. SHIRTS PRESSED	554	554	Each
4. PANTS PRESSED	709	743	Each
5. SHEETS	1,728	1,897	Each
6. PILLOW SLIPS	865	805	Each
7. HOSPITAL (Towels)	130	150	Each
8. MESS HALL (Pants)	84	70	Each
9. MESS HALL (Aprons)	35	0	Each
10. MESS HALL (Rag-lbs.)	50	0	Pounds
11. SNACK BAR (Towels)	30	0	Each
12. BAR (Towels)	15	0	Each
13. GALLEY (Rags)	20	0	Pounds
14. PAINT SHOP & POWER HOUSE (Rags)	150	190	Pounds

POST OFFICES

The post office facilities were operated as branches of APO 187 in accordance with the postal regulations contained in the Departments of the Army and Air Forces special regulations SR 65-220-1 AFM 182-3 for Unit Mail Service. A central Holmes & Narver postal facility was located on Elmer as shown in Figure 4-16 which served post offices located at the other camps. All mail arriving at the Jobsite had to be processed through APO 187 located on Fred, then through the H&N post office on Elmer, from which it was sent to Tare for camps on Bikini Atoll. The mail for Bikini Atoll left via air daily on the first plane departing, after it was sorted. From Tare, mail was delivered by helicopter to the off-island post offices. Throughout the Operation, mail was delivered with very few delays considering the number of times it was handled. Occasional delays in overseas mail were rectified by the revamping of air transport priorities by the Task Force Commander.

A difficult problem existed in that the APO 187 on Fred is the only legalized post office at the PPG, and therefore all papers and money necessary for execution of a money order, and all registered or insured mail must be processed there. From the off-base islands at Bikini, such money and papers had to pass through the Tare post office, then through Elmer, and finally to APO 187, with receipts and change money traveling the reverse route. This condition is inherent in the project under present postal regulations. It could be relieved somewhat by establishment of a Federal Post Office under jurisdiction of the Contractor.

COBBLER SHOP

A cobbler shop was operated only at Elmer by volunteer cobblers working during their off hours. A limited supply of materials was kept available for purchase by the cobblers. The price set for this work was as follows: heels only, sixty-five cents; half soles, one dollar and sixty-five cents; heels and half soles, two dollars. All money received under the above conditions was retained by the cobbler as his compensation.

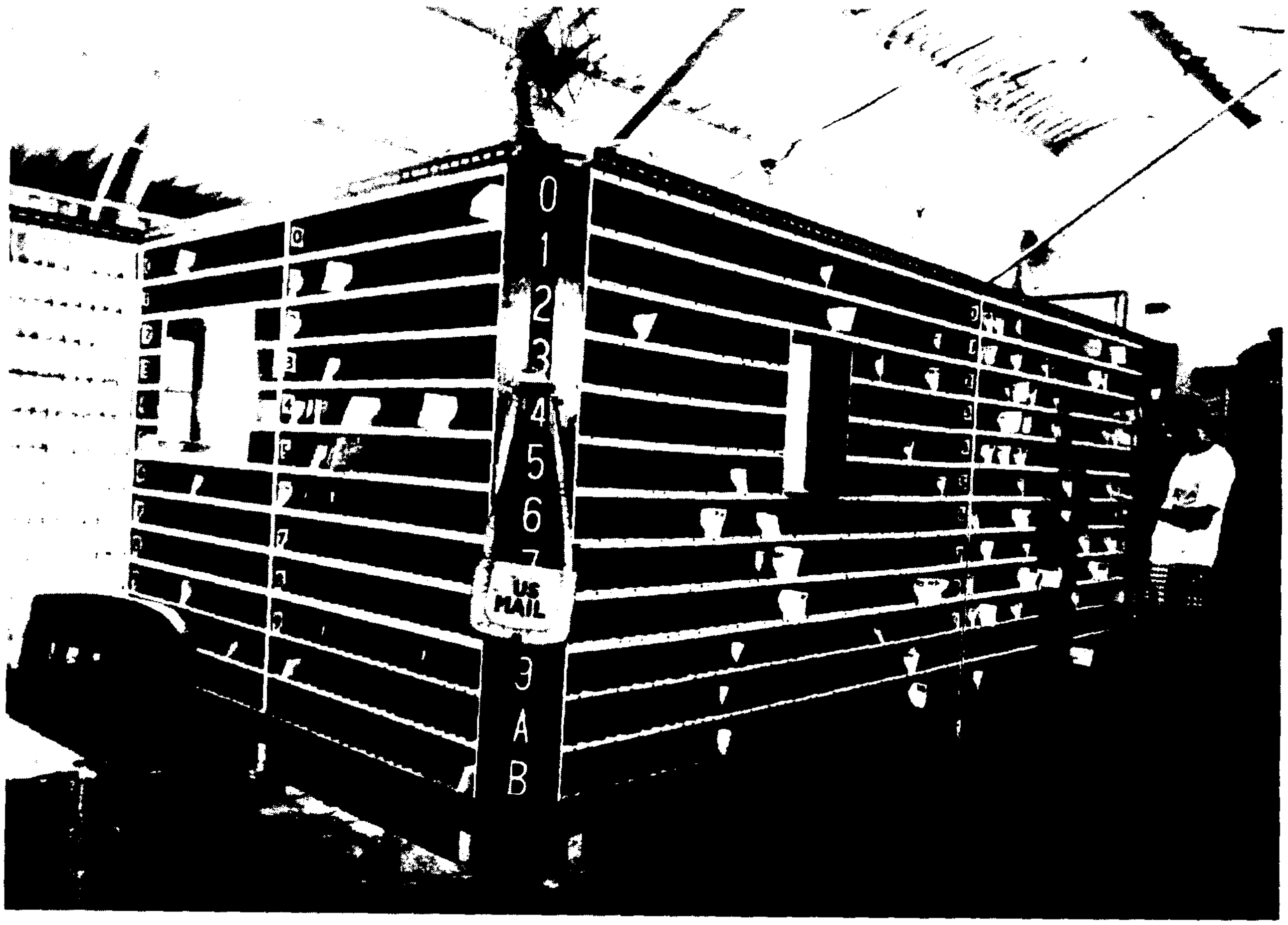

Figure 4-16. Central Post Office, Elmer Camp

BARBER SHOPS

A three-chair barber shop was operated at Elmer, a two-chair shop at Tare, and a one-chair shop at all other camps. Barber service was furnished by volunteer personnel who worked during off hours from their regular assignment. The price of haircuts was established at sixty-five cents, which was retained by the barber as his compensation. Figure 4-17 shows the barber shop at site Elmer.

Figure 4-17. Barber Shop, Elmer Camp

SECTION 2
ELECTRIC POWER GENERATION AND DISTRIBUTION

Two power plants were provided at sites Nan, Tare, Charlie and Ursula; one to furnish power for camp needs, the other for scientific purposes. This was done so that constant voltages and frequency would be assured on the scientific circuits by eliminating the fluctuating camp loads. However, when conditions permitted, one plant only was operated to meet all power demands. At all other sites generators were provided in numbers and capacities to meet the needs of each site. The generators used for OPERATION CASTLE are shown on Figure 4-18 for Eniwetok Atoll and on Figure 4-19 for Bikini Atoll.

Station NA-500 was housed in a partially sub-surface, earth-covered reinforced concrete structure designed to withstand the anticipated blast pressures and marine wave action. A similar building constructed at Ursula for OPERATION GREENHOUSE was utilized for the Scientific Power Plant at that site. All other generators, except the permanent ones at Elmer and Fred, were housed in simple, inexpensive

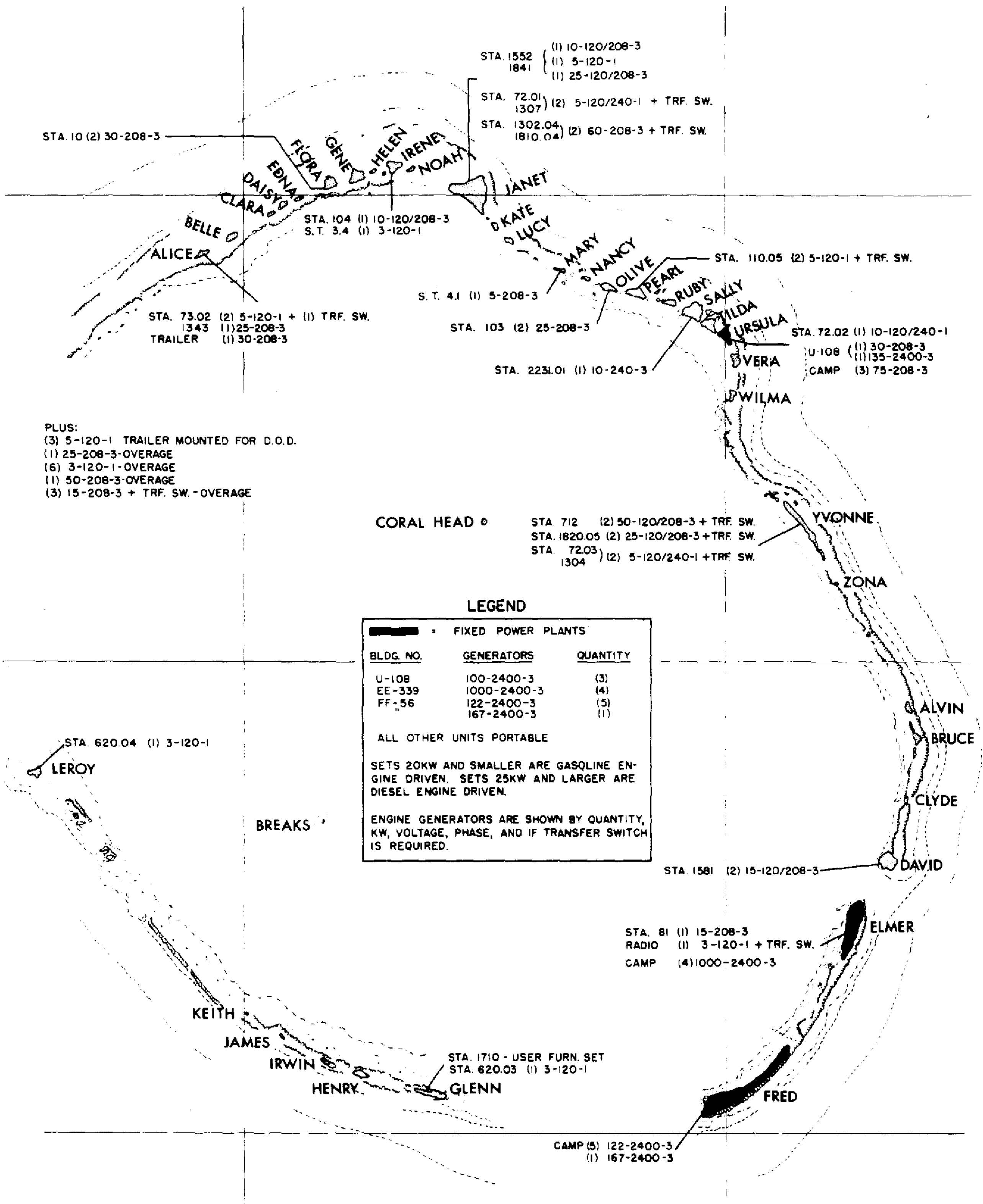

Figure 4-18. Engine Generator Requirements for Eniwetok Atoll (as of 2 December 1953)

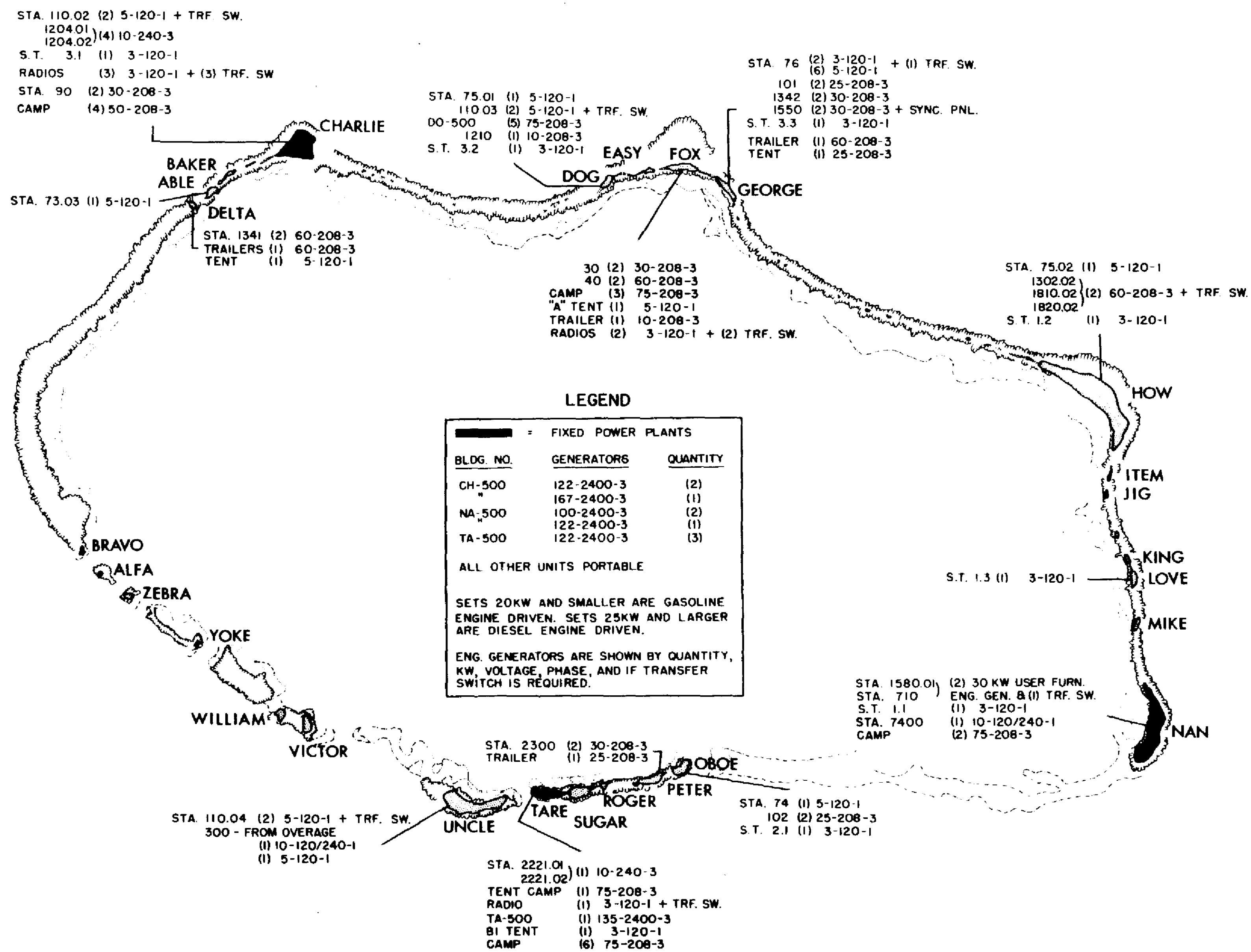

Figure 4-19. Engine Generator Requirements for Bikini Atoll (as of 2 December 1953)

expendable buildings or were set up without housing. Figure 4-20 indicates the building used at Nan to house the power and distillation plant.

The following power plants were expended during test operations:

Tare 500	Three units
Charlie 500	Three units
Dog 500	Five units
Fox Camp	Two units

A fourth 1000 K.W. generating unit with necessary switchboards and auxiliary machinery was installed in the CMR plant at Elmer. A submarine cable was then laid between this plant and site Fred so that the power load of that site could be partially carried by the Elmer plant. Due to the power demands at both Elmer and Fred during the operational phase, only part of the Fred load could be supplied by the Elmer plant; it was therefore necessary to operate the Fred plant throughout the operation to carry a share of the load.

Complete operating and production records of all fixed installations were maintained and reported monthly to the AEC. Power consumption for the entire operation is shown graphically in Figure 4-21 for Eniwetok Atoll and in Figure 4-22 for Bikini Atoll.

For reasons of economy, electrical power distribution was generally made through overhead lines on sites Elmer and Fred. A submarine cable was required between these sites, however, and underground cables were used at all other sites for scientific reasons. For the transfer of power over the submarine cable, the generated 2400 volts was first stepped up to 4160 volts and then stepped down to 2400

Figure 4-20. Camp Power and Distillation Plant - Site Nan

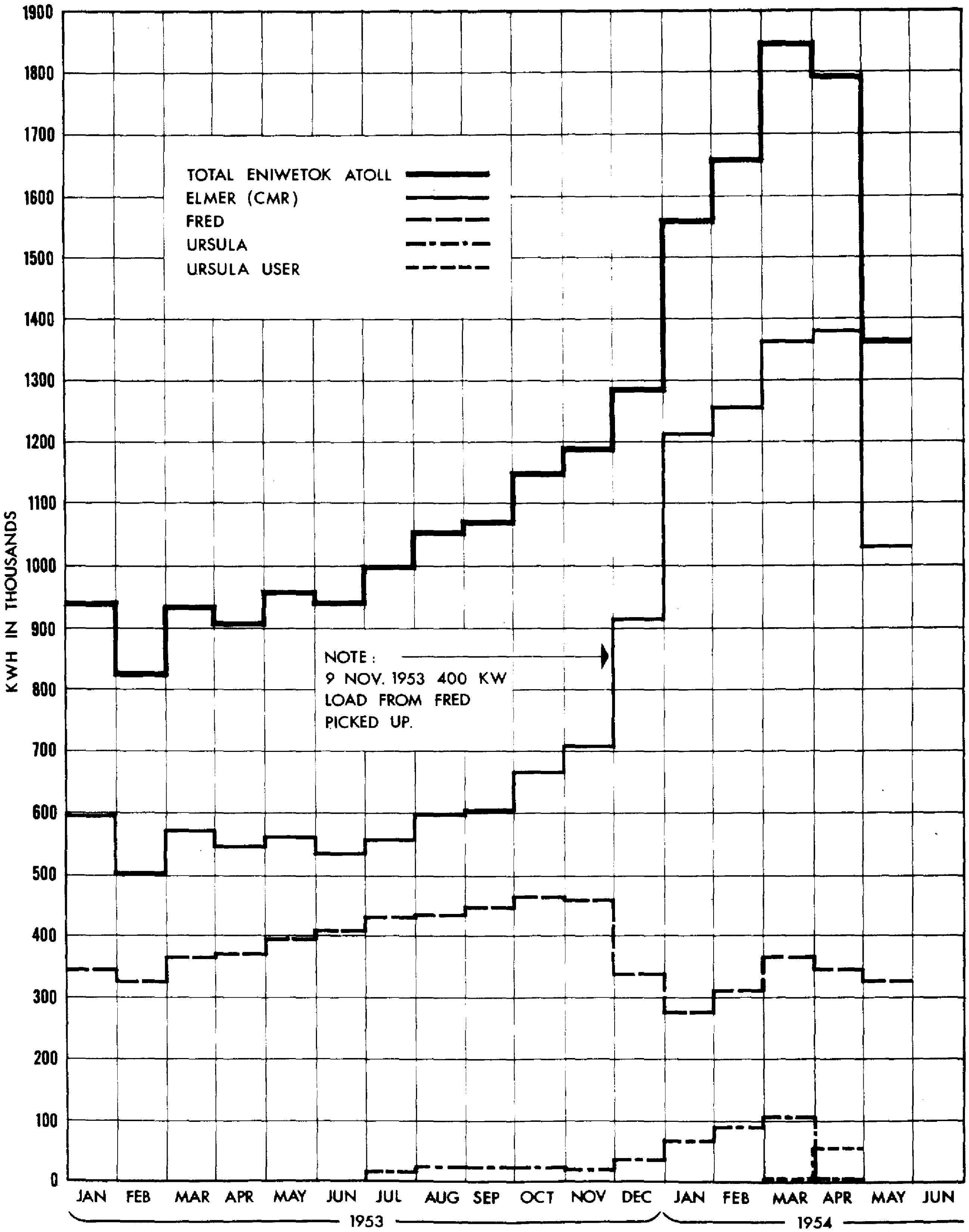

Figure 4-21. Monthly Average Power Consumption, Eniwetok Atoll

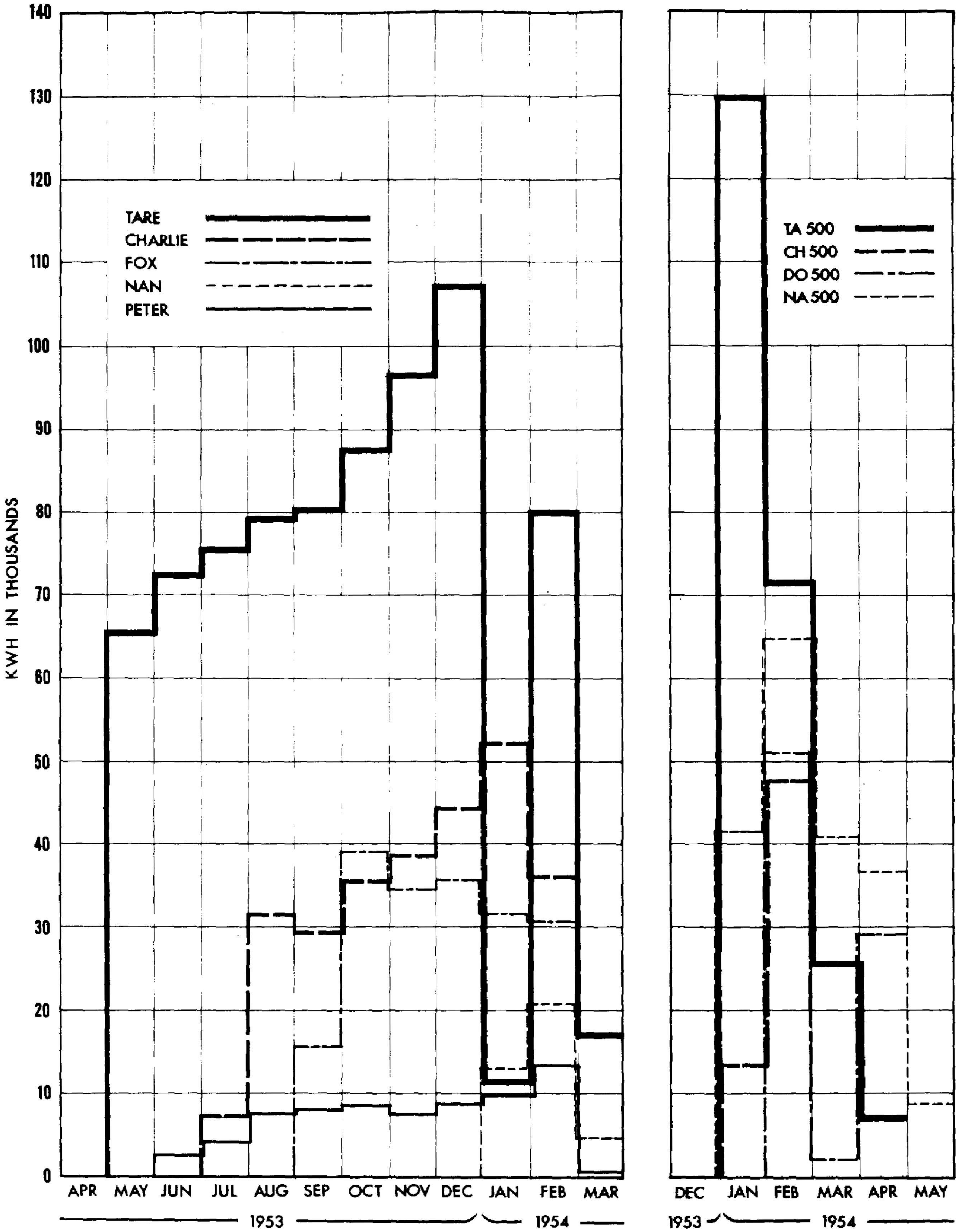

Figure 4-22. Monthly Average Power Consumption, Bikini Atoll

volts at Fred. At Ursula, 4160 volts and at all other sites 2400 volt circuits were used; these voltages were stepped down to the operating voltages of 208/117 by conveniently located transformers.

A serious failure in distribution occurred in the Fred-Elmer submarine line, necessitating the temporary operation of the Fred plant to provide all the needs of that site. In order to accomplish this, the power load was reduced by securing distillation units and cutting out unessential circuits. Though the cause of the break in the submarine cable was not definitely determined, the type of failure indicated that the cable might have been dragged and cut by a boat anchor. At the break, the cable was approximately 65 feet out from the position in which it was originally laid. It was successfully repaired.

