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COMPLETION REPORT

OPERATION REDWING

U. S. ATOMIC ENERGY COMMISSION CONTRACT AT-(29-2)-20
PACIFIC PROVING GROUND 1954 - 1956

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FOREWORD

The following report of Operation REDWING by Holmes & Narver, Inc. under contract to the United States Atomic Energy Commission, summarizes the planning, engineering, design, construction, maintenance, and management of the Pacific Proving Ground facilities for the period of 1 July 1954 through 10 August 1956. It has been prepared in accordance with the requirements of Contract AT-(29-2)-20 as set forth in Article III, General Requirements, Paragraph 1, Page 8.

Purely a documentary report, it has been abbreviated to features relevant to the activities of Holmes & Narver as the Architect-Engineer-Construction-Management Contractor. It records performance, and contains conclusions and recommendations based on the assumption that the Pacific Proving Ground will be used for future tests. It is designed to serve as a reference for the U. S. Atomic Energy Commission or other participants in projects of a similar nature.

REDWING was considerably more complex and of greater magnitude than any previous Operation held at the Pacific Proving Ground. Complexity was magnified by a few unusual design and construction requirements, a compressed schedule, and an expanded sphere of operations.

Much of the success of REDWING must be attributed to the effective liaison maintained with the AEC and the participating and supporting agencies. That the pre-operational phases proceeded without serious delay and generally on schedule, and that the test operations were successfully concluded, is clearly a tribute to the outstanding cooperation of the diverse components of Joint Task Force Seven.

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