Unsatisfactory operation of the General Motors engines in the CMR power plant developed late in 1952. Investigation disclosed that the chrome plating of the cylinder liners had deteriorated, that piston rings were stuck, and that main bearings were flaked. The cause of these conditions was determined to be the use of Navy oil symbol 9370 for lubrication, which had been recommended by the vendor of the engines. Through chemical analysis, it was found that the oil was not properly compounded to neutralize the corrosive effects of the high sulphur content of the Navy diesel oil furnished. All cylinder liners were replaced and RPM supercharged No. 1 SAE 40 was substituted for the Navy oil. The engines have been operated since this change was effected as follows: No. 1 - 4475 hours; No. 2 - 2818 hours and No. 3 - 4950 hours. Examination has indicated an entirely satisfactory condition with an expected increase in the operating life of the liners, pistons, rings and bearings.

The shift of all camp operations after the Bravo event from bases ashore to vessels in the lagoon at Bikini interjected problems of generator operation not encountered in former test operations. Due to the presence of radioactive contamination at some of the sites where work had to be done, personnel could be used in those areas for only a limited time. It was necessary to resort to considerable shifting of personnel in order to preclude over exposure. The generating units had to be operated unattended except for short visits by the daily refueling and servicing groups. Units were required to operate continuously over extended periods with exceptionally light loads. Trouble was experienced in gasoline engine ignition systems, particularly in fouling of spark plugs, excessive engine wear, and in diesel engines in fuel injectors. In several cases it was necessary to replace generators instead of repairing them on the site. Two complete units were replaced at Dog-500 just prior to the need for this Station for the scientific test operations.

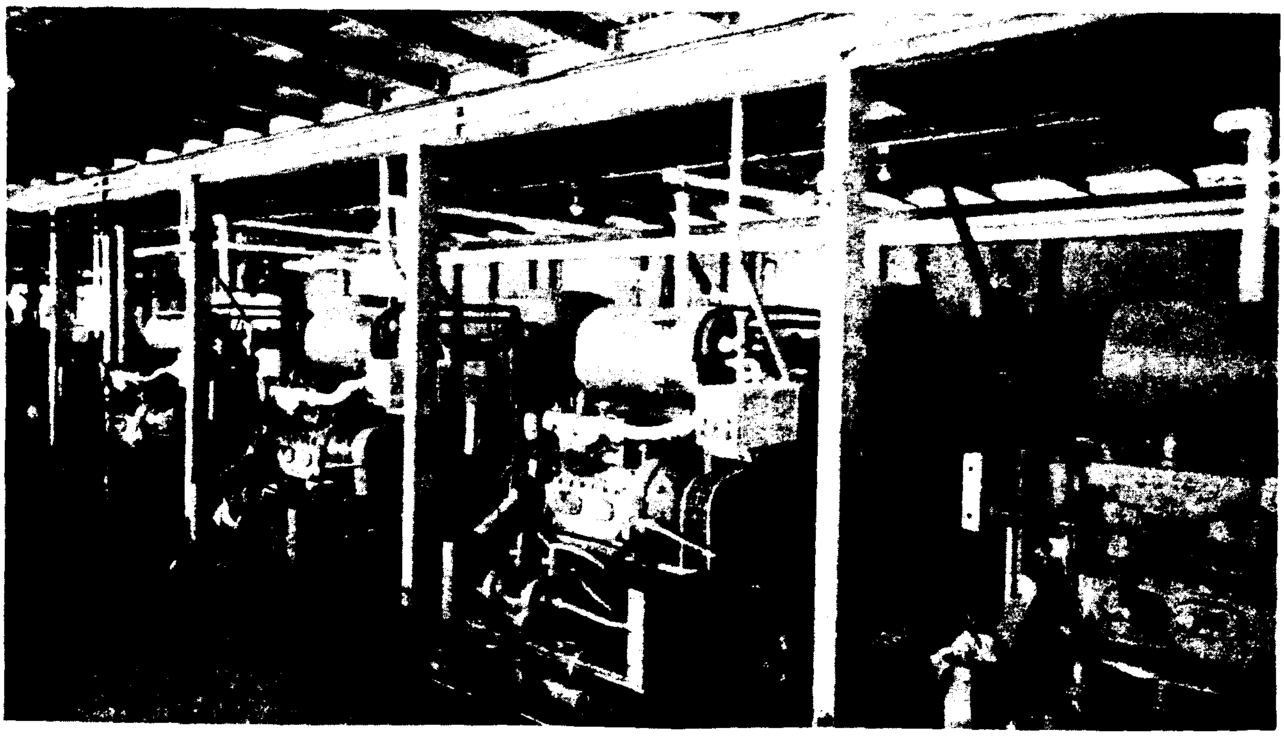

Figure 4-23. Water Distillation Units - Site Charlie

SECTION 3
FRESH WATER DISTILLATION AND DISTRIBUTION

The fresh water requirements were based on forecasted peak populations with an estimated daily per capita consumption of 40 gallons in the permanent camps and 35 gallons in the temporary camps. Experience gained with distillation units had indicated that they serve satisfactorily as the source of fresh water when provided in multiple units of liberal capacity to permit the fairly extensive maintainance necessary for this type of equipment. In determining the number and capacities of units required at each camp, consideration was given to "down time" of 25% for the units installed and to the difference between rated capacities and actual yields due to the fouling of tubes in use. As the program developed, it became apparent in April 1953 that it would be necessary to provide additional distillation units to meet the expected fresh water demands. After evaluation of all the factors available at that time, a decision was reached to procure six 600 gph and four 200 gph additional units. Though the original concept of the number of camps and population estimates changed somewhat thereafter, the acquisition of these additional units permitted the provision of adequate plant capacities at all sites. The following tabulation indicates the location of all units in February 1954, the month of peak population.

SITE	NO. OF UNITS	RATED OUTPUT G. P. H.	COMPRESSOR PRIME MOVER	STATIONARY OR PORTABLE	CAPACITY PER DAY
Elmer	6	600	Elect.	Stationary	
	3	600	Diesel	Portable	134,400
	1*	200	Diesel	Portable	
Fred	8	600	Elect.	Stationary	187,200
	5	600	Diesel	Portable	
Ursula	3	200	Diesel	Portable	14,400
Yvonne	1**	600	Elect.	Stationary	9,200
Tare	11	150	Gas	Portable	39,600
Charlie	4	150	Gas	Portable	14,400
Fox	4	150	Gas	Portable	14,400
Nan	4	150	Gas	Portable	14,400

* Used only for several days during emergency landing of Bikini Personnel after Bravo event.

** In inactive status.

The distillation units with their related equipment such, as boilers, pumps, and chlorinators, were housed at the temporary camps in simple inexpensive, expendable buildings. Figure 4-23 shows the installation at site Charlie. Ground and elevated storage tanks were provided in quantities to provide storage of one day's supply of fresh water. The piping to the elevated tanks was so arranged that these tanks rode the distribution system and thereby provided the necessary head. Asbestos-cement pipe for distribution lines was used for reducing the corrosion problems since it was available at Jobsite. Shallow salt water wells conveniently located adjacent to the distillation plants were the source of salt water. Figure 4-24 shows a typical elevated tank at a temporary campsite.

Operating experience indicated that consumption could be held to low rates only with careful water discipline by users and continued surveillance of the distribution systems to detect and rectify leakage as early as possible. Demands for fresh water were heavy for washing down planes, for decontamination purposes, and photographic laboratories. Also, the distillation plants on LSTs did not operate satisfactorily when the vessels were beached and it became necessary to augment the supply of water to these vessels from the source at Elmer. Records of daily production and consumption records for all purposes were maintained and reported monthly to the AEC. Consumption for both Eniwetok and Bikini Atolls is shown in the table at the bottom of page 4-32.

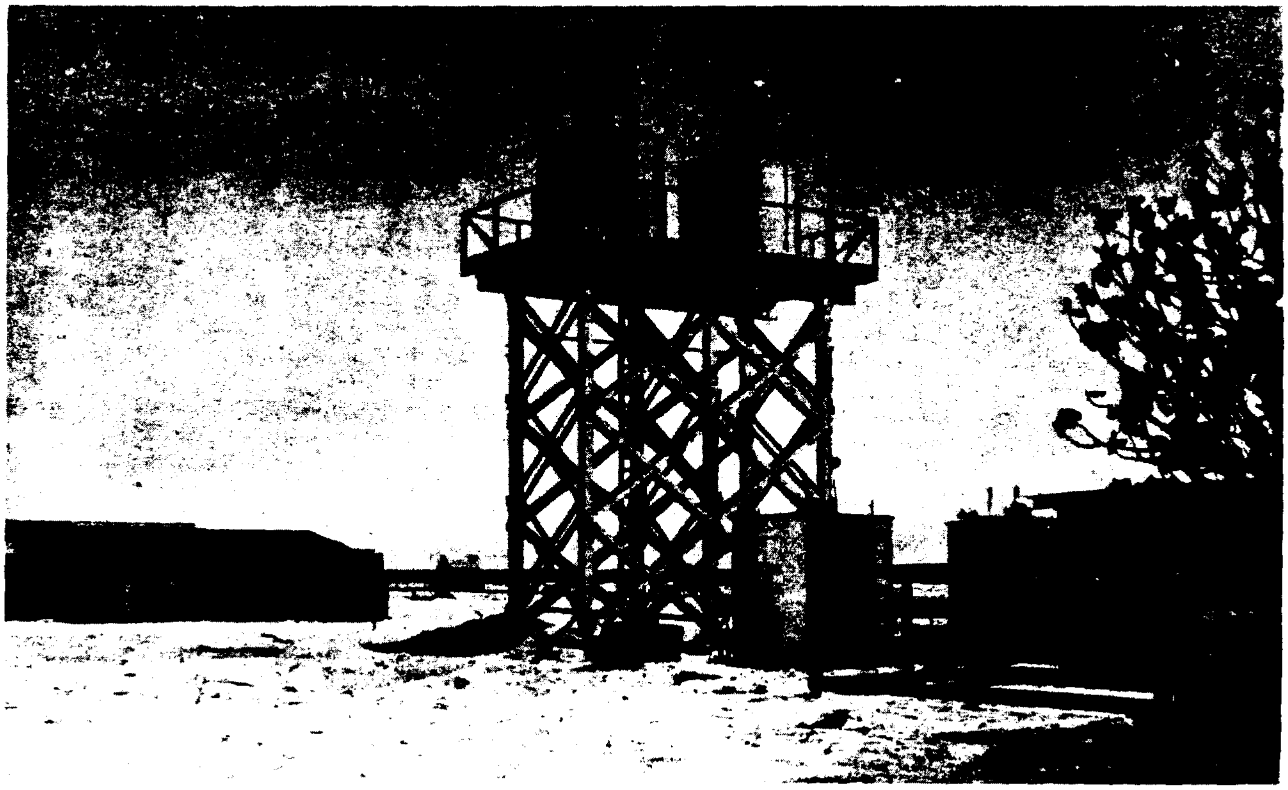

Figure 4-24. Elevated Water Tanks - Site Tare

The average daily per capita consumption is indicated in the following table:

WATER CONSUMPTION

AVERAGE GALLONS PER MAN PER DAY

		ELMER	FRED	URSULA	TARE	CHARLIE	FOX	NAN
1953	Jan.	70.5	53.5		31.7			
	Feb.	64.4	50.3		33.1			
	Mar.	64.0	55.3		34.3			
	Apr.	65.1	57.7		31.1			
	May	61.6	57.3		26.1	24.9		
	June	64.5	65.3		31.9	26.3	18.2	41.7
	July	61.6	62.2	49.7	30.9	34.1	23.3	28.7
	Aug.	57.2	57.0	43.5	32.4	39.8	28.2	34.2
	Sep.	63.1	57.0	39.8	35.1	36.0	31.8	34.9
	Oct.	66.1	47.6	33.2	34.7	33.5	31.5	33.5
	Nov.	55.4	44.0	39.7	28.1	30.5	32.2	27.5
	Dec.	54.8	45.1	32.2	25.0	30.0	32.4	26.8
1954	Jan.	48.9	40.9	30.3	27.5	29.5	33.0	31.0
	Feb.	48.2	40.9	30.1	27.9	29.4	28.9	32.8
	Mar.	47.7	39.6	34.8				
	Apr.	54.5	42.6	34.5				

The fresh water storage capacities at each camp were as indicated below:

SITE	TOWER	GROUND	TOTAL
Elmer	1 - 21,000 gallon tank	2 - 42,000 gallon tanks 2 - 80,000 gallon reservoirs	265,000 gal.
Fred	1 - 21,000 gallon tank	6 - 42,000 gallon tanks	273,000 gal.
Charlie	1 - 4,200 gallon tank	2 - 4,200 gallon tanks	12,600 gal.
Fox	1 - 4,200 gallon tank	2 - 4,200 gallon tanks	12,600 gal.
Nan	1 - Navy Cube (1,200 gal.)	3 - Navy cubes 1 - 4,200 gallon tank	9,000 gal.
Tare	1 - 4,200 gallon tank	2 - 21,000 gallon tanks	46,200 gal.

As result of the test operations at Bikini Atoll, the following distillation equipment was expended:

At Fox.

Badger Units Nos. DI-209, DI-164, DI-156 and DI-193
One acid pump
One 3″ motor driven salt water pump
One 3″ engine driven fresh water pump
One 2″ motor driven fresh water pump

At Nan.

Badger Units Nos. DI-157, DI-168, DI-169 and DI-102
One 2″ salt water pump
One 2″ fresh water pump

All other units and related equipment were salvaged and returned to Elmer for mothballing.

On cancellation of the Echo event, the entire plant at Ursula was dismantled and returned to Elmer for storage.

On 20 April the distillation repair shop on Elmer was established in Building 301 in the space formerly occupied by generators in that building. This permitted the retirement of the old SANDSTONE quonset type building No. 171 and other temporary structures which had outlived their useful life and so made space available for construction of new warehouses.

SECTION 4
MARINE OPERATIONS AND MAINTENANCE

GENERAL. The Marine Department functioned as a component of the Service Operations Division. The Superintendent of Marine Operations was directly responsible for the operational control of all marine craft, and the Superintendent of Marine Equipment and Repair was responsible for the upkeep and repair of all craft and equipment. For assistance in operational control, there was an assistant superintendent at each Atoll and dispatchers at all established camp sites. From a low in manpower strength of 77 men, this department expanded to a peak of 200 men during the operational phase.

The expansion in craft was as follows

	IVY	CASTLE
LCU	5	9
LCM	19	24
YTL	2	2
Taxi	3	3
Barges	4	10*
DUKWs	6	24
Sea Mule	1	1
AFDL	1	1

* 4 used as Zero Scientific Stations

There were encompassed in OPERATION CASTLE a wide variety of marine requirements included among which were:

(a) Water transportation for personnel and cargo.

(b) Locating, improving and marking boat channels.

(c) Overhaul of existing and planting of additional mooring buoys.

(d) Movement, mooring and positioning of barges fitted as Zero Stations.

(e) Support of Scientific groups in assembly and planting of waterborne Scientific Stations.

(f) Assistance to seagoing vessels in berthing.

(g) Assistance in installation and the maintenance of all underwater piping.

(h) Deep sea diving.

(i) Operation of cable laying boats.

WATER TRANSPORTATION. During the construction phase, intra-atoll water transportation requirements were met by the Holmes & Narver boat pool. For the operational phase the marine craft at the Jobsite were augmented by 19 LCMs and 5 LCUs provided by Commander Task Group 7.3. The volume of traffic and the general over-all cargo carried was closely watched and regular boat schedules were published so that the maximum use of available operating craft was made. The responsibility for the assignment of craft to meet the varying daily needs was delegated to the Marine Dispatcher. During the operational phase at Bikini Atoll, the scheduling was assumed by a panel consisting of the H&N Assistant Marine Superintendent and the U. S. Navy Boat Pool Officer. All operating craft and dispatchers' offices were equipped with ship to shore radios. This assured personnel safety and rescue, facilitated the control of the craft when out of sight of the dispatcher, and permitted diversion of craft in the lagoons as the need for this arose. All craft operators were required to report their departure from a site and their estimated time of arrival at their destination with information as to their needs for assistance in loading or unloading their cargos by riggers, heavy equipment operators or others. The dispatchers, therefore, could make the necessary arrangements for this assistance in advance and thereby reduce the time that the craft had to remain on the beach or at the dock.

DUKWs were widely used in connection with work on reef stations; on sites inaccessible by boats; for many scientific recovery jobs as they are somewhat self-decontaminating; and

Figure 4-25. DUKW on Site Bravo. Sites Alfa and Bravo were Restricted to DUKW's Only

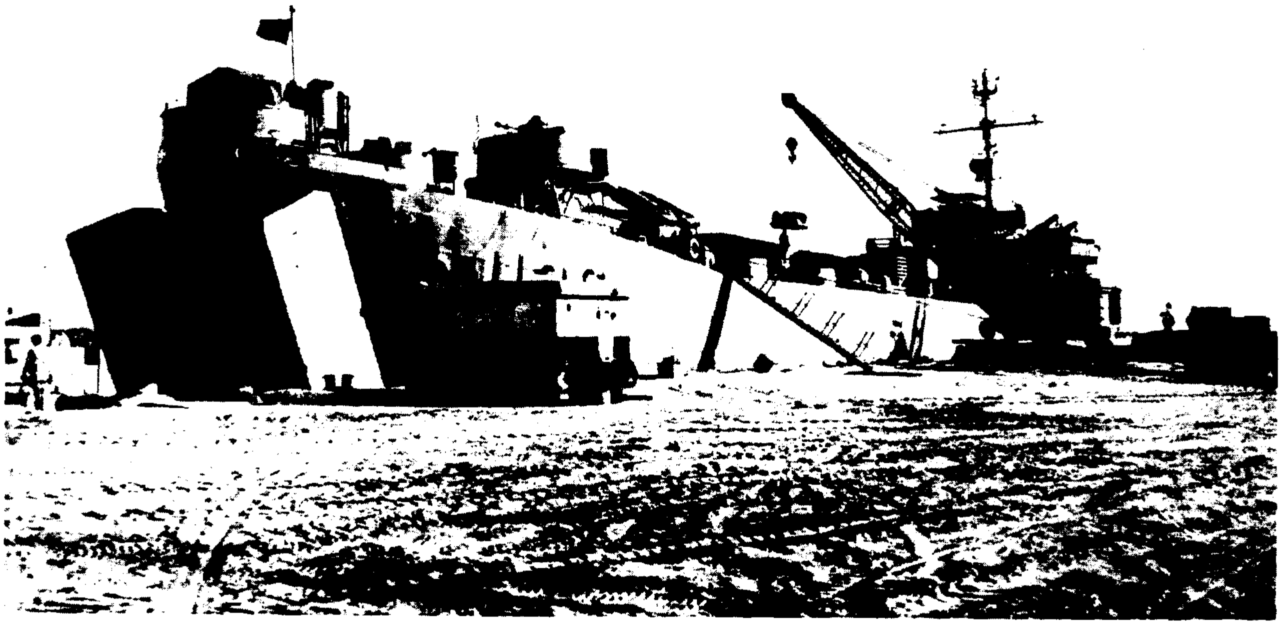

Figure 4-26. U. S. Navy LST Unloading at Site Tare

for other purposes. For the operational phase at Bikini Atoll a total of 15 of these craft were made available. Several of these were fitted with A-frames and proved advantageous for work in contaminated areas. The turnover of DUKW operators after Bravo due to radioactive exposure was exceptionally heavy. It was necessary during the later stages of the Operation to establish a training school in order to provide the number of operators required.

The stevedoring on board sea-going vessels was the responsibility of the Army Post Commander at Eniwetok Atoll and of the H&N Supply Superintendent at Bikini Atoll. At Eniwetok Atoll, the ship to shore marine carriers used were primarily barges, with LCUs and LCMs being used for rolling stock and reefer vessel cargoes. At Bikini Atoll, LCUs and LCMs were entirely used for this purpose.

The volume of cargo and passengers carried by the various types of marine craft is indicated in Figure 4-27.

Interatoll water transportation was principally furnished by the operation of the U. S. Navy LSTs. Figure 4-26 shows one of these vessels being unloaded at site Tare. Some heavy equipment, such as cranes, could not be loaded through the ramp opening of these vessels. To eliminate the necessity of complete disassembly of this equipment when interatoll transfer was required, this type of equipment was loaded in LCUs which were then docked in an LSD for the overseas trip. Towing of LCUs by LSTs was tried on several occasions. The experience with these towed craft indicated that towing should be undertaken only in fairly calm seas, with wind velocities below 12 knots. On the last tow of this type with wind velocities of approximately 17 knots, the LCU received some structural damage. Cargo vessels arriving in the area of operations were used in most cases for interatoll transportation. During the last stages of the operations at Bikini, Commander, Task Group 7.3 established a daily interatoll schedule, utilizing every type of craft available to him for this service.

Considerable difficulties were experienced in maintaining proper beach conditions for LST landings. The continued and extended use of the beaches by landing craft of all types resulted in ever changing beaching conditions. The beach sand gradient varied and hard coral heads and shelves were bared. Generally the beach had to be examined frequently by divers, and dredging or back filling had to be undertaken. The LSTs sustained some damage to forepeaks and bottoms. On Bravo minus 2, an LST at Tare was unable to retract with its own power. It was necessary to salvage the vessel by using two AFTs and a number of LCMs after the vessel was lightened by completely unloading its cargo. The vessel was retracted after approximately 36 hours of anxious effort due to the nearness of H-hour.

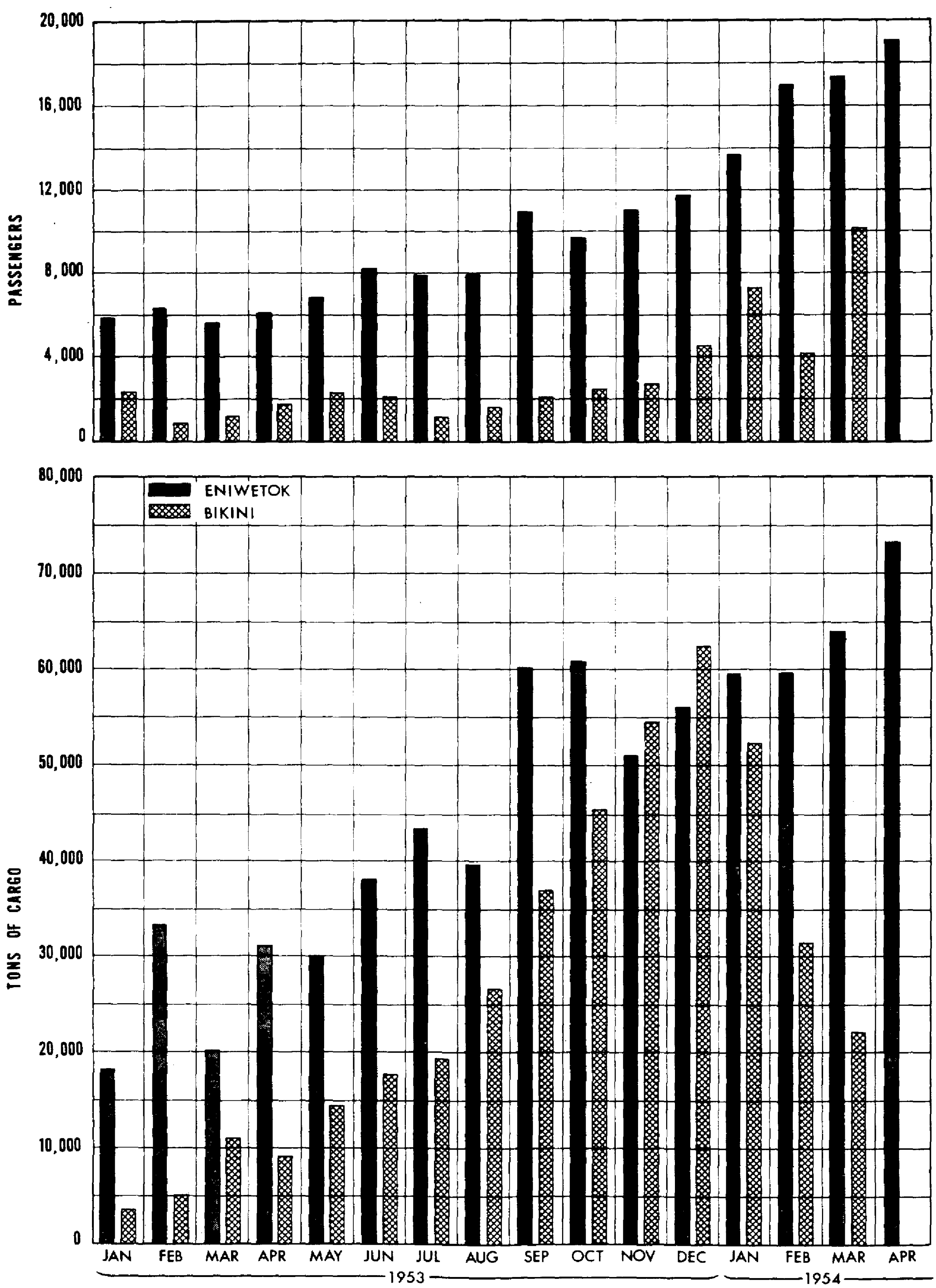

Figure 4-27. Passengers and Cargo Carried by H&N Marine Craft - Intra-Atoll

Figure 4-28. Pier and Loading Ramp at Site Tare

CHANNELS and BEACHING CONDITIONS. Channels leading to the various sites on Eniwetok Atoll were well established during the period of the previous two test operations. Although considerable shifting of beach sand was observed, no significant sanding up of channels occurred. The work undertaken for this operation consisted of lifting, overhauling and replanting of channel buoys at Ursula, and construction of a concrete ramp and the establishment of temporary channel lighting for night Dewar operations at this site. For channels and beaching conditions at this Atoll see Figure 4-30.

At the commencement of operations in Bikini Lagoon, a reconnaissance of all sites was made and the best natural approaches to the sites were located. The only natural satisfactory landing beach was found at How. At sites Tare, George, Charlie, Nan, Able and Uncle, blasting of coral heads and reefs was undertaken. Channels were marked with buoys constructed of empty oil or gas drums and anchored with concrete blocks. Range lights were erected at Tare, Charlie and George. A pier was constructed at Tare, and moles at Charlie and Able. For channels and beaching conditions at this Atoll see Figure 4-31. The pier and loading ramp at Tare is shown in Figure 4-28.

The installation and maintenance of navigational aids for sea-going vessels was the responsibility of the U. S. Coast Guard. The large-vessel channels within Bikini Lagoon were wire dragged by the U. S. Navy with support provided by the H&N boat pool The U. S. Navy Hydrographic office charts No. 6032 and 6033 revised as of 1 January 1954 indicate the hydrographic conditions and navigational aids in both lagoons.

MOORING BUOYS. At Eniwetok Atoll a number of existing small craft mooring buoys were lifted, overhauled and replaced off Elmer and Fred. A number of additional buoys were planted under Job IV work orders for small

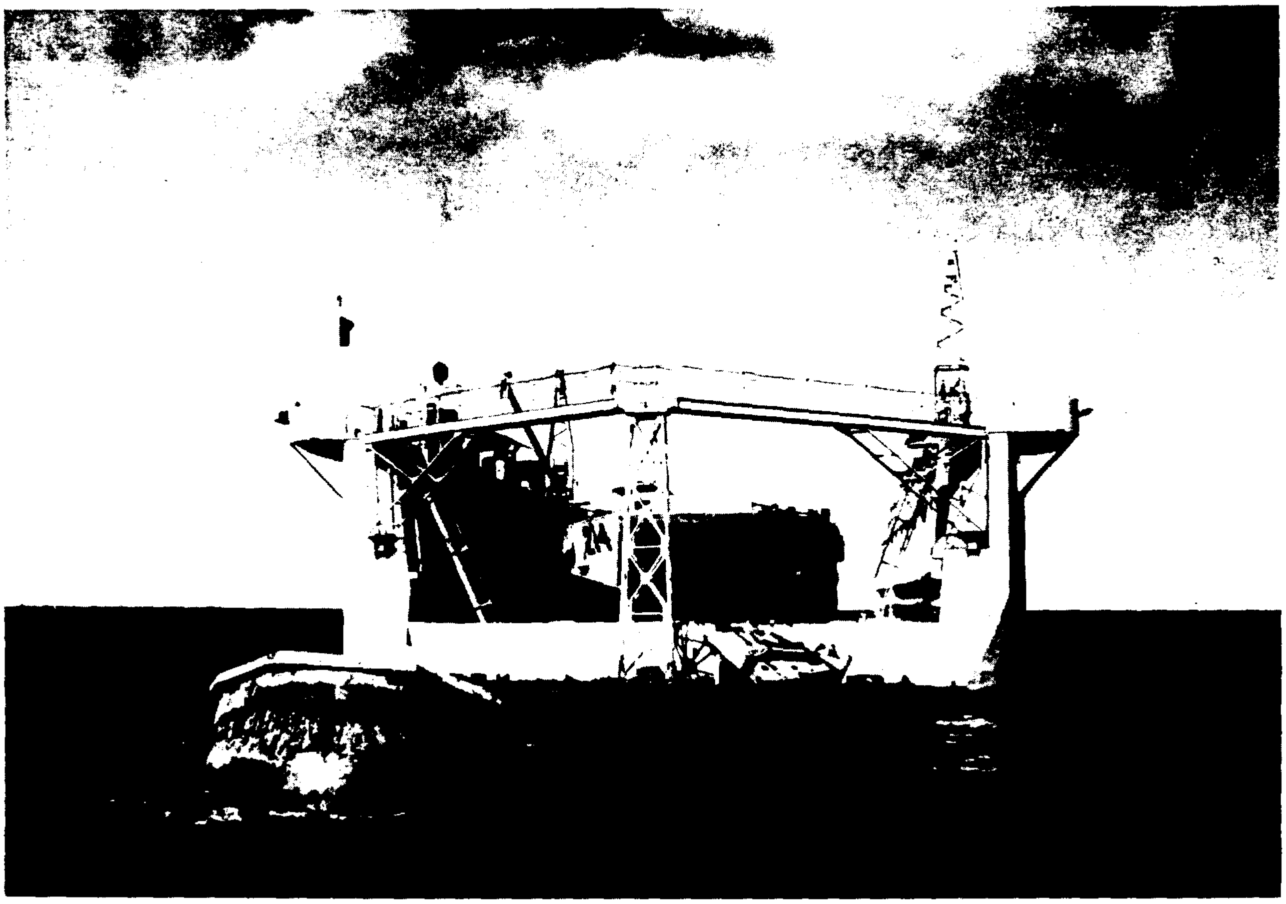

Figure 4-29. Buoy for Mooring Floating Dry-Dock

craft provided by other Task Groups. In Bikini Lagoon it was necessary to place mooring buoys off the sites of each established camp.

For moorings for large vessels, the assistance of ships of the U. S. Navy and Coast Guard was obtained. The work accomplished for large vessel moorings was as follows:

(a) Recovered, overhauled and replanted AVR mooring off Fred.

(b) Recovered and replanted POL moorings off Fred. The northern buoy was replaced with a telephone type buoy.

(c) Inspected four telephone buoys in Eniwetok Lagoon; lifted and replaced three.

(d) Planted two riser type moorings off Elmer.

(e) Inspected three barge moorings off Elmer, which were found in good condition.

(f) Inspected Dry-Dock moorings and replaced the buoy. Figure 4-29 shows the dry-dock moored and the buoy.

(g) Replaced northern POL buoy off Elmer with telephone type buoy. This was replaced out of position and at the end of the operation was placed in proper position.

(h) Recovered two riser type moorings off Janet, which were not replaced.

(j) Planted three telephone type moorings off Tare.

(i) Planted one riser type mooring off Fred.

(k) Planted two POL moorings off Sugar.

WATERBORNE SCIENTIFIC STATIONS. An interesting operation from the marine viewpoint was the work in connection with the movement and mooring of the Army-type, 585 ton barges fitted for the Zero Stations. Prior to the actual operations with these barges, a test barge having a large billboard to simulate the sail area of the actual Zero Station was moored off Fox for the study of the reaction of the barge to the various forces acting upon it. The barge remained in this area from May 1953 to September 1953. As a result of this study, which

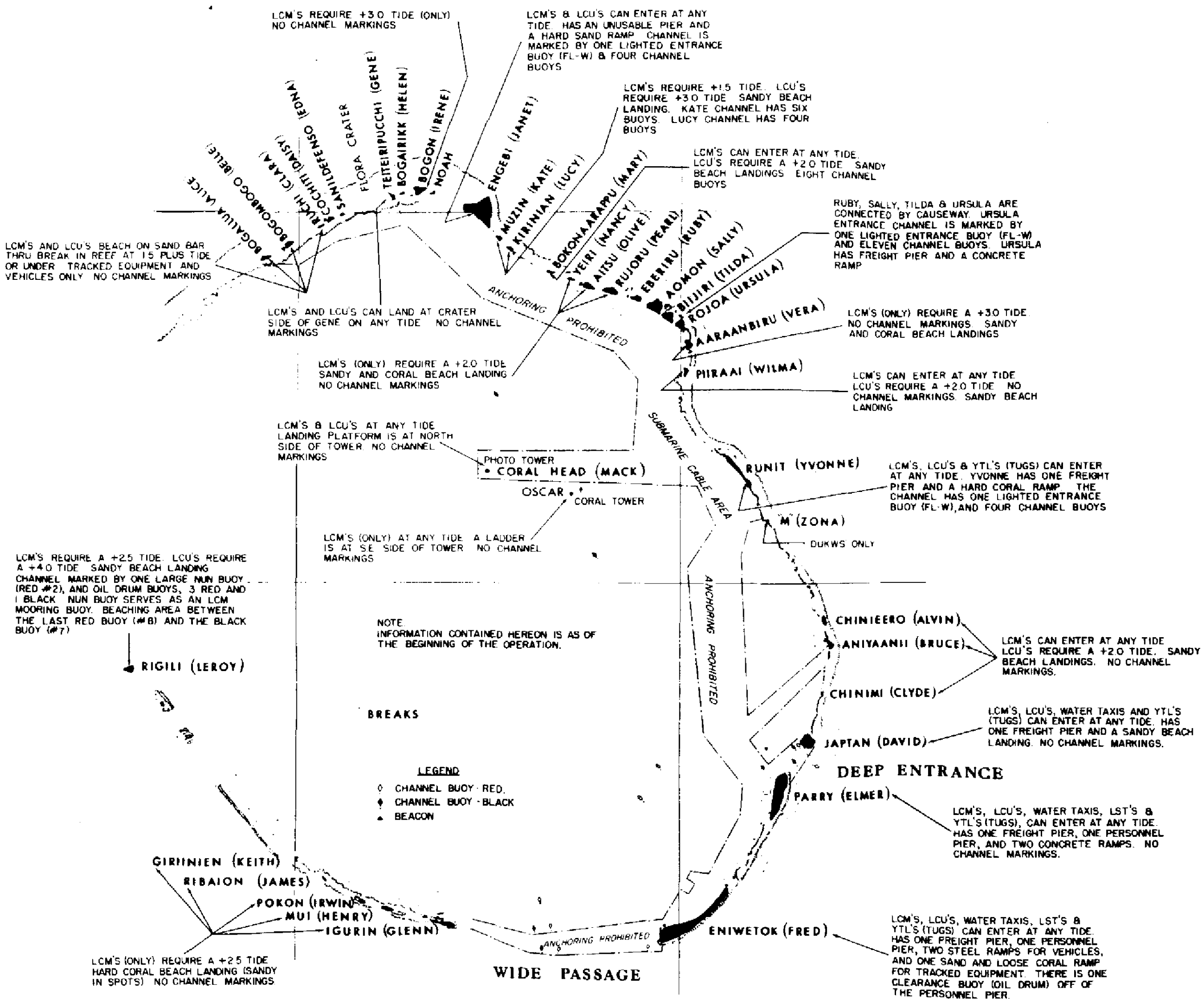

Figure 4-30. Beaching Conditions - Eniwetok Atoll

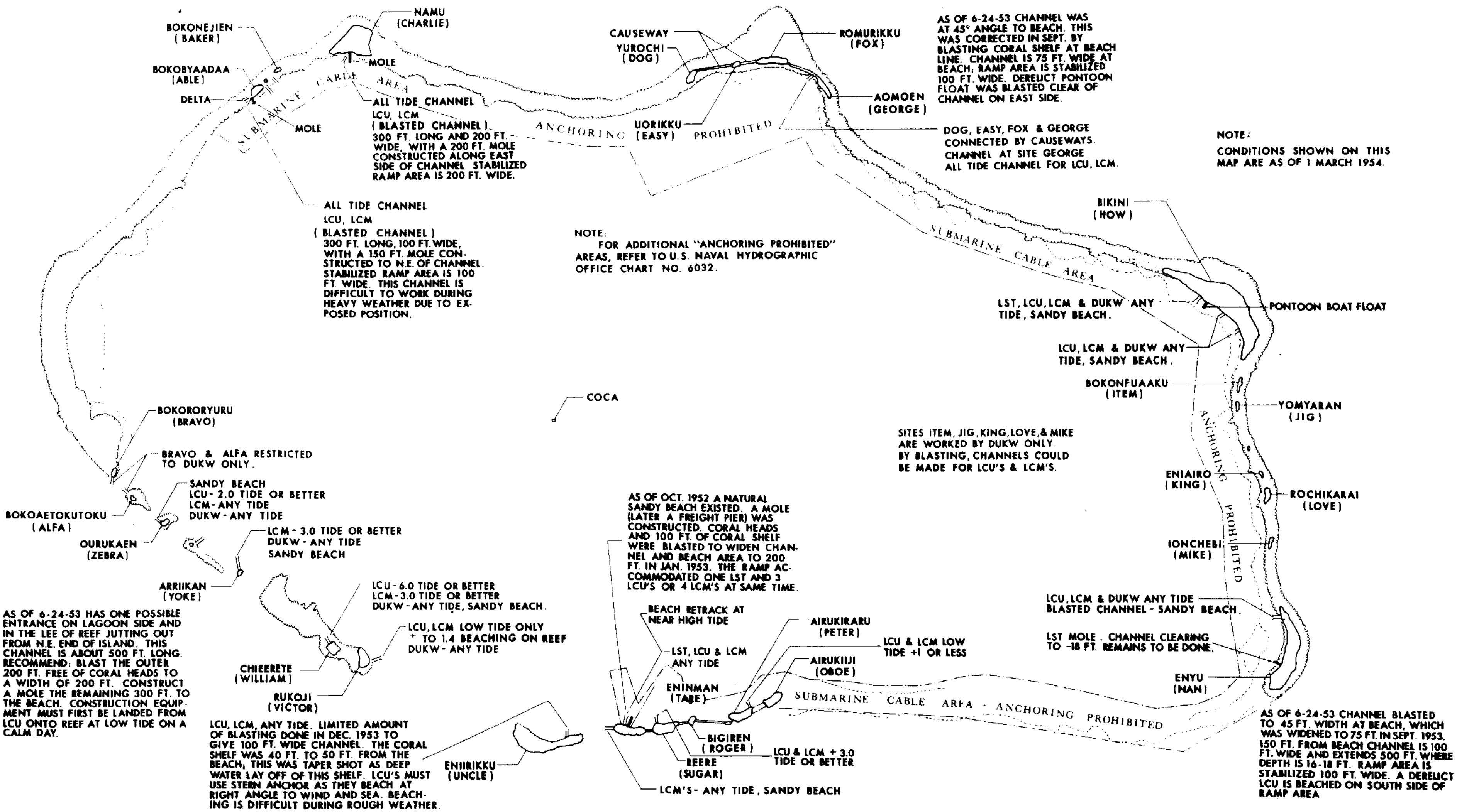

Figure 4-31. Beaching Conditions - Bikini Atoll

Figure 4-32. Landing Barge near Barge Stations for Helicopters

determined the mooring scheme as shown on Figure 4-33 it was determined that the movement of the center point of the barge could be kept within a 2 foot radius. Effectiveness of the mooring was well established with Station 90, which was placed in position on 8 March 1954 and expended on 27 March 1954. During this period, rather heavy weather was encountered with frequent wind velocities to 35 knots, yet the center point of the barge was retained within the permissible movement tolerances.

For laying the moorings for the test barges, an LCU was fitted with a special heavy wood covering on the after well deck and a heavy steel "A" frame installed at the stern to facilitate the dropping off of the 13,000 lb. anchors and chain. Each anchor was dropped over a marker buoy which had been previously planted in the position determined by a survey party. With the anchors planted prior to the arrival of the test barge, the tying-up of the test barge and final positioning was accomplished in three to four hours.

The barges were moved from Eniwetok to Bikini, an LCU and three LCMs were used in transfer the barge to the LSD at Eniwetok. At Bikini an LCU and three LCMs were used in undocking and final movement to and tying up to the mooring buoys. On the trial run with Station 30 in late January, the barge was undocked from the LSD off Fox near its final position. With a wind velocity of approximately 20 knots prevailing, the relative movements of the LSD and the barge while it was waterborne within the ship were excessive and hazardous. Due to this experience, all the test barges thereafter were unloaded from the LSD in the lee of How and then towed to their mooring Stations. This proved entirely satisfactory for all barge Stations.

During March of 1954, consideration was given to the feasibility of conducting a different test operation, using a barge Station outside the lagoon and beyond ground tackle depth. Two sea anchors were made of heavy canvas, forming an open-end cone ten feet long, ten feet in diameter at one end and sixteen inches in diameter at the other end, which was fitted over one inch pipe spreaders and equipped with a manila line bridle 20 feet long. The depth of sea anchor was controlled by use of two buoys. These sea anchors were tested in the deep entrance of Eniwetok Lagoon and were found to hold the stern of the barge within 25 degrees of the wind direction. After completion of this test of sea anchors, the proposal for the test in the open sea was abandoned.

Barges were used for Stations 10, 30, 40 and 90. They were also used for scientific purposes as follows:

Station 1840.01 - Moored close in off How.

Station 650 - First moored off Ursula for the Echo event and then, when this was cancelled, it was moored in the western end of Eniwetok Lagoon for the Nectar event.

Decontamination Barge - Fitted out as a decontamination Station and generally tied alongside the USNS Ainsworth.

A landing barge for helicopters in the Bikini Lagoon is shown in Figure 4-32.

The high winds and heavy seas generally prevailing in Bikini Lagoon during the operational phase was the cause of considerable recovery, repair and replacement work on the series 250 Stations. These Stations, designed and originally planted by Project 2.5 personnel, had too light a mooring gear for the rough

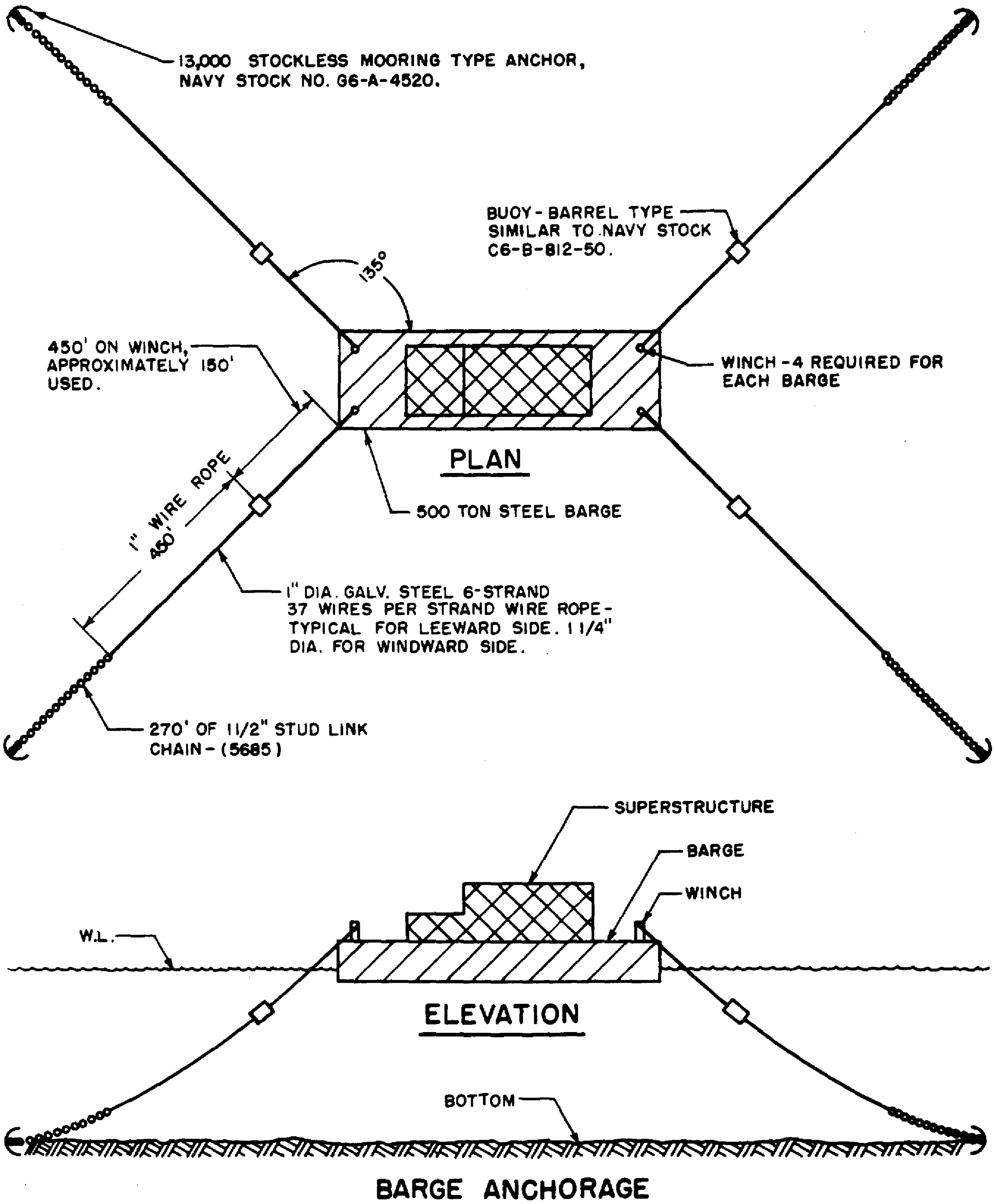

Figure 4-33. Barge Mooring Scheme

seas prevailing. Remedial measures by H&N forces consisted of replacing the mooring gear with heavier tackle. At Bikini Atoll the planting and mooring of the instrument cans of the 143 series was accomplished by the U. S. Navy. This work was undertaken at Eniwetok Lagoon by the H&N Marine Department.

ASSISTANCE TO LARGE VESSELS. All navy tankers tying to POL buoys were assisted by LCMs. The sea mule at Eniwetok and an LCM at Bikini were used to pass the POL submarine hose to the tanker and, on completion of delivery of fuel, to relay properly the hose on the bottom. In all beachings of LSTs, these vessels were assisted in making the mole and retracting from the beach.

HOUSEBOATS. LCUs were fitted out and operated as houseboats for the initial phases of all beachhead landings; to house and sustain two scientific groups off Dog-George area after 1 March 1954; and as a station vessel off the Flora Crater for the Nectar event. The boats were adequate for these uses and eliminated considerable lost time that would have resulted in traveling to and from an established camp or large vessel.

UNDERWATER PIPING. The Marine Department was responsible for maintenance of all submarine piping. In this connection two lines were laid to the POL farm on Sugar, one Jet Fuel line added to the POL farm at Fred, and considerable work undertaken in repairing existing POL lines in Eniwetok Lagoon. Prior to the arrival of tankers, all POL lines were tested by applying 80 lbs./sq. in. hydrostatic pressure. The steel piping developed a number of leaks which were repaired by using rubber patching clamped to the piping. This piping in all probability will require replacement in the near future. Considerable trouble was experienced with sea moss and trash from vessels at anchor; this foreign matter entered the CMR power plant sea water intake. To lessen this condition, a 90° vertical gooseneck was installed on the lagoon end of this intake.

DIVING OPERATIONS. All diving operations were performed by volunteers who could definitely prove previous schooling and experience. These men were given a thorough physical examination by the Jobsite doctor prior to being qualified as divers and were re-examined quarterly. The deep sea diving operations required during OPERATION CASTLE were largely concerned with the POL submarine hoses, due to the foul bottom.

Skin divers were used for shallow water diving in connection with work on underwater piping, hull inspection, inspection of ground tackle for small craft moorings, submarine cables and waterborne Scientific Stations.

The record of deep sea diving operations, which were limited to a depth of 130 feet, for OPERATION CASTLE follows:

DATE	DEPTH IN FEET	DESCRIPTION OF JOB
Jan. 5, 1953	110 - 120	Recover POL saddle Elmer and connect new chain and buoy.
Apr. 29, 1953	110 - 120	Disconnect hose from bent pipe and flange buoy off hose. O. W. O. #578, POL Eniwetok.
Apr. 29, 1953	110 - 120	Same as above.
Apr. 30, 1953	110 - 120	Lay in three sections of hose and connect up to steel pipe. #578, POL Eniwetok.
Apr. 30, 1953	110 - 120	Same as above.
Apr. 30, 1953	110 - 120	Same as above.
May 1, 1953	111 - 120	Add one section of hose to POL line and connect to steel pipe flange. O. W. O. #578, POL Eniwetok.
May 1, 1953	111 - 120	Same as above.
May 2, 1953	110 - 120	Same as above.
May 2, 1953	110 - 120	Same as above.
May 2, 1953	110 - 120	Same as above.
Feb. 23, 1954	90 - 100	Place chain weights on jet fuel lines POL Eniwetok.
Feb. 23, 1954	90 - 100	Same as above.
Feb. 24, 1954	80 - 90	Same as above.
Feb. 24, 1954	80 - 90	Same as above.

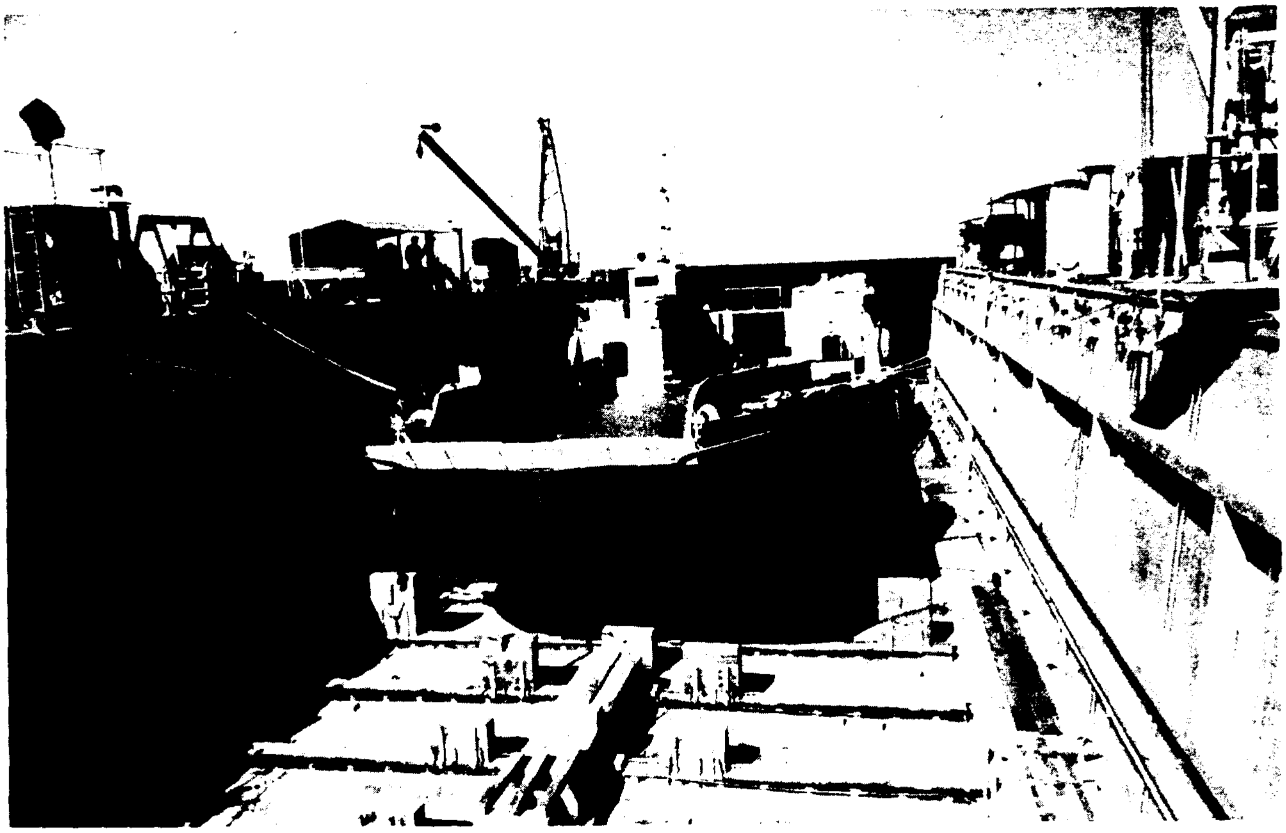

Figure 4-34. LCU Under Repairs in Floating Dry-Dock - Site Elmer

SUBMARINE CABLE LAYING and REPAIR. An LCM was fitted out as a cable laying and repair boat and was used extensively in both lagoons. The deck and bottom of this boat was reinforced, a gasoline winch placed alongside the wheelhouse, a large sheave installed over the wheelhouse, and four davits each carrying a large sheave placed on the starboard side of the boat. A special cable dolly was used in ordinary cable laying. For laying of the power cable between Fred and Elmer, the large reels were carried on a 3" steel bar hung between heavily constructed brackets on the gunwales on each side. For investigation of suspected damaged cables, the cable was run through the four sheaves hung from the davits on the starboard side. The sheaves were first lowered to the bottom where divers would place the cable in the sheave, which was then raised by the use of the davit. After the wire was through all sheaves, the boat moved forward and the cable was inspected as it passed through these sheaves.

MARINE MAINTENANCE

Conditions under which the landing craft operated at Bikini Lagoon were hazardous with respect to propellers, shafting, underwater bearings and bottoms. This was more pronounced in the early stages of the operation prior to blasting and marking of channels. A factor that added considerably to the maintenance problems was that the greater part of the landings had to be made on the generally prevailing weather sides of practically all sites. The waters in this lagoon were rougher than ordinarily encountered on sites at Eniwetok.

A small, simple and inexpensive repair shop and rigging loft was installed at Bikini. All major engine overhaul was accomplished at Eniwetok Atoll, and Bikini was kept supplied with overhauled spare engines. For work on bottoms of the LCMs, they were generally lifted out of the water by dock cranes, and repairs were effected on the mole. The maintenance of LCUs at Bikini was a difficult problem. Bottom repairs were effected when practicable by use of divers or beaching the craft at high tide and effecting repairs at low tide. Every opportunity that was afforded for interatoll transfer of craft was taken advantage of to exchange craft in order to keep craft in best operating condition at Bikini.

After 10 March an LCU was fitted out as a tender, and a staff of mechanics kept the boats operating at Bikini by trouble shooting only until the end of the operations in the Atoll. No major overhaul was accomplished. During this period the services of the LSD were made available for hull repairs. On completion of the operations at Bikini all the craft were returned to Eniwetok, where major overhaul was scheduled.

Maintenance facilities at Eniwetok consisted primarily of the engine repair shop, DUKW shop, electrical and injector shop, the hull repair yard, and a Gilhoist and floating dry dock. These were adequate. Water Taxis and LCMs were beached for major repairs; tugs, LCUs and barges were dry-docked. Figure 4-34 shows an LCU in the floating dry-dock.

The H&N marine repair group was called upon during this Operation for servicing and maintenance on craft under the control of and operated by other Task Units. This work was accomplished under Job IV work orders.

All items of maintenance work performed on each craft were recorded in a maintenance history. A record of dry dock operations indicated that the AFDL-5 was used for 31 dockings during the period from January 1953 through April 1954.

EXCHANGE OF CRAFT. The terms and conditions that apply to loans of marine craft by the Navy Department to the Atomic Energy Commission is outlined in the Joint AEC - Department of the Navy agreement OPNAV 4000 .10 A (7/1/53). In accordance with this agreement, joint inspections were made on all exchanges effected for this Operation. The reports of these inspections were furnished the AEC Resident Engineer, and copies were retained in the Contractor's files for future use in adjudication of costs. The following are the exchanges effected during this operation:

Returned to the U. S. Navy after OPERATION IVY

1 - LCU
2 - YC Barges (wooden)
6 - LCMs

Received from the U. S. Navy for OPERATION CASTLE

4 - LCUs
5 - LCMs
2 - YC Barges (steel)

To be returned after OPERATION CASTLE

1 - YTL (wooden)
4 - LCUs
1 - AFDL-5. (To be returned to Jobsite after dry docking).

Received from the U. S. Army

6 - Army type 585-ton barges - four of these were expended for Scientific purposes.
15 - DUKWs. One expended and surveyed.

Returned to the U. S. Army

15 - DUKWs.

A comparison of costs of major overhaul of LCMs by the Navy and the Jobsite was made. The Jobsite costs were actual costs incurred, and the Navy costs were those estimated for work on LCMs returned to the Pearl Harbor Navy Yard after OPERATION IVY. This comparison is indicated below.

Based on this comparison, all LCMs hereafter will be retained at the Jobsite after completion of an operation, and the boats will be overhauled by Jobsite forces and mothballed on the site.

	NAVY YARD		JOBSITE	
	A-boat	B-boat	C-boat	D-boat
Hull	$9,362.00	$9,576.00	$4,910.00	$5,240.00
Machinery	3,287.00	3,287.00	4,665.00	4,665.00

SECTION 5
AIR TRANSPORTATION

Interatoll air transportation for the movement of personnel, mail and urgently-needed materials and supplies was provided by means of PBMs until 30 January 1953. On this date the landing field on Peter-Oboe was placed in use and thereafter flights of C-47 type planes were regularly scheduled. At first the schedules called for two flights per week, but were increased as the tempo of the work increased, reaching a peak in 1954 of four flights per day six days a week. In March and April of 1954, during periods in which the airfield at Bikini could not be used, PBMs were again provided to furnish this support. Passenger scheduling was handled through the Project Manager's office on Elmer and the Assistant Resident Manager's office on Tare.

Passenger traffic was heaviest during the month of February 1954 and is indicated in the following table:

Week Ending	Flight 1 Tare	Flight 1 Fred	Flight 2 Tare	Flight 2 Fred	Flight 3 Tare	Flight 3 Fred	Flight 4 Tare	Flight 4 Fred	Total Passengers
2-7-54	60	94	30	26	82	69	29	14	404
2-14-54	56	88	36	48	65	101	50	17	461
2-21-54	83	104	43	27	85	102	9	45	498
2-28-54	65	86	43	52	81	83	9	25	444

Intra-atoll island air transportation at Eniwetok Atoll was provided by the Air Force via small liaison planes of the L-13 class and helicopters of the H-13 and H-19 class. Air dispatchers were located at the Elmer and Ursula airfields during the operational phase when traffic was heaviest. In June and July of 1953, due to a shortage of pilots, curtailment of service was necessary and transportation services were provided by water taxis. Interisland airlift at Eniwetok reached a peak in March of 1954 and the following table indicates the volume of passenger traffic for this month.

Week Ending	Number of Flights L-13	Number of Flights H-13	Number of Flights H-19	Passengers Carried L-13	Passengers Carried H-13	Passengers Carried H-19
3-7-54	280	58	—	838	45	—
3-14-54	230	42	37	690	42	96
3-21-54	162	36	131	483	26	254
3-28-54	184	52	98	540	41	246

At Bikini, interisland air support was provided by helicopters solely, thus eliminating the need for construction of airstrips at the various sites. Helicopter pads, consisting primarily of small areas of stabilized coral, were provided at each camp site. This service was first initiated on June 1953 and proved to be of material assistance because of the craft's ability to land small working parties at isolated locations. In addition it eliminated considerable lost time in boat travel. Flights were placed on a schedule basis with provisions for special flights as the need for them arose. During the period of heavy traffic, dispatchers were located at each camp site to coordinate the needs of the elements of the Task Force. Passenger traffic for the month of January is indicated below:

Week Ending	No. of Flights	No. of Passengers
3 January	231	856
10 January	276	1037
17 January	447	1473
24 January	447	1552
31 January	554	1758

SECTION 6
LAND TRANSPORTATION

The vehicles available for land transportation were allocated to the various sites according to the actual needs of each. These vehicles were placed in motor pools under the control of a dispatcher. At sites other than Elmer and Tare, the duties of the dispatcher were assumed by a clerk as additional duties. Permanent assignments of vehicles from the pools were permitted to certain individuals where the need for this was quite evident. With a few exceptions, all vehicles were required to be returned to the pool at the end of the day's work.

Daily bus service was provided at Elmer with the route passing the main installations on that site. Bus service was provided to and from the airfield at Peter with the schedule arranged to meet all incoming and outgoing planes.

In June 1953 there were at the Jobsite a total of 112 light vehicles under H&N control, which included ¼ ton jeeps, ½ ton pickups, ¾ ton weapon carriers and 1½ ton personnel carriers. Additions to this fleet were received as follows:

July 1953 — 5 - ¼ ton jeeps
— 3 - 1½ ton personnel carriers
Aug. 1953 — 6 - 1½ ton personnel carriers
Oct. 1953 — 5 - 1½ ton personnel carriers
Nov. 1953 — 8 - 1½ ton personnel carriers
— 5 - ¼ ton jeeps
Dec. 1953 — 3 - 1½ ton personnel carriers
Mar. 1954 — 7 - ½ ton Dodge Power Wagons

With the arrival of the military and scientific personnel the total number of vehicles at the Jobsite was greatly augmented by those of other agencies; these were pooled for most effective usage. The maintenance of all vehicles, other than those at Fred, was performed by contractor personnel.

SECTION 7
COMMUNICATIONS

The need for reliable communication systems for the correlation of the entire enterprise as a harmonious whole was manifested by two conditions not encountered in previous test operations; (1) the use of one Atoll as the main base for supply and field management with the major portion of the work to be accomplished on another Atoll 185 miles away, and (2) the destruction of shore facilities on Bikini Atoll as a result of the first test operation.

With the operations on two widely separated atolls, dependable interatoll communication was fundamental and requisite because Task Force personnel were quartered and maintained offices on various ships, and the required work was scattered throughout the various sites of the atoll, the dissemination of information pertaining to this work, the division of this work into tasks, and the assignment of qualified personnel to the tasks for efficient accomplishment was a difficult problem.

Dependable teletype facilities were installed at Tare by elements of the U. S. Army Signal Corps and were made available to the Contractor shortly after the first landing in October 1952. Although the delivery time from originator to addressee was measured in hours, on the whole this service was generally satisfactory. When immediate exchange of information between atolls was necessary, the radio-phone facilities of the U. S. Army Signal Corps were made available to the Contractor. This service was limited in use for security reasons. It was, however, satisfactory until the terminal equipment at Bikini was shifted from ashore to afloat. Due to radio-interferences that prevailed on board ship, the transmission and reception of messages over this circuit was often erratic and unreliable. When this occurred, the radio-phone network of Task Group 7.1 (EG&G), which retained its terminal equipment in Station 70 on site Nan, was used for emergency calls. At times the ships CW-(Code) radio facilities were made available for transmission of messages between Atolls.

Radio-phone facilities for communication within an atoll were widely used. At both atolls the Contractor operated and maintained marine and administrative networks. The marine network provided the means for marine dispatcher-to-craft communication and the administrative network between offices and forces in the field. For the terminals for forces in the field, the equipment was installed in vehicles. During the construction phase at Bikini Atoll prior to the installation of the telephone systems, these radio-phone networks were absolutely essential for the proper performance of the work required. Walkie-Talkie sets were provided for such operations as surveys, unloading bulk fuel from tankers, communications between batch plants and concrete pours, and, in general, on sites where other types of rapid communications were not available. The U. S. Navy intership radio-phone circuits were at times used to transmit messages for the Contractor as needed between ships which were not within the Contractor's networks. Figure 4-35 shows a radio-phone installation in an LCM boat.

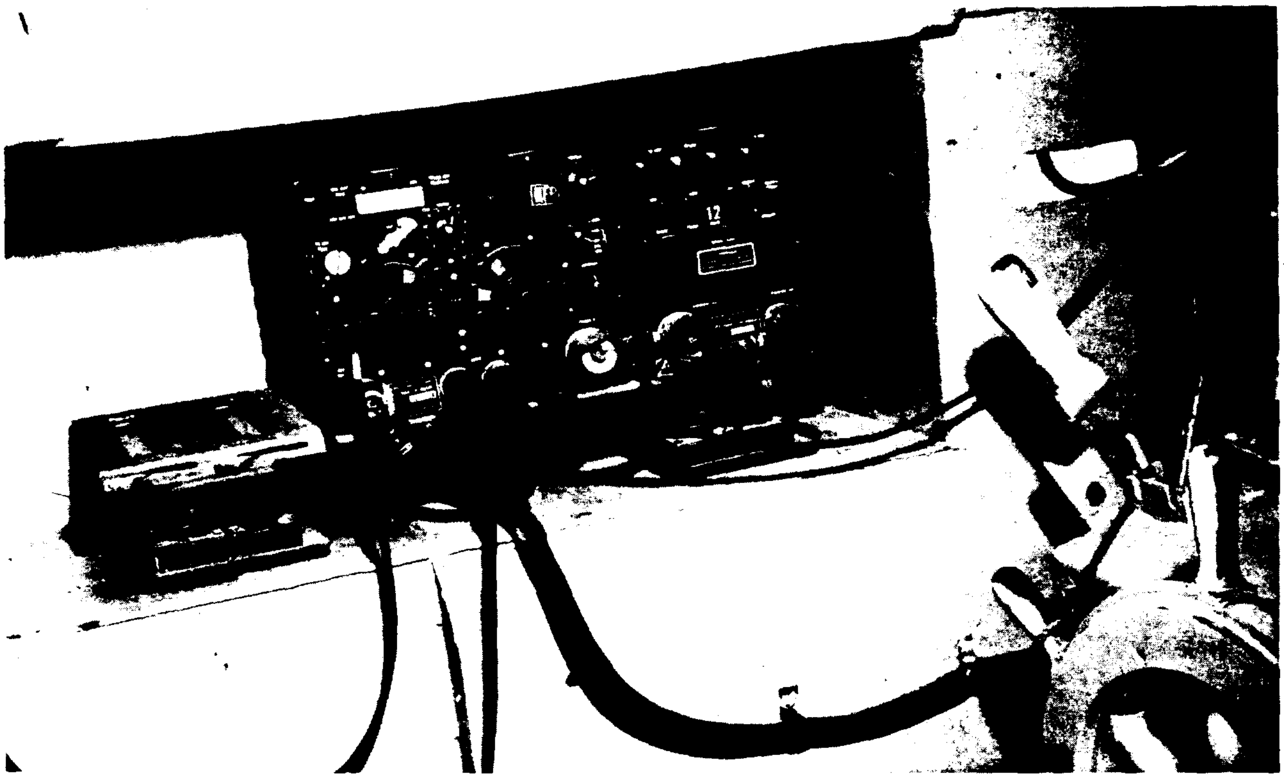

Figure 4-35. Radio-Phone Installation in an LCM Boat

The following table indicates the radio equipment for which the Contractor was responsible for operation and maintenance:

Eniwetok Atoll

Number	Type
23	AN - PRC/10 Radio Set (Walkie-Talkie, Army)
16	AN - VRC/18 Radio Set (12 volt)
6	AN - VRC/18/24 Radio Set (24 volt)
1	FSTRU - 140 BR (CW) 1-A 60 Watt Base Station
4	Model PA - 8270-J
3	Model FSTRU - 80BY (BW) 1-A
9	Model FMTRU - 80 D (A) 1-D
5	Model H-13-1A "Handie-Talkie"
20	Model VN - VR C/18/12 (12 volt) (Marine)
11	Model AN - VRC/7 (6 volt) (DUKWS)
2	TCS (Navy Type)

Bikini Atoll

Number	Type
26	AN - VRC/18/12 (12 volt)
13	AN - VRC/7 (6 volt)
3	AN - PRC/10
1	Model FSTRU - 140 BR (CW) 1-A (Base Station)
4	PA - 8270-J
7	Model - FMTRU - 80
5	Model H-13-A
3	AN - VRQ/3 (12 volt)
18	AN - VRC/18/12 (12 volt)
27	AN - PRC/10
2	AN - VRC/18/24

A direct line telephone system was in existence at Eniwtok Atoll with exchanges located at sites Elmer and Fred. To meet the needs of OPERATION CASTLE it was necessary to install an exchange at Ursula and connect this to the existing system. At other sites, field phones connected through the nearest exchange were provided as required. At Bikini Atoll an entirely new network was laid with exchanges located at camp sites. This system was first used in November 1953. There was no connecting line between the two atoll systems.

During construction and post-test periods, the exchanges, for reasons of economy, were manned only during the nine hours of the scheduled work day. During operational phases the services were generally extended so as to provide 24-hour continuous service. The telephone exchanges were staffed during the peak of operations as follows:

Elmer	— one chief operator and eight operators
Ursula	— two operators; relief operator provided from Elmer
Tare	— one chief operator and two operators
Charlie	— three operators
Fox	— three operators
Nan	— three operators

With the exception of the exchange at Elmer, the systems as installed were adequate. During busy hours at site Elmer, seated operators answered calls and men standing behind them disconnected completed calls. The traffic figures during the peak periods indicates that this exchange approached 100% usage of the circuits available. This extreme usage indicates an enlarged exchange is required to handle peak period traffic for a future operation of the size of CASTLE. Figure 4-36 shows the exchange at Elmer.

Figure 4-36. Telephone Exchange - Site Elmer

The exchanges provided were as shown in the following table:

EXCHANGES

Site	Type	No. of Positions	Equipped Lines	Equipped Trunks	In Use Lines	In Use Trunks
Tare	Kellog	1	100	20	100	20
Nan	Kellog	1	60	20	26	15
Fox	BD-9	1	60	40	22	7
Charlie	BD-9	1	60	40	24	7
Ursula	Kellog	1	60	20	27	10
Elmer	Kellog	3	280	40	277	34
Elmer (Fred)	Kellog	1	50	15	0	15

The telephones at each site during peak operations were as follows:

Site	Common Battery	Magneto Kellog	Magneto EE8
Tare	122	0	48
Nan	32	0	26
Fox	25	0	22
Charlie	27	0	20
Ursula	33	6	18
Elmer	335	9	14
Total	574	15	148

While most of the communications between atolls requiring rapid transmission were handled by either teletype or radio-phone, the volume of official mail was considerable. Mail of a routine nature, such as confirming data, correspondence containing information and instructions in which time was not considered essential, plans, drawings, and other documents, was handled through this medium. The handling of this mail was in accordance with AEC instructions and Security Regulations and was accomplished through a classified mail messenger service. At the start of this service, military couriers were used, but this service was later performed by Contractor employees. The mail pouch was manifested, the pouch sealed and then placed in custody of the courier for transit between atolls. At destination the pouch was receipted for, and upon verification of the contents, a copy of the manifest was signed and returned to the originator.

SECTION 8
SALT WATER SYSTEMS AND SEWAGE DISPOSALS

Salt water requirements at all temporary camps were met through the use of shallow water wells. The camp needs of site Elmer were met through the use of a well in Building 301, while the CMR area received its supply through a lagoon intake. An entirely new well and pumping station was built at Fred to meet the requirements of that site, but due to pump difficulties this supply had to be augmented at times by the lagoon intakes through the old pumping station. Although some "sanding up" of the wells was experienced, on the whole they proved far more advantageous as a source of salt water than the open lagoon intakes. Marine growths and other foreign materials were effectively screened through well operation. On the other hand the marine growths and foreign material, particularly paper trash from vessels in the harbor, entering wells through a lagoon intake excessively aggravated the operational work load of the CMR power plant.

At all pumping stations, except the CMR area, both motor driven and gas engine driven pumps were provided to insure reliability of the salt water supply. Tower tanks were installed which rode the distribution system, thereby providing the necessary head. The pipe networks were generally constructed of asbestos cement pipe of various sizes. Except for a few breaks in the piping system (the normal incidence of accidental breakage), there were no particular problems in the salt water distribution systems.

The general topography of the various camp sites permitted the use of relatively short sewer lines with gravity flow. Because of the flat terrain and consequent low gradients of the systems, it was necessary that they be watched for clogging. Disposal was effected through ocean or lagoon outfalls as determined by economy of construction. These outfalls were of sufficient lengths to keep the beaches free of bacterial contamination.

In general, vitrified clay pipe of 4", 6" and 8" sizes was used for the collecting lines and outfalls. Manholes were conveniently located to facilitate maintenance, though on the whole, little was required.

SECTION 9
FUEL HANDLING AND STORAGE

Bulk fuel was received from U. S. Navy Tankers at tank farms located on sites Elmer, Fred and Sugar. These tankers were moored to POL buoys off each site and pumped through a submarine piping system consisting of 4" steel pipe and 4" reinforced rubber submarine hose. Prior to the arrival of tankers, the submarine system was hydrostatically tested, and any defects found were corrected. The submarine lines were picked up and passed to the tanker and, on completion of fueling, the lines were recieved and laid on the bottom by H&N personnel. The first discharge through the system was always directed to the lagoon until the lines were clear of salt water. All lines were cross-connected so that mogas or diesel could be received through either of the lines.

Bulk fuel was generally distributed to Users from the tank farms by tank trucks. The fuel was delivered directly to mobile equipment or into temporary distribution tanks generally made of Navy pontoons. On Elmer, diesel oil was pumped directly to tanks adjacent to the distillation plant where it was centrifuged. It was delivered from this point via piping to the marine fuel station or tank trucks to other Users. Gasoline pumping stations for mogas were located on Elmer and Fred. All other gasoline stations consisted of elevated pontoon storage tanks with gravity feed to mobile equipment.

H&N operated and maintained the fueling systems on all sites except that on Fred. At this site H&N was responsible for the maintenance of the tank farms and the Armed Forces were responsible for operation of the entire systems.

The main difficulty with handling of bulk fuel was in the maintenance of a leak-proof underwater piping system at sites Fred and Elmer. This was primarily due to the foul bottom conditions at these sites. This condition was aggravated during the operational phase by the need for frequent replenishment of the tank farm at Fred with avgas and jet fuel due to the heavy usage during this period. It was not unusual to have the sea mule at this site four times a week to pick up and relay the hoses as required by standard operating procedures. Leaks developed in both the steel tubing and rubber hose which in a number of cases required deep sea diving operations to effect repairs.

The construction of a deep water pier with fueling lines at Elmer would eliminate the difficulties experienced with submarine lines at that site.

The complete tank farm at Sugar was expended in the test operations.

The storage capacities at each tank farm are indicated below:

ELMER

No. of Tanks	Type	Capacity Gals. - Each	Kind of Fuel
4	Horizontal	10,000	Mogas
5	Horizontal	10,000	Diesel
1	Vertical 2-Ring Invasion	42,000	Mogas
5	Vertical 2-Ring Invasion	42,000	Diesel
*3	Vertical 1-Ring Invasion	42,000	Diesel

Total: Diesel 386,000 gals. Mogas 82,000 gals.

*At CMR - Power Plant and filled by tank trucks.

FRED

No. of Tanks	Type	Capacity Gals. - Each	Kind of Fuel
4	Horizontal	10,000	JP4 Gas.
4	Horizontal	10,000	Mogas
1	Vertical 2-Ring Invasion	42,000	JP4 Gas.
1	Vertical 2-Ring Invasion	42,000	Mogas
4	Vertical 2-Ring Invasion	42,000	Avgas
2	Vertical 2-Ring Invasion	42,000	Diesel

Totals: JP4 Gas. - 82,000; Mogas - 82,000
Avgas 168,000; Diesel - 94,000.

SUGAR

No. of Tanks	Type	Capacity Gals. - Each	Kind of Fuel
1	Vertical 2-Ring Invasion	42,000	Avgas
2	Vertical 2-Ring Invasion	42,000	Diesel
1	Vertical 1-Ring Invasion	42,000	Diesel
1	Vertical 1-Ring Invasion	21,000	Diesel
1	Vertical 1-Ring Invasion	21,000	Mogas

Totals: Avgas 42,000 gal.; Diesel 147,000 gals.;
Mogas 21,000 gals.

Figure 4-37. Nan Camp Looking Towards Lagoon

CHAPTER V
MAINTENANCE

SECTION I
GENERAL

The climate and geography of the Pacific Proving Ground, and the nature of its usage, contribute to a high factor of deterioration.

Maintenance, as defined in the Holmes & Narver Contract, required the Contractor to furnish all labor, equipment, materials and supplies to preserve and maintain properly all facilities and structures at the Pacific Proving Ground not expended during tests, including but not limited to buildings, utilities, roads and airstrips, docks, equipment, materials and supplies and technical structures. With particular reference to the Military garrison on site Fred, the Field Manager in April, 1953 directed as follows: "Until further notice you are requested to maintain all base facilities except communications on Eniwetok Island as a matter of routine maintenance; this does not, however, include Military equipment."

As a matter of organizational efficiency, the maintenance of all marine equipment and power and water distillation plants was accomplished as a function of Service Operations; all other maintenance was a function of the Construction - Maintenance Division. Therefore, action on recurring or routine maintenance was initiated upon the authority of the General Superintendent of Construction - Maintenance or the General Supervisor of Service Operations. In addition, however, for control and record purposes, work orders were also used as follows:

EQUIPMENT MAINTENANCE WORK ORDERS. These were issued by the Accounting Division, with the Project Manager's approval, to document and accumulate the cost of labor, parts and materials used in the repair and maintenance of equipment. A separate work order was issued to cover each basic class of equipment such as heavy mobile, pick-up and personnel carriers, jeeps, compressors, welders, seacraft, T-boats, M-boats, etc.

MAINTENANCE WORK ORDERS. These were issued if the value of the maintenance work exceeded $1,000 or if the work was of a technical nature.

DAMAGE REPAIR WORK ORDERS. These were issued to cover work which could not have been foreseen and which, therefore, was not included in budget estimates, such as repair for damage caused by storms, nuclear device detonation, accidental fire, etc. Work of this nature exceeding a total cost of $100 was covered by approval of the AEC Resident Engineer.

OPERATIONAL WORK ORDERS. These were issued for specialized work within the Contractor's Divisions or between Divisions to cover maintenance of a minor nature not directly related to normal maintenance work.

The tropical atmosphere, humidity, and salt spray prevalent at the Pacific Proving Ground was conducive to rapid corrosion and deterioration of ferrous materials. The work of properly maintaining equipment and facilities was continuous. Cleaning, sandblasting and painting of metal surfaces was necessary at frequencies indicated below.

EQUIPMENT	PAINTED EVERY:
Rolling and Heavy Stationary Equipment	Six months
Trailers	Six months
Power equipment (generators, etc.)	Twelve months
Office equipment (safes, files, cabinets)	Twelve months
Beds	Twelve months
Mess Hall, Galley, Snack Bar, Bakery (furniture and equipment)	Six months
P. O. L. System	Six months
Water Towers and Tanks	Nine months
Distillation Units	Twelve months
Rock Crusher	Nine months
Batch Plant	Nine months
Gantry Crane	Twelve months
Reefers, mobile and stationary	Six months
Fire Hydrants	Twelve months

EQUIPMENT	PAINTED EVERY:
125-foot Tower and Cab	Twelve months
75-foot Towers	Twelve months
M-boats (24 each)	Three months
T-boats (9 each)	Six months
Steel barges (6 each)	Twelve months
DUKWs (20 each)	Continuous rotation
Dry Dock	Twelve months
Sea Mule	Twelve months
Tug Boats (2 each)	Twelve months
Sea Craft (3 each)	Three months
Gilhoist and Tractor	Twelve months
Buoys, large (25 each)	Twelve months

SECTION 2
BUILDINGS AND STRUCTURES

From the maintenance viewpoint, the aluminum buildings proved well suited for general use at the Proving Ground as they were practically unaffected by corrosion and therefore did not require paint as a protective measure. This was particularly true of the first aluminum buildings erected, which have apparently been maintenance-free for about five years. Caution, was necessary however, in structures where dissimilar metals or alloys made contact. This was the case in the use of cast aluminum shutter clevises and stud post cups, while rolled aluminum was used for shutter and stud posts; this was conducive to electrolysis, as was a similar condition in the Butler type buildings where aluminum siding or roofing was permitted to make direct contact with steel purlins or girts. Corrective measures consisted of using felt between the different types of metals, using neoprene washers around bolts, and greasing or coating cast or moving parts with oil.

Routine maintenance consisted of repairs to roofing and siding due to normal incidence of accidental or storm damage, weatherproofing along the bottoms, and operational repairs to doors and sashes.

Maintenance of tents primarily involved repairing or replacing canvas deteriorated by the elements. Preventive measures for canvas consisted of weatherproof spraying and reduction of chafing wherever possible. Experience indicated that canvas in this climate was good for one year's usage.

The Fred cargo pier, rehabilitated CeeBee pier surviving from 1949, was entirely rebuilt, and the Elmer pier required extensive repairs during OPERATION CASTLE. This was due to normal wear, though damage to the Elmer pier was abetted by frequent docking of LSTs. All earth-filled docks were continually subjected to wave and current action with resultant undermining and erosion. The continued movement of heavily-loaded tractor vehicles severly abraded the surfaces of the docks. Selected small aggregate stabilized with water and rolled proved to be the best surface. Weekly use of a scraper, followed by watering and rolling, was necessary to maintain a proper surface particularly for use by fork lifts. It was considered, however, that in spite of such maintenance, the heavy service and frequent cargo boat impact justified the earth-fill type of dock. The maintenance requirement compared favorably with that of alternative types, timber being subject to a high incidence of marine teredos, and steel to rapid corrosion. Timber pile piers (such as the personnel piers at Elmer and Fred) were periodically inspected to determine the damage caused by marine life or wave action, and timber replacements were made as found necessary. Concrete boat ramps required frequent cleaning to rid them of accumulated sand.

Maintenance of buildings and structures in Military service followed the same pattern as those buildings allocated to civilian use and required similar attention. Considerable repair and replacement work was found necessary in Military buildings on site Fred, at Eniwetok, which, being beyond the scope of normal routine work, was covered by maintenance work orders. Some of the buildings on Fred requiring maintenance included the radar tower, hangar, weather station, air operations building and dismantling of the POL tanks. The Contractor also furnished as a maintenance item various materials such as cement, aggregate, sand, lumber and paint to the Military personnel for work undertaken by them to maintain Military-owned facilities.

Very little maintenance work was required for the Scientific Structures. Principally, the work consisted of painting the towers as necessary and lubricating bolts, nuts, dogs and other movable parts of the various structures. Electric fixtures, wiring and plumbing facilities were repaired when required.

SECTION 3
ELECTRICAL SYSTEMS

During operating periods, all electrical generating units were under observation by operators for unusual mechanical noises, overheating, or smoky exhausts. A check of the fuel and lube oil consumption and operating logs usually indicated need for adjustments, replacements or repair. A maintenance history was kept on each unit into which all items of maintenance work were entered. Repeated or too frequent replacement of the same parts indicated the need for corrective action.

In general, preventive and corrective maintenance was accomplished on the 1000KW generators after 600-1000 operating hours; other units after about 300 operating hours. At these times the units were secured and opened for removal of carbon accumulation, check and adjustment of all operating parts, cleaning of windings, and adjustment of brushes.

As the dividing line between operation and maintenance was sometimes thinly defined, it was necessary to cover under "Operation" in Chapter IV, Section 2, certain major items of non-routine maintenance. Briefly reviewed, these were as follows:

(a) Relining of three General Motor 1000 KW generators due to deterioration of liner plating which was caused by use of a lube oil not properly compounded to neutralize the high sulphur content of the diesel oil furnished.

(b) Repairs to Engine No. 2 of CMR power plant necessitated by a crankcase explosion caused by the seizure of #15 piston to its liner.

(c) Repairs to Cummins engines in the Tare base power plant were required since, shortly after their installation, they developed mechanical difficulties which resulted in the breaking of the fuel pump drive shafts and the gear pump drive shaft pins. This was rectified by slackening the fan belts which drove the shafts, and the use of high temperature resistant grease in the gear pump drive.

(d) Frequent cleaning of screens in the CMR power plant was due to excessive accumulation of marine growth and trash.

In certain instances, radioactive contamination, combined with the exigency of the test program, did not permit proper servicing, adjusting, or on-site repair of generators. Gasoline operated prime movers gave the most trouble, primarily from fouled plugs, and salt spray deposits on spark plug porcelains. It was often necessary to exchange units. A particular case was the exchange of two 75 KW generators at site Dog Scientific Power Plant DO-500 just prior to the Yankee event. Due to radiation exposure conditions existing at the site, this job had to be accomplished hurriedly.

Overhead electrical distribution systems were subject to accelerated deterioration due to the action of the salt-laden atmosphere, and messenger and guy wires and galvanized hardware corroded. In the future, all replacements of guy wires will be done with copperweld wires. Salt incrustation of insulators, a severe problem in similar Pacific areas, was avoided by the type of insulator used and by a periodic high pressure washing routine. The continuous and necessary operation of elevated mobile equipment such as cranes or trucks with A-frames caused a number of breaks in the overhead lines. This suggests the need for overhead clearances greater than is normal in construction camps. All submarine cables were tested periodically and repaired as necessary. On 9 March 1953, telephone cable number 105 between Elmer and Yvonne was found punctured; this required 700 feet of replacement cable. Breaks in submarine cables, usually attributable to chafing with the surge of the sea on sharp coral formations, were, in several cases, caused by ships dragging anchors across them even though the "Cable Crossing" signs were conspicuous.

For the post-test operating period, the painting of 149 transformers was scheduled. Routine maintenance of interior circuits covered mainly repair or replacement of fixtures and outlets, bulb replacements, minor line repairs, and replacement or repair of the various types of electrical apparatus and appliances.

Maintenance of communication systems was performed in two general categories: maintenance of equipment installed in buildings (i. e. telephone switchboards, instruments, radio transmitters and receivers) consisting of normal checking, repairs, and parts replacement; maintenance of portions of the system installed outdoors (i. e. telephone aerial and submarine cables, antennae, transmitters and receivers mounted in boats and vehicles) required an unusual amount of maintenance due to deterioration caused by climatic factors.

SECTION 4
WATER SYSTEMS

FRESH WATER SYSTEMS. The major maintenance work for the fresh water systems concerned the upkeep of the distillation units. This equipment required constant observation during operating periods for signs of steam or water leaks and mal-functioning of equipment.

Periodic removal of the salt scale formation was required; removal was generally accomplished after approximately 300 operating hours for the 600 gph units, and 150-200 hours for the 150 and 200 gph units. This salt scale was removed by circulating through the system a mixture of two parts of 33 percent muriatic acid and one part of 75 percent phosphoric acid.

Retubing of the older 600 gph units became necessary and repairs were started; by 20 April 1954, two units at site Elmer and two at site Fred had been retubed. The wall thickness of the tubes in these evaporators was materially reduced by corrosion so that tube leaks developed frequently. The following tabulation shows the condition of tubes prior to retubing of the four units.

TUBE WALL THICKNESS						NUMBER OF LEAKS AT TIME OF RETUBING
SITE	UNIT	NEW	MIN.	AVG.	MAX.	
Elmer	DI-22	.049	.016	.033	.039	12
Elmer	DI-53	.049	.018	.036	.040	11
Fred	DI-56	.049	.016	.036	.044	10
Fred	DI-63	.049	.022	.040	.045	13

When overhauling evaporators, all auxiliary equipment such as heat exchangers, vapor compressors, water level controls, pumps, etc. were opened for inspection and repaired as found necessary.

Central lubricating oil systems were installed at both site Fred and Elmer. This lubricating system considerably reduced difficulties formerly experienced in the lube oil systems of the vapor compressors. The installation of brine blow-down pumps made of stainless steel in lieu of the pumps of copper alloy formerly used decreased considerably the brine pump overhaul requirements. Acquisition of "Airtool" tube rolling equipment resulted in better tube rolling with a resultant increase in the useful life of tubes. With the use of this equipment, the reduction in wall thickness in rolling was absolutely controlled and the work was more rapidly accomplished.

The Universal engines driving the vapor compressors of the "Badger Units" are no longer manufactured and this interjected a difficult spare part problem. This was solved somewhat by on-the-job- manufacture and by substitution of engine parts from other makes. These engines were old and required continuous observation and frequent overhaul. It was the practice to maintain (at site Tare) overhauled spare engines for immediate replacement as the need arose.

Very little maintenance was required on the fresh water distribution system. However, continued vigilance for indications of leaks in the underground system was essential as leaks ordinarily did not show on the surface due to the permeability of the coral formation of the atolls. Water consumption was checked daily and closely watched during the hours between midnight and 0400. A sharp unaccountable increase in consumption usually indicated a leak. When this condition ocurred, the system was checked by isolating sections and applying air pressure of 95 pounds per square inch to the system. If a leak was in the system it was readily indicated by a quick drop in test pressure and by blowing to the surface. The bolted steel fresh water tower tanks, both at site Elmer and Fred, survivals from OPERATION GREENHOUSE were in poor condition and a project was initiated for their renewal.

SALT WATER SYSTEMS. Salt water wells penetrating beyond the brackish range into water of the same composition as sea water, were, in general, more satisfactory as a source of supply than were direct intakes from the lagoon. The water taken directly from the lagoon continually carried marine growth from the sea and trash from ships; this accumulated on screens or strainers. On one occasion, the supply of sea water at site Fred failed due to clogging of the system by the accumulation of small fish on a check valve.

Maintenance difficulties experienced with wells seemed more temporary. When wells were first placed in operation, the system suffered from accumulations of silt and, in some cases, contamination with organic matter. However, after the wells were in operation for several weeks, these conditions generally cleared up. A rather unusual condition was experienced when the new well at site Fred was first placed in operation. This well was fouled with a soft, white organic growth which appeared to come from a 30-inch local lateral which functioned as collection sump in the coral formation. This became very thick and plugged pump suction strainers, caused foaming in evaporators, and fouled the heat exchangers. A charge of three pounds of "Percheron"(active ingredient Calcium Hypochlorite 70%) was placed in the well which caused the organic matter to rise to the surface of the water where it could be skimmed off. After several months of operation the organic substance disappeared from this well.

All metal piping and fittings suffered from the corrosive action of salt water and from loss of aperture and plugging due to salt deposits and metallic oxide. The salt water header in the distillation plant at site Elmer had to be completely renewed. All the pump casings in the CMR system required lifting and repairs as corrosion took place in the threaded joints and the casings separated. The salt water tank at Elmer was renewed because corrosion had so thinned the metal plates that structural failure was considered probable.

SEWER SYSTEMS. Maintenance of sewer systems was primarily concerned with preventing the clogging of service lines and mains. Heavy paper towels and other trash were thrown in toilets, wash basins and urinals; excessive oxidizing of metal lines also took place. Because of the flat terrain of the various camp sites and the consequent low gradients of the sewage collection systems, periodic flushing was required.

SECTION 5
AIRSTRIPS AND ROADS

AIRFIELDS. As the airfields on sites Elmer and Fred at Eniwetok Atoll were completely reconditioned, and the one on Peter-Oboe at Bikini was newly constructed for the CASTLE test program, maintenance by itself was limited in scope. Primarily, this consisted of small patchwork, patrolling, watering and rolling only as aircraft operations warranted. The intense use of the Fred airstrip during OPERATION CASTLE did result in dislodgement of the dust palliative stabilized areas, and future retreatment will be necessary.

ROADS. All roads, except those on Fred, were satisfactorily constructed and maintained without bitumul finish. The patrol grader was used on schedule, and also after heavy storms, to maintain the surface. A water truck was used to allay the dust during prolonged rainless periods.

The bitumul-treated roads on Fred, though frequently used by tractored vehicles and other heavy equipment, stood up very well. Some patching was required. A power broom was used for sweeping when necessary.

The roads on all islands at Bikini were, on the whole, satisfactory and maintenance consisted of the occasional use of the motor patrol. The road between Fox and George became inundated during a few very high tides or storms and after the water drained off it was necessary to remove the accumulated debris (Figure 5-1).

The causeways, built of earth and rock-fill, suffered heavily from storms and high tides; erosion was excessive during these periods. When this ocurred it was necessary to haul replacement fill and then re-blade. An aggravated erosion condition which appeared to threaten the Operation on the Ruby-Sally causeway was alleviated by constructing on the ocean side of the causeway a bulkhead of steel rails and two-inch boards, which was then back filled.

Generally a stockpile of fine aggregate was maintained on various sites which was used, as necessary, to maintain roads and stabilized areas.

Figure 5-1. Road between Fox and George

SECTION 6
MISCELLANEOUS EQUIPMENT

During the peak of operations, there were 275 typewriters, 74 adding machines or calculators, and 30 other miscellaneous office machines such as mimeograph, cash-registers, dictaphones, etc. that had to be maintained. Difficulties experienced were aggravated by corrosion of metal and deterioration of rubber parts. To retard corrosion, all machines were sprayed with clear laquer. In general, office machines were sent to the shop for servicing and repair every three months. During the operational period, machines could not be spared; consequently, when the opportunity for servicing did arrive, the machines usually needed more work than that normally required.

Regular maintenance crews at each camp furnished the necessary specialized servicing and repair of refrigerating equipment. This was a substantial effort, since there were 150 refrigerators, 219 water coolers, 17 ice cream hardening cabinets, 10 ice cream freezers, and 22 ice makers (or snow machines). Some of the older units were equipped with condensers which are no longer manufactered and were repaired only by improvisations; spare parts were unattainable.

The furniture used for housing, such as beds, tables, chairs and lockers, was repaired as needed. A supply of spare springs for the beds and spare canvas seats and backs for the chairs was stocked and replacements were made by janitors when the need for this occurred. Bed frames were sandblasted and painted at least once a year. All office furniture was similarly repaired and painted as the need arose.

All kitchen facilities, such as ranges, bake ovens, deep-fry units, steam kettles, etc. required continual upkeep as well as adjustment. Personnel were designated by the plumbing, sheet metal, electrical and refrigeration shops to be responsible for the upkeep of this equipment. As soon as trouble developed, these shops were immediately contacted to perform the required trouble shooting.

Laundry equipment, such as washers, dryers and pressers, was maintained in a manner similar to that of galley equipment. The large flat work ironer reached an age when complete overhaul was necessary; this work was scheduled for action between operations.

Maintenance requirements of latrine facilities were necessarily heavy. Toilet seats, mirrors, shower heads and basin stopper chains were broken frequently.

Maintenance of marine equipment is covered in Chapter IV, Section 4, since under the provisions of the contract it is considered as a Service Operation (Job 2).

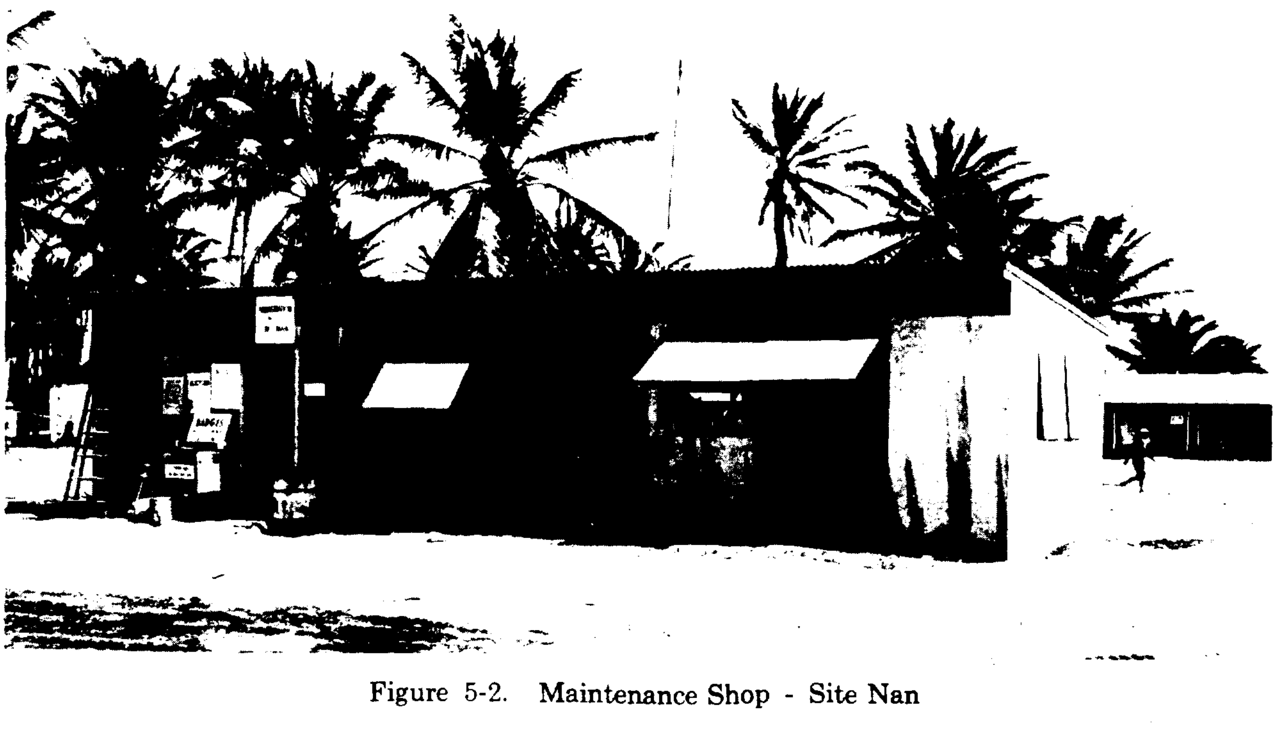

Figure 5-2. Maintenance Shop - Site Nan

CHAPTER VI
SUPPORT SERVICES

SECTION I
GENERAL

The support of OPERATION CASTLE involved certain specialized but broadly inclusive applications of the Contractor's function and production potential to the technical installation work of the scientific groups. This contractual obligation, being neither a usual and recurring service operation nor expressly a predictable engineering or construction job, was called Support Services and was separately defined by Job IV of the AEC-Holmes & Narver Contract.

These services were related only to the actual test operations as an assistance to technical or scientific groups engaged under the auspices of the Commission in instrumentation and similar implementation of the test series. In general, the units of work called for were of minor magnitude, but because each detail of the complex test technique was important, the men, equipment, fabrication and materials furnished under this phase of the Contract were a high priority concern of Management. Under 1479 separate work orders issued by 78 Using Agencies or Scientific Groups, the Contractor supplied construction equipment, skilled workers, shop repair and fabrication, installation and post-test recovery, surveys, decontamination, packing, crating and shipping, and labor and materials. The effort expended 179,424 man-hours, the rate being about 30,000 man-hours per month in February, March, April and May of 1954, which was, of course, the period of intense test activity.

The need for Support Services was occasioned, in part, by factors which the best of long range planning could not foresee or obviate. When Scientific Stations were equipped by their Users and tested, it was found necessary, occasionally, to make improvements. Much scientific equipment was complex and delicate; it suffered damage in shipping or installation, or was found faulty when tested. Support Services were also in part, according to plan, since much pre-test assistance required by Scientific Using Agencies could be more conveniently, more readily, and more economically provided by the Contractor; the alternatives implying duplication of men and material, and imposing an unwarranted burden upon the housing and subsistence capability of the Proving Ground for the brief time involved. A representative list of such services is appended to this chapter. Among them are represented a proportion of man-hours attributable to the unexpected destruction and radioactive contamination resulting from the Bravo shot, but in general Support Services were a normal aspect of the Operation.

A rigid procedure was followed in screening work requests, in establishing a reasonable priority on each, and in validating them by obtaining adequate approvals. The procedure was designed to hold the work to predetermined limits to accomplish its primary purpose; to schedule effectively and dispose men and equipment for a minimum of non-productive transit time; and to identify and control costs and properly allocate them. This procedure provided that: (1) work orders would be initiated by the group, unit or project desiring the service; (2) the work orders would be forwarded to the AEC Resident Engineer for approval and determination of the relative urgency of the work; (3) approved work orders would then be forwarded by the AEC Resident Engineer to the Contractor's Project Manager for assignment of the work within his organization; (4) on completion of the work, the AEC Resident Engineer and the requesting agency would be given a Notice of Completion.

Frequently, consultation with the Contractor's technical personnel as to methods and procedures was necessary prior to the submission by a Using Agency of the formal work request. In urgent cases, however, Support Services were provided with the verbal approval of the AEC Resident Engineer. All such cases were later confirmed through written work orders. Many work orders called for the furnishing of laborers or artificers to contribute work to an installation for which, due to its intricacy or for security reasons, the requesting agency alone had full knowledge of the end purpose. A number of such work orders were accompanied by requests for employees by name who had previously worked with the same requesting agencies. These requests were honored as a rule, since furnishing the same man for the same job expedited the job by reducing the craftman's orientation and instruction time, minimized the supervision time, and resulted in the most effective use of special skills. Harmonious relationships existed between the Contractor and other elements of the Task Force in the somewhat indeterminate but vital scope of Support Services. The services furnished under Job IV work orders were sufficiently diverse to cover the entire range of function of the Contractor.

The financial statement covering these services is contained in the JTF Cost Report included in Appendix I of this report. During the construction phase of OPERATION CASTLE, few support work orders were issued. With the arrival of the various scientific elements of the Task Force in January 1954, the tempo of this service greatly increased, reaching its peak during the operational period.

The inclusion in this report of an itemized account of the services provided under each Job IV work order would result in an unnecessaily voluminous and repetitious report. Various items are listed below which are representative and which are indicative of the diversity of the services furnished.

1. Furnish labor, material or equipment to assist in the installation or erection of scientific equipment.
2. Provide duplication and blueprinting services.
3. Furnish labor and materials to effect repairs to U. S. Naval vessels and U. S. Navy light marine craft.
4. Repair and service distillation and refrigeration equipment at the Weather Station on Rongerik Island.
5. Provide temporary light, power and telephone circuits.
6. Provide houseboat services.
7. Recover scientific data and equipment.
8. Paint signs and perform other miscellaneous painting.
9. Erect tents.
10. Fabricate boxes, stools, work benches, spare parts for equipment and numerous other items.
11. Provide postage stamps.
12. Provide survey services, including hydrography and topography, of shot craters.
13. Fuel, service and provide mooring buoys for Task Group 7.1 marine craft.
14. Construct landing platforms for YAGs.
15. Move aircraft, panels and other equipment to and from YAGs.
16. Collect and ship water and soil samples.
17. Provide powdermen and explosives.
18. Furnish supplies and material including but not limited to: lumber, aggregate, cement, battery acid, oxygen, acetylene, paint, manila cordage, wire rope, clamps, shackles, thimbles, and canvas.

TABLE I

JOB IV WORK ORDERS ISSUED
BY ATOLL — BY MONTH

MONTH	ENIWETOK	BIKINI	TOTAL	TOTAL MAN-HOURS
Jan. 1953	1		1	
Feb.	3		3	
March	7		7	
April	7		7	6,045
May	3		3	
June	2		2	
July	20		20	
August	12		12	
Sept.	18	1	19	
Oct.	20	1	21	18,445
Nov.	34	11	45	
Dec.	22	9	31	
Jan. 1954	159	117	276	9,847
Feb.	197	286	483	30,308
March	214	76	290	30,972
April	199	28	227	35,863
May	74	3	32	29,292
June	—	—	—	18,652
	992	532	1,479	179,424

19. Decontaminate certain Scientific Stations and areas.
20. Waterproof cabs of towers.
21. Pack, crate and ship equipment and supplies.
22. Sandbag certain stations.
23. Provide janitorial services to Scientific Stations.

Table I shows the work orders issued by month; Table II indicates the work orders issued per unit.

TABLE II
JOB IV WORK ORDERS — BIKINI AND ENIWETOK
BY GROUP

USER	NO. OF WORK ORDERS	USER	NO. OF WORK ORDERS
JTF	112	Project 3.1	8
TG 7.1	150	Project 3.2	4
TG 7.2	9	Project 3.3	2
TG 7.3	31	Project 4.1	4
TG 7.4	16	Project 6.2	27
TG 7.5	13	Project 6.4	51
TU 2	48	Project 6.5	10
TU 3	15	Project 6.6	4
TU 4	33	Project 7.1	12
TU 6	8	Project 7.4	3
TU 7	26	Project 11.1	4
TU 8	6	Project 11.2	8
TU 9	12	Project 11.3	6
TU 12	73	Project 12.1	26
TU 13	9	Project 12.2	3
TU 14	50	Project 12.3	29
TU 15	72	Project 13.1	15
Program 12	23	Project 13.4	38
Program 13	4	Project 14.1	15
Program 15	2	Project 15.1	38
Program 18	10	Project 15.2	13
Program 22	4	Project 15.3	1
Program 22.996	7	Project 15.5	1
Program 23	2	Project 16.1	5
Program 23.996	10	Project 18.1	84
Program 24	2	Project 18.2	1
Project 1.1	6	Project 18.3	7
Project 1.2a	32	Project 18.4	6
Project 1.2b	17	Project 18.5	2
Project 1.3	6	Project 18.6	1
Project 1.4	54	Project 19.1	7
Project 1.6	29	Project 21.1	2
Project 1.8	7	Project 21.2	4
Project 2.1	6	Project 21.3	6
Project 2.2	4	Project 21.4	3
Project 2.3	10	Project 22.1	25
Project 2.5a	41	Project 23.1	21
Project 2.5b	19	Project 24.1	9
Project 2.6a	8	Cancelled or Deleted	24
Project 2.6b	8		

CHAPTER VII
TEST OPERATIONS AND ROLL-UP

SECTION I
TEST OPERATIONS

In order to insure adequate support to the various Military and Scientific Agencies during the period of the test operations, the Contractor was responsible for the performance of the following functions:

1. Provide support personnel, material and equipment to assist in instrumentation and recovery of scientific data.
2. Dismantle camps no longer needed.
3. Operate marine craft on a close schedule in accordance with the requirements of all agencies concerned.
4. Adjust camp facilities and schedules as the population shifts indicated.
5. Take measures to minimize the effects of blast, wave action and radioactive contamination to facilities, equipment and supplies.
6. Roll-up as required by Job V of the Contract as a parallel operation with the test operation.
7. Evacuate personnel at times specified from various sites and maintain an accurate muster account at all times.
8. Provide for unattended operation of certain utilities as required for the test operation.
9. Organize re-entry groups in case of postponement.

Prior to the Bravo test, the possibility of damaging pressures to principal Bikini camps (according to responsible authorities) was considered remote. In view of this, and the fact that camp structures were of expendable construction, the blast protective measures taken were limited. The windows and doors of all buildings were left open, the sides of all tents were rolled up and furniture was moved to the center of the tents. Part of the sheathing of Stations 2210 and 2310 was removed. The fuel tanks for Power Plants NA-500 and TA-500 were covered with earth and all fuel and water tanks were filled. The water towers, batch plants and generator sheds were guyed with steel cables, using heavy mobile equipment as anchors. All mess hall supplies, equipment and utensils were covered with tarpaulins, and PX supplies were laid on the floor and covered (with the exception of a few items that were screened in by wire mesh on the shelves). All marine craft were anchored or buoyed off site Nan with the exception of four LCMs which were taken to sea in the LSD Belle Grove.

Damage that ensued due to pressures and wave action has been the subject of special reports to the Atomic Energy Commission and is not contained in this report.

A requirement of the Headquarters of JTF SEVEN was the preparation and submission, by each Task Group, of a check list of tasks to be performed for each event covering the period of Shot Day minus five through Shot Day plus three. These check lists covered major events and indicated when facilities could be secured, equipment moved, and which utilities were to be left operating during shot time. The lists were supplemented by Task Group 7.1 vehicle and van movement plans which identified the vehicle or van, its location, date and time to be picked up, and its destination. With the foregoing plans and check lists, detailed boat movement plans were formulated which permitted the full utilization of each boat. The preparation for the Bravo event was accomplished as planned and this shot was fired on schedule. It is referred to in the schedules as B-Day.

Planning for the evacuation of personnel from Bikini Atoll for the Bravo event first contemplated a reduction of the Contractor's force to not exceed 650 men at the close of B minus two day. Each division was advised on 9 February 1954 the exact number of personnel (for each division) to be on each site at Bikini on this date. As personnel became surplus to the needs of the operation, they were returned to Elmer and then to the Zone of the Interior.

On the arrival of the USNS Ainsworth at Bikini Atoll, just prior to B-Day, arrangements were made for messing, berthing and for other facilities on board, and for the help and personnel the Contractor would provide to assist the vessel in supporting Task Force personnel. Assignments of cabin and troop spaces were made by Task Groups in accordance with the number of each group boarding the vessel.

The muster and final accounting for all personnel aboard the evacuation ships was delegated to the Holmes & Narver Director of Industrial Relations. The personnel were arranged in muster groups consisting of a group leader and a unit of men selected to board the same ship from the same location at the same time. Each group varying in size, contained men who could be released from work at the same time, and each group was assigned a time for assembly and muster at embarkation points. In addition to the group leader's identificaion and muster of his men, each person was checked off on two successive master lists. All men with continuing shore duty were constantly accounted for, and their necessary movements were known. The evacuation was accomplished on schedule and at departure time no person was unaccounted for either by absence or by error in record. The sequence utilized in reporting and accounting for all personnel was as follows:

1. Individual personnel reported to the group leader.
2. Group leader reported to site muster officers.
3. Muster officers reported to:
   a. TQM for verification of muster with ship's passenger lists.
   b. Personnel officer for his certification to JFT Headquarters that all personnel were accounted for.

The above procedure was used for each test. Actual evacuation of personnel for the Nectar event at Eniwetok was not required; however, plans were made for emergency evacuation of Eniwetok Atoll had the occasion for this arisen. These plans contemplated an accurate and detailed account of all personnel on the day prior to Nectar, called N minus one, and included steps for emergency air transportation to Honolulu of all personnel who had cumulative radiation exposure of 2500 mr or more. All other personnel were scheduled to be taken to sea on vessels which were anchored in the harbor, and marine craft had been designated to ferry the personnel from pre-designated staging areas to the ships.

Prior to the first evacuation from Bikini Atoll, considerable thought was given to the capability for continued operation from afloat in the event of unacceptable contamination at the various sites. Plans were made for the use of an LST or LCU as a tender with improvised shops, the construction of a decontamination station on a barge, the support of two Scientific Groups off site Fox with LCUs as houseboats, decontamination of equipment and areas as would be required, and methods and procedures to enable the men to accomplish work ashore while they were being quartered and messed afloat. Re-entry plans were formulated which covered steps to be taken in case of postponement and full reoccupation of the various sites. These plans designated key persons by name with assigned tasks as first re-entry personnel, and these men were scheduled for evacuation in the USS Bairoko; from this vessel they could be flown by helicopter to critical sites. Jeeps were parked at the helicopter mats on Tare, Charlie, Fox and Nan to provide tre transportation needs for the re-entry personnel, and tank trucks loaded with diesel and gas were located at these sites for refueling vital equipment in case of extended postponement. Priority of debarkation of all other personnel was established so as to provide for the most expeditious restoration of camp and other facilities.

Following the Bravo detonation, though contamination was excessive, it was necessary to land re-entry personnel as early as possible to secure or service operating equipment and to collect scientific data. The useful service period of each man was brief. For example, one man who was required to service the DO-500 power plant on Dog was landed by helicopter at approximately H plus 10 hours; he remained in the area less than two minutes during which time he accumulated 2400 mr of radiation.

Due to weather and sea conditions prevailing during the entire test period at Bikini, it was impractical to tow LCMs or LCUs to sea. The LSD Belle Grove could carry 19 LCMs, and accordingly 15 Navy LCMs and four H&N LCMs were taken to sea aboard this vessel. The U. S. Navy Helicopter Barge and Navy Repair Barge were towed to sea, but all other light craft were anchored or moored to buoys off site Nan. All DUKWs were beached at either Nan or Tare and covered with tarpaulins. The craft remaining in Bikini Lagoon were badly contaminated after Bravo and the first order of work on return after the test was the decontamination of these craft. The 19 LCMs that were taken to sea in the LSD were not contaminated; these were extensively used while other craft were being cleared of radioactive contamination. A decontamination group was put ashore at Tare to reduce the contamination of the dock area, plus the equipment necessary to continue operations at that site. The fitting out of a decontamination station on a 500-ton barge was rushed at Elmer and this barge was towed to Bikini where it was generally kept tied alongside the USNS Ainsworth (see Figure 7-1). The entry of all men to all sites at Bikini was under strict Rad-Safe control and procedures.

Due to the high winds and resulting rough waters at Bikini Lagoon, which prevailed throughout practically the entire test period, the boating conditions were poor. There were times when the transfer of personnel from a boat to a vessel or to the decontamination barge was extremely hazardous. Fortunately, no serious personnel accidents ensued from these conditions, and as transfer of personnel at sea was absolutely essential for the accomplishment of the mission, such boat operation was continued throughout the period of operations.

After the execution of the Bravo event, the schedule of operations had to be considerably changed. The support tasks assigned to the Contractor became a day to day determination. The Contractor's Resident Manager remained aboard the command ship, the USS Estes, for closest possible liaison with the heads of the various Scientific and Military Groups. Here he reviewed daily changes in schedule, support requirements, and reports on contamination. These were communicated via radio, or by messenger, to an Assistant Resident Manager quartered in the USNS Ainsworth, in which vessel were practically all of the Contractor's personnel. Each evening at 1700 the Assistant Resident Manager held a conference with all supervisors, and the User's requirements for he following day were detailed and tasks assigned to various personnel. Shot Day minus two became "Generator Refueling Day" and Shot Day minus one "Generator Check Day." Shot Day was frequently changed due to meteological conditions.

The repeated postponements of the various shots interjected a difficult problem in servicing and maintaining equipment required to operate continuously and, generally, unattended. Mechanical troubles in dehumidification systems and electric generators developed. The need for frequent re-entry into contaminated areas subjected maintenance and operating personnel to frequent radiation exposures, and as the allowable limit was approached these men were evacuated to Elmer. Thus, continual shifting of personnel was necessary to maintain an adequate staff for special jobs at Bikini Atoll.

Each person entering a contaminated area carried a film badge which was returned to the Rad-Safe Group, who evaluated, recorded and reported the accumulated exposures to appropriate personnel. A separate report was made of all personnel whose accumulated dosage had reached 2500 mr or over. This report acted as a warning to supervisory personnel responsible for detailing men to work in contaminated areas.

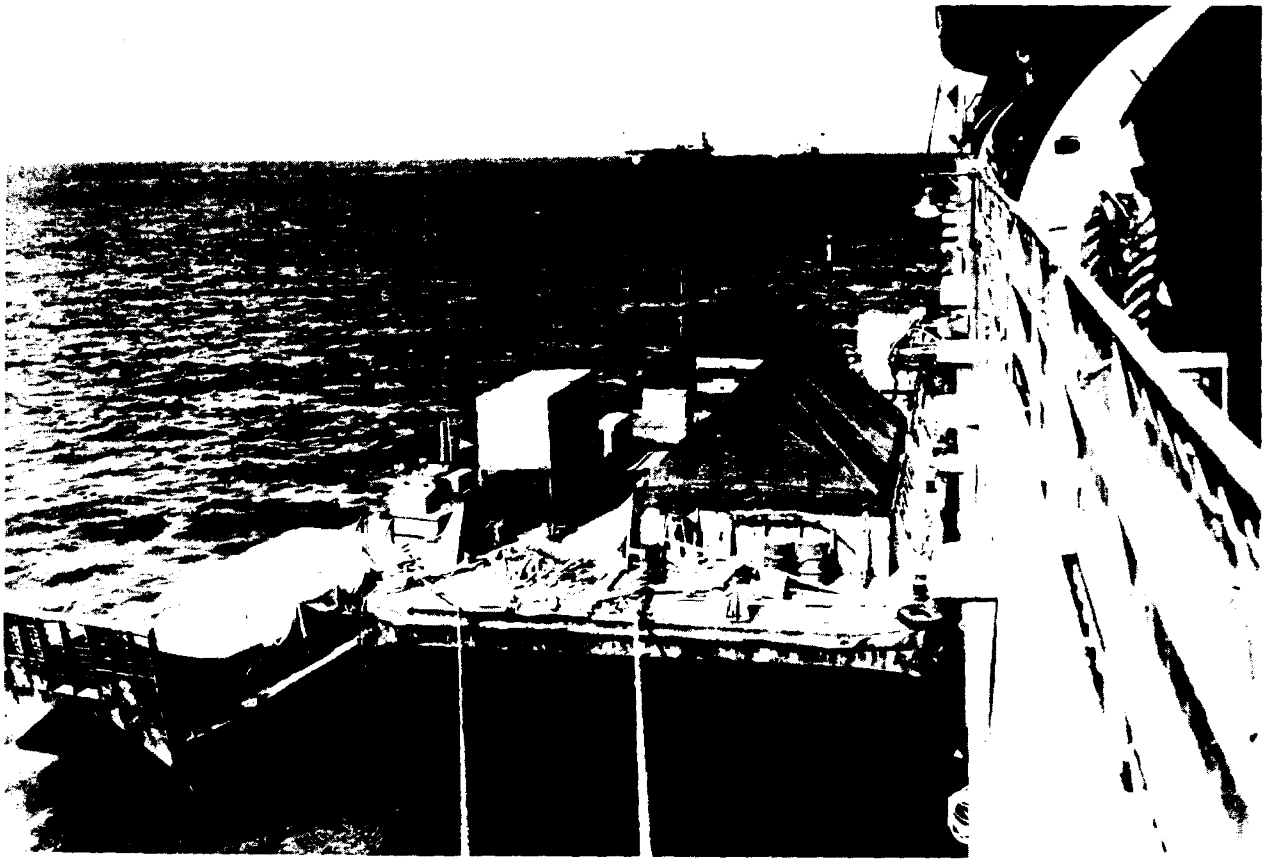

Figure 7-1. Decontamination Barge Tied Alongside the USNS Ainsworth

Due to the extent of the ultimate contamination, a heavy work load was imposed on the Rad-Safe Group and there were times when the evaluation of the film badges was not completed until several days after exposure. As a result, men were detailed to work in contaminated areas without current knowledge of their cumulative exposure. Because of this fact, several of the Contractor's personnel received cumulative dosages in excess of the 3900 mr per 13-week period. None of these overexposures were excessive to the point of impairment of health. Nevertheless, it was the cause of considerable concern because of the always-present problem that these employees might claim damages based on such overexposure.

The tests were completed. The successful integration of the Proving Ground's Using Agency requirements with the mechanics of personnel assignment, transportation, radiological safety and evacuation was assured through mutual application and the cooperative spirit of the various components of the Task Force.

SECTION 2
ROLL-UP

The concept of the Pacific atolls of Eniwetok and Bikini as a permanent proving ground implies a reasonable re-use of its facilities and equipment. However, the nature of the Proving Ground's function requires prolonged interruption of continuity in point of time. The term "roll-up" is applied to the salvaging of all supplies, facilities and equipment at the close of a test operation and putting same in such a state of repair and preservation that only minimum maintenance work will be necessary until re-use is required. At the close of one test operation, another operation can be reasonably expected; yet due to the time element, a complete demobilization must be met.

The Roll-Up Services detailed in Job V of Contract AT(29-2)-20 obligated Holmes & Narver, as the Contractor, to rehabilitate and preserve buildings and structures, and to repair, clean, paint, and preserve both mobile and stationary equipment for storage and possible re-use for future tests. Materials and equipment not required, including User's gear, are returned to the Z. I.

The roll-up commenced when the heavy construction period neared its end. After the equipment had served its purpose, it was returned to the Elmer base at Eniwetok Atoll where it was overhauled, sandblasted and painted (as required), and preservative was applied to moving parts before it was placed in storage.

Prior to the initial test, the roll-up phase of the Operation began at Bikini Atoll. Construction equipment, installations, and stocks of warehouse material, in addition to scientific trailers and various types of User equipment, were completely removed from sites Able and Charlie. Only the essentials to maintain a 75-man camp were left at site Fox. Many of the Fox camp buildings were dismantled and different types of stored materials transferred; one walk-in reefer was left for food storage, and if the demand warranted, was to be supplemented by the site Tare mess facilities. The removal of equipment or materials from sites Nan and Tare was not considered necessary.

For the orderly accomplishment of the foregoing, a schedule of events was formulated and published. This schedule detailed, for each of the days of B minus five through B minus one, the actual facilities, equipment or stores to be removed on each day from Charlie and Fox to Tare for transshipment by larger vessels to Elmer. The issue by TG 7.1 of a schedule for removal of scientific vans and other vehicles was of material assistance in coordinating the Contractor's and Scientific Group's requirements.

Reoccupation of Nan, Tare and the reduced camp at Fox had been scheduled after Bravo, and planning for this period anticipated the eventual use of Nan as a staging area for equipment and supplies which were to be removed from Tare prior to the scheduled Koon event. Consequently, a mole was constructed at Nan for the beaching of LSTs in order to facilitate the final evacuation of Nan. However, due to the widespread destruction and radioactive contamination at practically all sites at Bikini Atoll following the Bravo event, plans for reoccupation were abandoned and all personnel thereafter were quartered on ships.

Immediately following the Bravo event, notification was received that preparations for the future scheduled Bikini tests would be conducted from aboard ship. In compliance with the new instructions, only those Contractor personnel engaged in recovery and salvage operations were quartered aboard ship for specific work assignments and were under Rad-Safe control.

One important item of work after Bravo was the salvaging of personal effects at all camps at Bikini. Due to the possibility of claims arising from loss of personal effects, this work was planned in detail and performed under close surveillance of supervisors and Military Police. All personal effects were placed in lockers or packaged, properly identified, and then shipped to Elmer. At this site, personnel picked up their belongings after verification with a questionnaire which they had previously submitted covering the effects that were left at Bikini at the time of Bravo evacuation.

The roll-up of the Tare and Nan camp facilities proceeded as a parallel operation with the preparation for succeeding tests. The bottleneck was interatoll transportation, and advantage was taken of every opportunity that was offered to ship rolled-up equipment to Elmer. As an example, the LSD Belle Grove was loaded with salvaged and recovered equipment when it departed Bikini to pick up Stations 30 and 40. The LSTs would beach or retract only at or near high tide. The working schedules of the men engaged in loading these vessels were based somewhat on tidal conditions so that the LST would remain on the beach a minimum of time. It was not unusual for men to work during the night hours.

After the Koon event, the LSTs were not permitted to beach at any site in Bikini Atoll. Loading of these vessels thereafter was accomplished by ferrying cargo by light marine craft to the ship's side where it was picked up by a crane which the Contractor had placed on the ship's top deck. Vehicles and rolling stock were loaded onto the tank deck of the LST by marrying the ramp of the vessel with the ramp of an LCM, as shown in Figures 7-2 and 7-3.

A partial removal of camp equipment and materials from the Ursula area took place as part of the preparation for the Echo test. (This does not include the removal of any scientific equipment). However, on 14 April 1954, the

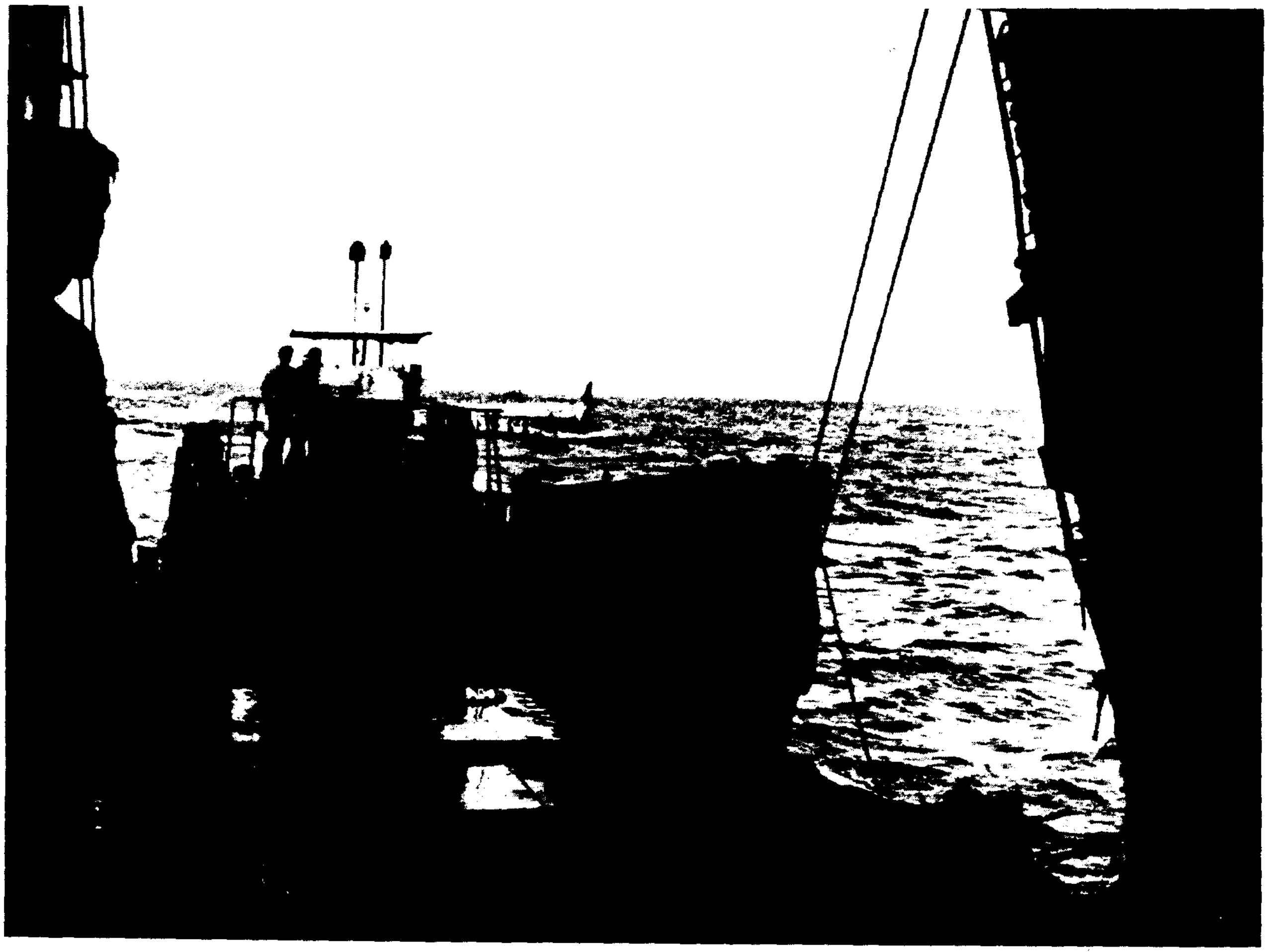

Figure 7-2. Marrying the Ramp of an LST with the Ramp of an LCM

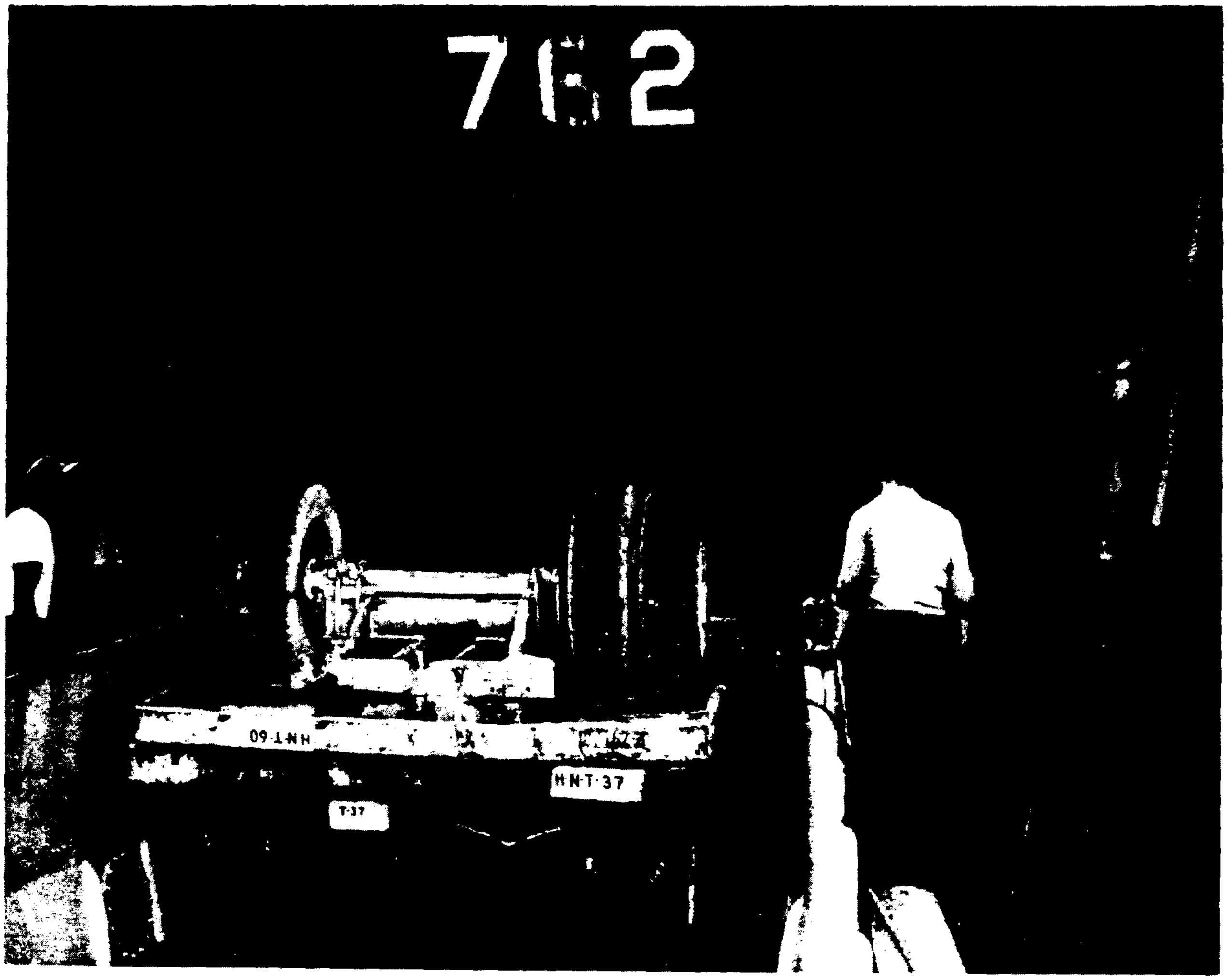

Figure 7-3. Transferring Vehicles Afloat onto the Tank Deck of an LST

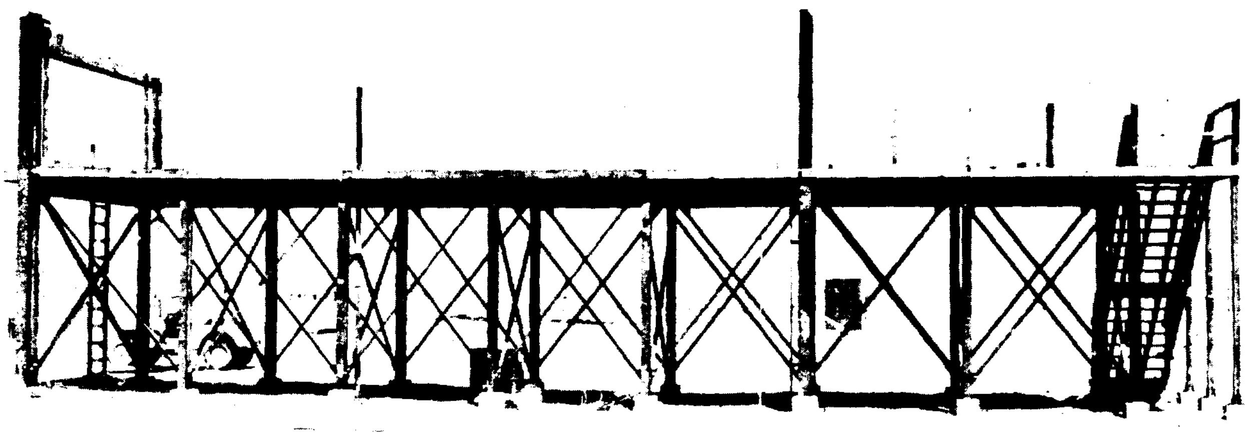

Figure 7-4. Station 2311 Stripped for Nectar Test

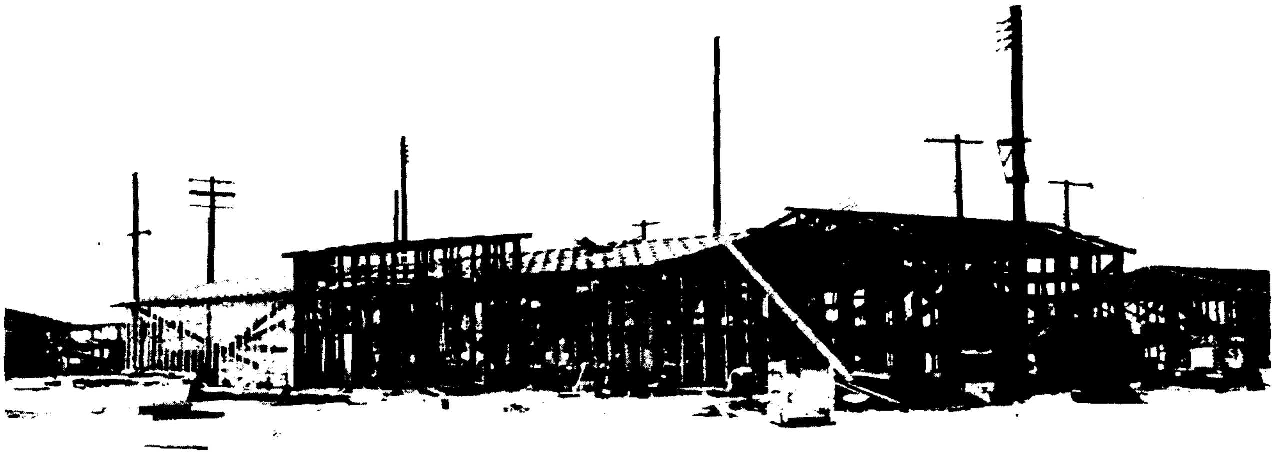

Figure 7-5. Ursula Mess Hall - Prepared for Nectar Shot Blast

Contractor was advised that this experiment (Echo) had been cancelled and was requested to effect the roll-up of the Ursula camp and the Scientific Structures and equipment that would not be needed. This change in plans also included the complete removal of the remaining camp equipment and materials, as well as all scientific equipment and instrumentation from the Ursula group of islands. The entire evacuation was accomplished hurriedly in order to meet an established deadline of three days.

Preparing the Ursula area for the Nectar test within this short period required considerable planning, and as part of the plan the aluminum roofing and siding from all camp buildings and Scientific Stations was removed and all canvas shelters were taken down. This also included stripping the wooden part of Station 2311 (Figure 7-4), and dismantling Station 1812.05. The only major item of equipment left in the area was a traveling crane and its associated equipment (located in Station 60 at Ruby). Figure 7-5 shows the siding removed from the Ursula mess hall and the studding cross-braced. Figure 7-6 shows the area of Station 60 after

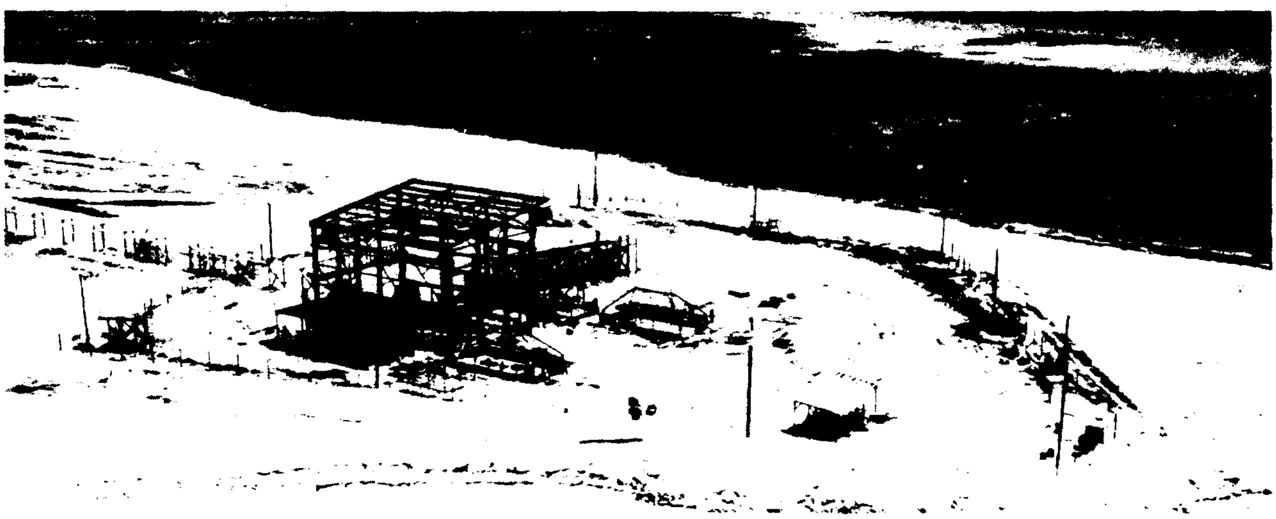

Figure 7-6. Station 60 at Ruby With All Facilities Dismantled for Nectar Blast

dismantling of all facilities. Figure 7-7 shows the protection provided for the traveling crane and associated equipment in Station 60. The entire roll-up was completed in the time allowed.

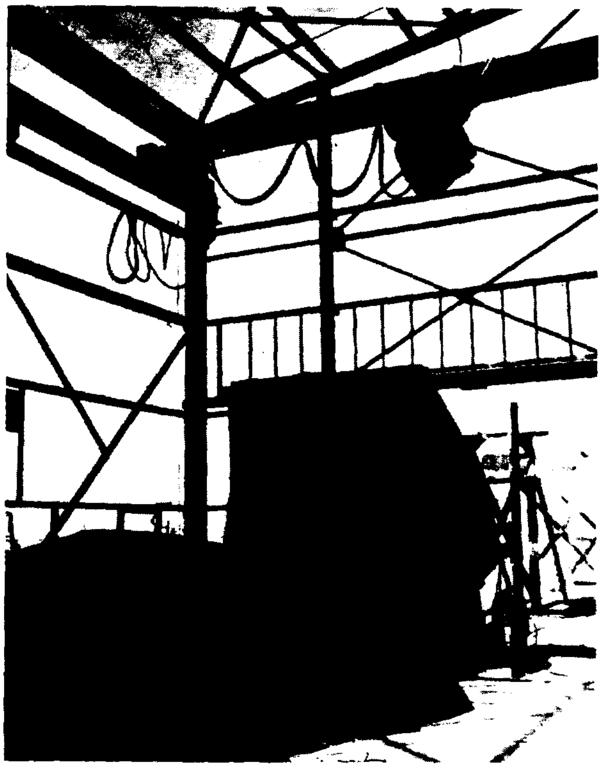

Figure 7-7. Station 60
Protection Provided for Equipment

The USNS Ainsworth was used in lieu of the USS Curtiss as a personnel housing craft during the post-Yankee roll-up. This substitution of vessels was deemed more practical to both the User and Contractor staff.

During the roll-up period, H&N coordinated their needs for transportation to Bikini Atoll with the requirements of the various Scientific Groups in order to take advantage of whatever facilities were scheduled for use. The vessels utilized usually carried one or more DUKW which enabled the men to visit any of the islands within the Atoll.

The majority of the equipment from the Scientific Stations at Bikini Atoll was removed by 3 May, prior to test Yankee. The final equipment roll-up started only three days after the execution of the Yankee event on 8 May.

The post-test roll-up in the Bikini Atoll area was accomplished expeditiously despite very adverse working conditions. Much of the equipment was from areas considered radioactively contaminated, but because of prompt action this equipment was salvaged immediately rather than temporarily abandoned and recovered later as originally planned.

The major portion of the post-Yankee roll-up consisted of removing equipment from Stations 70 and NA-500, Nan; Station 1342 and 1550, George; and removing the marine craft from Bikini Atoll. The removal of mooring gear was also an important part of the roll-up.

Rolling stock and equipment of both H&N and the Users was shipped from the Bikini area by Navy craft to Eniwetok for decontamination. However, since the existing Rad-Safe facilities at Elmer were taxed beyond their capacity, especially in regard to heavy equipment, a new fenced-in wash-down area approximately 150 ft. x 200 ft. was provided on the ocean-side of the island east of the CMR Area. Fresh and salt water lines were laid and a 50 ft. x 50 ft. concrete slab was poured near the beach (within the fenced area) for proper water run-off. A boiler was installed to furnish the live steam used to clean off engine and chassis grease; salt water was used for washing down exteriors and interiors of equipment. As the equipment was brought into the area from Bikini, decontaminating was begun immediately, and at times many H&N employees were used to accomplish the decontamination program and also to allow the various Task Groups to make preparations for an early return of their equipment to the Z. I. It was also the responsibility of the Contractor to maintain, repair, and service various Task Groups equipment and vehicles while at Jobsite and also to assist in their preparation for return to Z. I. (Figure 7-8).

Desicants were scattered throughout scientific buildings and these buildings were then closed and sealed with heavy masking paper.

Eleven DUKWs, seven M-boats, five LCUs and two barges were removed from Bikini Atoll during the final roll-up. These vessels were loaded with recovered equipment and were transported aboard the LSD Belle Grove to Elmer; the initial trip was on 8 May 1954. The same procedure was followed with other marine craft until 11 May, when the last of the equipment was removed and the roll-up at Bikini Atoll was considered complete. At 1015 hours on 12 May, the LSD Belle Grove arrived at Elmer with the last load of equipment, after having been used for three successive trips between Bikini and Eniwetok Atolls during this period.

In compliance with an additional part of the roll-up plans, an LCU was dispatched to Rongerik on 12 May via an LSD Navy Craft in order to dismantle and remove the equipment from a weather station located in Rongerik Atoll. With the return of this craft, all equipment involved in the post-Yankee roll-up had been removed to Elmer.

One of the more difficult problems encountered during the final roll-up was that of maintaining a work crew consisting of men with sufficient experience who had not reached the permissible dosage of radiation exposure.

The post-Nectar recovery program at Eniwetok Atoll for scientific equipment and other facilities was started on 17 May 1954; this work was completed by 20 May 1954. As the test period of OPERATION CASTLE came to an end, a considerable amount of repair, overhauling and preservation of equipment and the return of stores to warehouses had been completed. The mothballing program of H&N equipment was started on 21 May. The final removal of AEC property and the last of the mothballing was completed approximately on 10 June.

During the interval between operations, maintenance of Scientific Stations or facilities at both Atolls will be on a minimum basis. It is anticipated that transportation will be arranged through the Navy which will permit inspection trips to Bikini every four to six months at which time anti-corrosion measures will be accomplished to the extent possible.

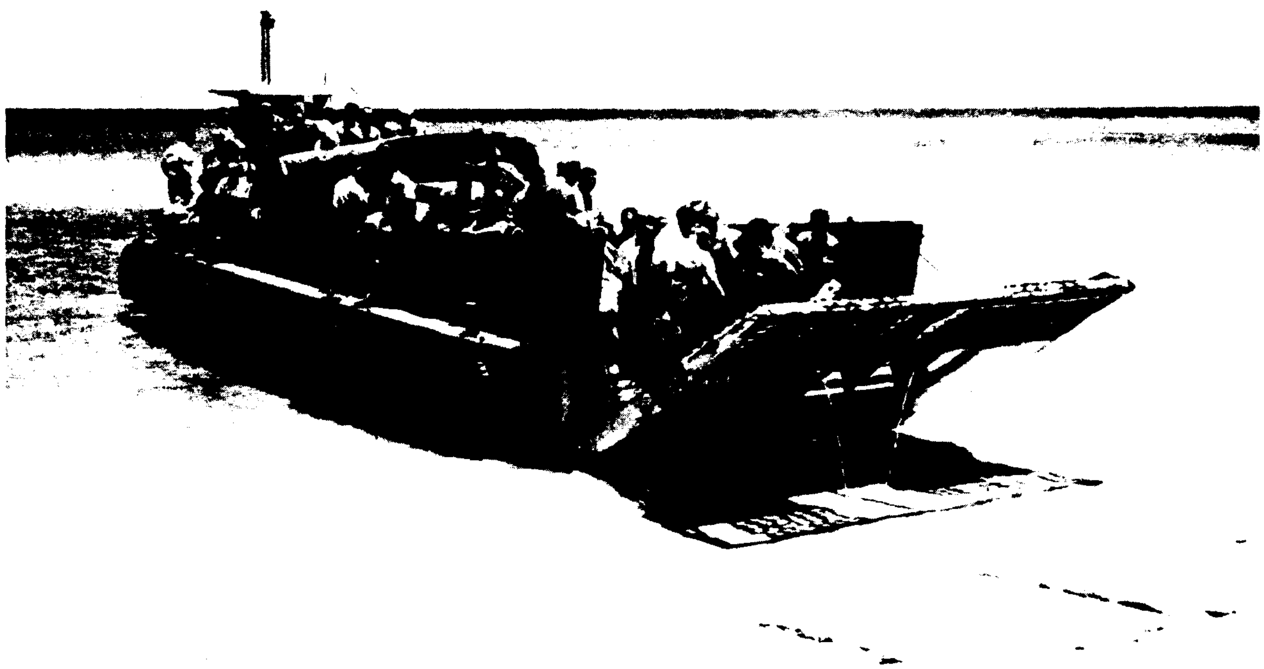

Figure 7-8. Various Task Groups with Equipment Leaving Elmer for Fred for Return to Z. I. Mission Accomplished

APPENDIX A

Appendix A is a summary of the Cost Report of Work with Final Costs as of 30 June 1954. Included likewise is the Final Cost Report for Joint Task Force SEVEN cumulative to 30 June 1954. The Balance Sheet as of 30 June 1954 completes this Appendix.

TABLE OF CONTENTS

HOLMES & NARVER, INC.
Engineers - Constructors

Contract AT(29-2)-20
OPERATION CASTLE

Final Cost as at June 30, 1954

Cont. Item No.	Description	F/Y 1953	F/Y 1954	Total
	JOB I - EXPENDABLE CONSTRUCTION			
1 thru 24	Temporary Camp with additions and added facilities	$ 1,255,597	$ 239,603	$ 1,495,200
25	Airstrip & Helio Mat with Access Roads & Additions - Tare Group	641.768	13,861	655,629
26	Causeways - Sites Tare & Charlie	20,788	261,421	282,209
27	Scientific Structures - All Sites	513,353	10,865,312	11,378,665
28	Construction Equipment - All Sites	1,186,621	441,247	1,627,868
29	Submarine Cable with additions - All Sites	103,932	1,167,422	1,271,354
31	Re-establish Camp & Additions - Ursula	173,452	218,414	391,866
32	Fill Crater - Ruby	55,168	(7,036)	48,132
33	Misc. Construction - All Sites	209,231	28,435	237,666
34	Special Engineering Reports	24,924	—	24,924
35	Airport Facilities and Additions - Tare Group	91,459	(271)	91,188
36	Temporary Camp with additions and added facilities - Charlie	427,263	188,821	616,084
38	Test Facilities Furn. & Fixtures - All Sites	—	51,434	51,434
39	Temporary Test Support Facilities & Procurement Cost - Elmer	—	210,000	210,000
40	Temporary Test Support Facilities & Procurement Cost - Fred	10,712	1,054,653	1,065,365
44	Incidental Construction, Test Progress - All Sites	—	394,903	394,903
57	Temporary Camp with additions and added facilities - Site Nan	34,676	232,273	266,949

Final Cost as at June 30, 1954 (Cont.)

Cont. Item No.	Description	F/Y 1953	F/Y 1954	Total
63	Temporary Camp with additions and added facilities - Site Fox	$ 24,869	$ 380,206	$ 405,075
64	P. O. L Facilities - Sugar	2,424	85,221	87,645
67	Misc. Construction (Operations) - All Sites	—	140,065	140,065
68	JTF Construction - Fred & Majuro	—	460,982	460,982
69	Dual Liquification Engineering	6,732		6,732
70	Radio Communications - All Sites	—	94,824	94,824
72	Submarine Telephone Cable - All Sites	—	146,204	146,204
74	Concrete Seawall - Fred	—	209,467	209,467
99	Long Range Program Reports	—	14,119	14,119
	General Construction - All Sites	118,794	140,316	259,110
	Undistributed Costs at 6/30/53	1,514,060	(1,514,060)	—
	Unallocated Costs at 6/30/54	—	367,531	367,531
	Total Job I-Expendable Construction	6,415,823	15,885,367	22,301,190
JOB II - CAMP OPERATION & MANAGEMENT				
	Support of Personnel Other than Contractor	414,332	5,046,688	5,461,020
JOB III - MAINTENANCE SERVICES		2,071,301	3,604,029	5,675,330
JOB IV - SUPPORT SERVICES		161,644	1,499,325	1,660,969
JOB V - ROLL-UP SERVICES		124,030	765,747	889,777
	GRAND TOTAL - JOBS I Thru V	$9,187,130	$26,801,156	35,988,286
	Less Reimbursable Work			1,708,225
	Add Depreciation			6,398,643
	TOTAL J. T. F. 7 COST REPORT			$40,678,704

APPENDIX A

Contract AT(29-2)-20

Joint Task Force 7 Cost Report - (FINAL REPORT)

Cumulative to June 30, 1954 - Installation Costs

Cost Code No. (A) / Function	OPERATING COSTS					CAPITAL COSTS				TOTAL
						BUILDING				
	Payroll (B)	Supplies & Materials (C)	Other Costs (D)	Consumed in Operation (E)	Total Oper. Cost (B)(C)(D)(E) (F)	Payroll	Material (G)	Other Costs	Credits	Grand Total (F) + (G) (J)
SCIENTIFIC PROGRAMS										
Prog. 11										
11.1	$ 646	$	$ 1,364	$ 967	$ 2,977	$ 320	$ 22	$ 625	$ 967	$ 2,977
11.2	255	177	581		1,013					1,013
11.3	1,230	138	2,253		3,621					3,621
Total Program 11	2,131	315	4,198	967	7,611	320	22	625	967	7,611
Prog. 12										
12.1	5,370	4	9,726	1,102,287	1,117,387	219,942	181,441	700,904	1,102,287	1,117,387
12.2	224		417	101,779	102,420	20,017	10,240	71,522	101,779	102,420
12.3	1,421	283	2,637	445,206	449,547	89,770	56,033	299,403	445,206	449,547
Total Program 12	7,015	287	12,780	1,649,272	1,669,354	329,729	247,714	1,071,829	1,649,272	1,669,354
Prog. 13										
13.1	1,504	2	2,828	166,579	170,913	24,513	47,712	94,354	166,579	170,913
13.2	76		151	166,579	166,806	24,513	47,712	94,354	166,579	166,806
13.3	648		1,062	166,581	168,291	24,513	47,714	94,354	166,581	168,291
13.4	18,846	86	34,004	539,692	592,628	90,130	117,388	332,174	539,692	592,628
13.5	207		347	797,980	798,534	143,545	161,036	493,399	797,980	798,534
13.99.6	83		193		276					276
Total Program 13	21,364	88	38,585	1,837,411	1,897,448	307,214	421,562	1,108,635	1,837,411	1,897,448
Prog. 14										
14.1	2,708	237	5,105	17,600	25,650	3,550	2,669	11,381	17,600	25,650
Prog. 15										
15.1	16,951	7	30,987	275,422	323,367	53,988	47,541	173,893	275,422	323,367
15.2	829	317	1,654	59,071	61,871	11,594	11,035	36,442	59,071	61,871
15.99.6	612	93	1,236		1,941					1,941
Total Program 15	18,392	417	33,877	334,493	387,179	65,582	58,576	210,335	334,493	387,179
Prog. 16										
16.1	191	6	341		538					538
Prog. 17										
17.1	$ 55	$	$ 107	$ 3,531	$ 3,693	$ 117	$ 1,702	$ 1,712	$ 3,531	$ 3,693

APPENDIX A

Cumulative to June 30, 1954 - Installation Costs (Cont.)

Cost Code No. (A)	Function	OPERATING COSTS					CAPITAL COSTS				TOTAL
							BUILDING				
		Payroll (B)	Supplies & Materials (C)	Other Costs (D)	Consumed in Operation (E)	Total Oper. Cost (B)(C)(D)(E) (F)	Payroll	Material (G)	Other Costs	Credits	Total Grand Total (F) + (G) (J)
SCIENTIFIC PROGRAMS											
Prog. 18											
18.1		$10,835	$ 485	$21,002	$ 21,682	$ 54,004	$ 4,098	$ 4,751	$ 12,833	$ 21,682	$ 54,004
18.2		60		98	16,008	16,166	3,195	3,229	9,584	16,008	16,166
18.3		248		419	16,008	16,675	3,195	3,229	9,584	16,008	16,675
18.4		765		1,315	29,710	31,790	6,247	4,622	18,841	29,710	31,790
18.5		238	10	397	29,715	30,360	6,249	4,622	18,844	29,715	30,360
18.99.6		3,069	192	5,587	13,022	21,870	2,760	1,357	8,905	13,022	21,870
Total Program 18		15,215	687	28,818	126,145	170,865	25,744	21,810	78,591	126,145	170,865
Prog. 19											
19.1		613	85	1,168		1,866					1,866
Prog. 21											
21.1		282	127	525		934					934
21.2		64	25	133		222					222
21.3		375	289	824		1,488					1,488
21.4		66	5	119		190					190
Total Program 21		787	446	1,601		2,834					2,834
Prog. 22											
22.1		1,019	148	1,884		3,051					3,051
22.99.6		5,004	2,854	11,922	1,113,779	1,133,559	223,594	156,504	733,681	1,113,779	1,133,559
Total Program 22		6,023	3,002	13,806	1,113,779	1,136,610	223,594	156,504	733,681	1,113,779	1,136,610
Prog. 23											
23.1		1,143	130	2,078	704,451	707,802	106,089	166,572	431,790	704,451	707,802
23.99.6		1,387	2	2,426		3,815					3,815
Total Program 23		2,530	132	4,504	704,451	711,617	106,089	166,572	431,790	704,451	711,617
Prog. 24											
24.1		635	34	1,180		1,849					1,849
24.99.6		482		980	122,173	123,635	15,239	35,495	71,439	122,173	123,635
Total Program 24		1,117	34	2,160	122,173	125,484	15,239	35,495	71,439	122,173	125,484
Prog. 25											
25.1		$ 14	$	$ 26	$	$ 40	$	$	$	$	$ 40

Cumulative to June 30, 1954 - Installation Costs (Cont.)

Cost Code No. (A)	Function	OPERATING COSTS Payroll (B)	Supplies & Materials (C)	Other Costs (D)	Consumed in Oper. (E)	Total Oper. Cost (B)(C)(D)(E) (F)	CAPITAL COSTS BUILDING Payroll	Material (G)	Other Costs	Credits	TOTAL Total Grand Total (F) + (G) (J)
Task Group 7.1											
TU-1		$ 478	$	$ 1,300	$ 323	$ 2,101	$ 65	$	$ 258	$ 323	$ 2,101
TU-2		40,671	3,797	77,298		121,766					121,766
TU-3		2,040	206	4,271		6,517					6,517
TU-4		16,634	1,301	30,426	1,183,786	1,232,147	87,663	359,731	736,392	1,183,786	1,232,147
TU-6		412	13	739		1,164					1,164
TU-7		7,960	5,211	21,721		34,892					34,892
TU-8		100	18	186		304					304
TU-9		626	439	1,442		2,507					2,507
TU-12		10,676	649	19,269	232	30,826	53	37	142	232	30,826
TU-14		6,988	408	17,664	389,669	414,729	57,582	103,840	228,247	389,669	414,729
TU-15		13,419	560	26,481	200,241	240,701	27,863	56,266	116,112	200,241	240,701
TG 7.1		163,459	29,604	343,438	6,160,841	6,697,342	530,015	924,603	4,706,223	6,160,841	6,697,342
Total TG 7.1		263,463	42,206	544,235	7,935,092	8,784,996	703,241	1,444,477	5,787,374	7,935,092	8,784,996
Total Scientific Programs		$341,618	$47,942	$691,311	$13,844,914	$14,925,785	$1,780,419	$2,557,103	$9,507,392	$13,844,914	$14,925,785

Cost Code No. (A)	Function	OPERATING COSTS Payroll (B)	Supplies & Materials (C)	Other Costs (D)	Consumed in Operation (E)	Total Oper. Cost (B)(C)(D)(E) (F)	CAPITAL COSTS BUILDING Payroll	Material (G)	Other Costs	Credits	EQUIPMENT Material (H)	Credits	Net Capi[t Value (G) + (I] (I)
TG 7.5 - BASE FACILITIES													
7.5.1	Construction	$	$	$	$7,019,886	$7,019,886	$881,497	1,626,223	$ 4,765,900	$ 7,019,886	$ 5,760	$	$ 259,4
7.5.2	Operation & Maintenance	1,622,325	624,704	8,881,549		11,128,578							
7.5.4	Roll-Up Operations	288,514	28,876	572,388		889,778							
7.5.5	Common to TG 7.5	92,641	6,401	216,992	6,398,643	6,714,677	324,773	13,182,373	1,432,968	7,225,719	6,174,970	3,554,370	10,334,9
	Total Logistical Costs	2,003,480	659,981	9,670,929	13,418,529	25,752,919	1,206,270	14,808,596	6,198,868	14,245,605	6,180,730	3,554,370	10,594,4
	GRAND TOTAL	$2,345,098	$707,923	$10,362,240	27,263,443	$40,678,704	$2,986,689	$17,365,699	$15,706,260	$28,090,519	$6,180,730	$3,554,370	$10,594,4

Contract AT(29-2)-20
Joint Task Force 7 Cost Report - (FINAL REPORT)
Cumulative to June 30, 1954 - Reimbursable Work

		OPERATING COST				SCIENTIFIC CONSTRUCTION				
Cost Code No.	Function	Labor Civilian	Materials	Other Costs	Total Operating Costs	Labor Civilian	Materials	Other Costs	Total Construction Costs	Total Expenditures
REIMBURSABLE WORK										
7.1 - Scientific Programs										
Prog. 1										
1.1		$ 788	$ 695	$ 1,993	$3,476	$ 871	$ 1,084	$ 3,210	$ 5,165	$ 8,641
1.1a		149		268	417	2,095	11,575	15,246	28;916	29,333
1.2a		7,420	456	13,911	21,787	13,412	6,855	40,861	61,128	82,915
1.2b		921	61	1,677	2,659	4,851	6,502	17,323	28,676	31,335
1.3		3,607	146	6,455	10,208	13,853	7,555	42,616	64,024	74,232
1.4		8,655	375	18,537	27,567	6,198	12,745	27,910	46,853	74,420
1.6		3,149	234	6,204	9,587	218	271	802	1,291	10,878
1.7		3,434	86	5,978	9,498	11,145	7,068	34,470	52,701	62,199
1.8		479	116	926	1,521					1,521
199.6				141	141	3,264	4,062	12,040	19,366	19,507
	Total Program 1	28,602	2,169	56,090	86,861	55,907	57,735	194,478	308,120	394,981
Prog 2										
2.1		853	260	3,391	4,504	2,421	1,551	6,310	10,282	14,786
2.2		384	47	732	1,163	5,098	3,334	16,994	25,426	26,589
2.3		695	294	1,369	2,358	3,106	2,821	10,232	16,159	18,517
2.5a		15,971	256	32,471	48,698	14,008	3,818	38,950	56,776	105,474
2.5b		3,018	159	5,807	8,984	4,608	1,668	12,700	18,976	27,960
2.6a		737	183	1,363	2,283	435	542	1,605	2,582	4,865
2.6b		428	211	872	1,511					1,511
299.6						1,524	1,895	5,619	9,038	9,038
	Total Program 2	22,068	1,410	46,005	69,501	31,200	15,269	92,410	139,239	208,740
Prog. 3										
3.1		999	44	2,019	3,062	13,888	8,131	42,623	64,642	67,704
3.2		307		571	878	582	623	1,842	3,047	3,925
3.3		395		715	1,110	435	542	1,605	2,582	3,692
399.6						317	270	1,193	1,780	1,780
	Total Program 3	1,701	44	3,305	5,050	15,222	9,566	47,263	72,051	77,101
Prog. 4										
4.1		$ 489	$ 497	$ 1,456	$ 2,442	$	$	$	$	$ 2,442

Reimbursable Work (Cont.)

	OPERATING COST				SCIENTIFIC CONSTRUCTION				
Prog. 6									
6.2	$ 1,923	$1,058	$ 4,118	$ 7,099	$ 660	$ 653	$ 2,149	$ 3,462	$ 10,561
6.2a	79	64	213	356					356
6.2b	7		5	22					22
6.3					217	271	803	1,291	1,291
6.4	9,728	6,042	22,616	38,386	653	813	2,407	3,873	42,259
6.5	712	89	1,456	2,257	1,329	1,997	4,801	8,127	10,384
6.6	309	377	773	1,459	1,361	1,362	4,410	7,133	8,592
699.6					872	1,083	3,210	5,165	5,165
Total Program 6	12,758	7,630	29,191	49,579	5,092	6,179	17,780	29,051	78,630
Prog. 7									
7.1	832	151	1,665	2,648	1,690	767	4,352	6,809	9,457
7.2	56		107	163					163
7.4	161	244	455	860	653	813	2,407	3,873	4,733
799.6					217	271	803	1,291	1,291
Total Program 7	1,049	395	2,227	3,671	2,560	1,851	7,562	11,973	15,644
OTHER REIMBURSABLE COSTS									
Task Unit 13 - Miscellaneous									
(1) Support Services and Incidental Test Construction	1,021	179	1,757	2,957	437	542	1,606	2,585	5,542
(2) Clearing and Grading, Sites Uncle thru Zebra					2,040	1,200	8,760	12,000	12,000
(3) Buildings 418 and 418a - Elmer					4,321	6,769	15,668	26,758	26,758
(4) Pro rata share of clearing and grading on Nan, Fox, Charlie, and Eniwetok Atoll					1,422		6,943	8,365	8,365
(5) Pro rata share of Submarine Cable					2,979	20,358	26,317	49,654	49,654
(6) Pro rata share of Scientific Power Houses					3,225	7,194	14,387	24,806	24,806
Total - Task Unit 13	$ 1,021	$ 179	$ 1,757	$ 2,957	$14,424	$36,063	$73,681	$124,168	$127,125

Cumulative to June 30, 1954 - Reimbursable Work (Cont.)

Cost Code No.	Function	SCIENTIFIC CONSTRUCTION Civilian Labor	Materials	Other Costs	Total Construction Costs	Total Expenditures
Contract Item 68 - JTF-7 Construction						
68.1	Warehouse Bldg. 638	$ 7,879	$ 1,972	$ 23,839	$ 33,690	$ 33,690
68.2	Wood Prefabricated Bldgs.	6,401	1,121	17,743	25,265	25,265
68.3	Steel Prefabricated Bldgs.	5,540	3,262	18,984	27,786	27,786
68.4	Airfield Improvements	4,104	3,714	30,240	38,058	38,058
68.5	Parachute Bldg.	6,591	3,409	17,000	27,000	27,000
68.6	Floor Slab - Hangar Bldg.	5,598	1,216	34,263	41,077	41,077
68,7	Rehabilitate Bldg. 135	823	599	2,052	3,474	3,474
68.8	Extension Bldg. 4	2,483	2.009	8,037	12,529	12,529
68.9	Modifications - Bldg. 15	17,444	5,488	41,162	64,094	64,094
68.10	Bldg. 640	1,113	308	3,100	4,521	4,521
68.11	Addition to Bldg. 90	2,239	1,424	6,643	10,306	10,306
68.12	Bldg. 610 - Photo Lab.	4,211	5,853	14,376	24,440	24,440
68.13	Bldgs. 617 - 620	3,027	675	9,128	12,830	12,830
68.14	Electric Service - Bldg. 616	1,083	727	3,139	4,949	4,949
68.15	Office Ltg. Bldgs. 632 thru 637			67	67	67
68.16	Elec. & Dehumidif. Sys. Bldg. 604, 605	3,265	9,305	14,110	26,680	26,680
68.18	Paint Rep. Sec. Bldg. 606, 611, 632, 637	39		75	114	114
68.19	Office Ltg. Bldgs. 607 thru 609			67	67	67
68.20	Lighting Modifications - Bldg. 118	909	594	2,242	3,745	3,745
68.21	Bldg. 630 - Parachute Repack	817	1,537	2,965	5,319	5,319
68.23	Bldgs. 614 & 615 - Depot Supply	1,937	126	6,200	8,263	8,263
68.24	Additional Wiring - Bldg. 631	287	306	791	1,384	1,384
68.25	Paint Bldg. 604, 605, 607-610, 630 & 631	880	217	2,199	3,296	3,296
68.26	Additional Electric Service	2,390	7,071	12,105	21,566	21,566
68.28	Mod. Bldg. 635 & Constr. Pit Latrine	222	90	568	880	880
68.29	Power Outlets - Bldg. 90	81		155	236	236
68.31	Temp. Emerg. Power Connect. - Bldg. 90	366	526	1,168	2,060	2,060
68.33	Add'l. Constr. Requirements - Var. Bldgs.	1,144	280	2,551	3,975	3,975
68.35	Install water cooler, Bldg. 633 - Fred	59		121	180	180
68.36	Inst. Photo Print Washer - Bldg. 610	13		26	39	39
68.37	Temporary Housing of Rongelop					
	Natives - Ejit, Majuro Atoll	7,509	15,607	28,403	51,519	51,519
	Concrete Seawall - Fred	44,369	6,808	158,209	209,386	209,386
	Trenching for Telephone Cable	457		1,629	2,086	2,086
	Total - Contract Item 68	$133,280	$74,244	$463,357	$670,881	$670,881

Joint Task Force 7 Cost Report - (FINAL REPORT)
Cumulative to June 30, 1954 - Reimbursable Work (Cont.)

Cost Code No.	Function	OPERATING COST: Labor Civilian	OPERATING COST: Materials	OPERATING COST: Other Costs	OPERATING COST: Total Operating Costs	SCIENTIFIC CONSTRUCTION: Labor Civilian	SCIENTIFIC CONSTRUCTION: Materials	SCIENTIFIC CONSTRUCTION: Other Costs	SCIENTIFIC CONSTRUCTION: Total Construction Costs	Total Expenditures
	MAINTENANCE SERVICES									
MWO - 7323	Replace Armature - LST 1126	$ 14	$ 43	$ 63	$ 120	$	$	$	$	$ 120
7324	Turnbuckle Dogs for LST 1126	192	32	435	659					659
7327	Rewind Shut Coil for LST 1126	50		98	148					148
7329	Repairs to Navy LCM 48	253	1	585	839					839
7339	Drydock AJR	1,186	87	2,700	3,973					3,973
7353	Sandblast & Paint LCM 46 - 48	508	191	1,333	2,032					2,032
	Total	2,203	354	5,214	7,771					7,771
	Total Other	3,224	533	6,971	10,728	147,704	110,307	537,038	795,049	805,777
	TOTAL REIMBURSABLE	$69,909	$12,678	$145,245	$227,832	$257,685	$201,267	$896,531	$1,355,483	$1,583,315
	Total Transfered to SFOO									$1,583,315
	Untransfered Balance (Per Balance Sheet)									

Contract AT(29-2)-20

Joint Task Force 7 Cost Report - FINAL REPORT

Cumulative to June 30, 1954 - Reconciliation - Fiscal Years 1953 and 1954

	JTF-7 Cost Report	Cost and Budget Report
RECONCILIATION - OPERATING COSTS		
Total Installation Costs - June 30, 1954	$40,678,704	$28,573,140
Reconciling Items:		
Total Costs - June 30, 1953 Per JTF-7 Cost Report		10,404,704
Program 9000 Costs Per C. & B. Report - June 30, 1954		⟨2,569,196⟩
Other Costs not included in JTF-7 Cost Report		
Category 3990-Undistributed DD&T		
" 10110-Inventory Changes		638,356
" Reserve for Loss on Excess Personal Property		444,190
" 10410-Other Costs-Fund		⟨150,425⟩
" 10424-Test Facilities Destroyed or Abandoned		⟨99,549⟩
" 10429-Miscellaneous		2,155,839
" 10430-P/Y Costs- 10431-Adjs. P/Y Costs-Fund		212,911
10432-Adjs. P/Y Costs-Non-Fund		1,068,734
Adjusted Totals	$40,678,704	$40,678,704

Contract AT(29-2)-20
BALANCE SHEET
June 30, 1954

ASSETS

Cash in Banks and On Hand			
General Fund and Payroll Account		$ 60,892.40	
Overseas revolving Fund		58,730.75	
Petty Cash Funds	$ 104,150.00		
Les: Reimbursments In Transit	58,730.75	45,419.25	
Trustee for Travel Fund		228,312.29	$ 393,354.69
Accounts Receivable			
All Other		95,362.71	
Less: Reserve for Bad Debts		10,000.00	85,362.71
Reimbursable Work - Other Federal Agencies Inventories			
*Current Use and Excess	2,329,457.09		
**Expendable Construction Inventories	2,134,492.75	4,463,949.84	
Less: Reserve for loss on Excess Personal Property		444,189.72	4,019,760.12
Prepayments and Deferred Charges			
Rent			4,081.46
Plant			
Completed Plant	21,115,084.39		
Less: Reserve for Depreciation	10,780,088.60	10,334,995.79	
Plant and Equipment Changes in Progress			
All Others		259,494.18	10,594,489.97
Deposits			12,183.88
TOTAL ASSETS			$15,109,232.83

*Includes $713,527 Excess Personal Property
* " $37,572 of long supply (approximately)
** " $1,627,540 " " " "

Total Commitments at June 30, 1954: $908,655.

Contract AT(29-2)-20
BALANCE SHEET
June 30, 1954

LIABILITIES AND AEC EQUITY

Liabilities			
Accounts Payable:			
Trade	$ 128,634.92		
U. S. Government	1,399,803.87	$ 1,528,438.79	
Accrued Liabilities: Accrued Expenses (Other Accruals)	644,797.89		
Funds Held for Others	1,873.45		
Travel Fund Held for Employees	228,312.29	874,983.63	
TOTAL LIABILITIES			$ 2,403,422.42
AEC Equity			
Current Account		⟨3,035,511.21⟩	
Net Cot of Operations and Prior Year Adjustments (Exhibit B)		⟨27,086,488.02⟩	
Investment Account		14,829,932.61	
Cash Accountability		27,997,877.03	
TOTAL AEC EQUITY			$12,705,810.41
TOTAL LIABILITIES & AEC EQUITY			$15,109,232.83

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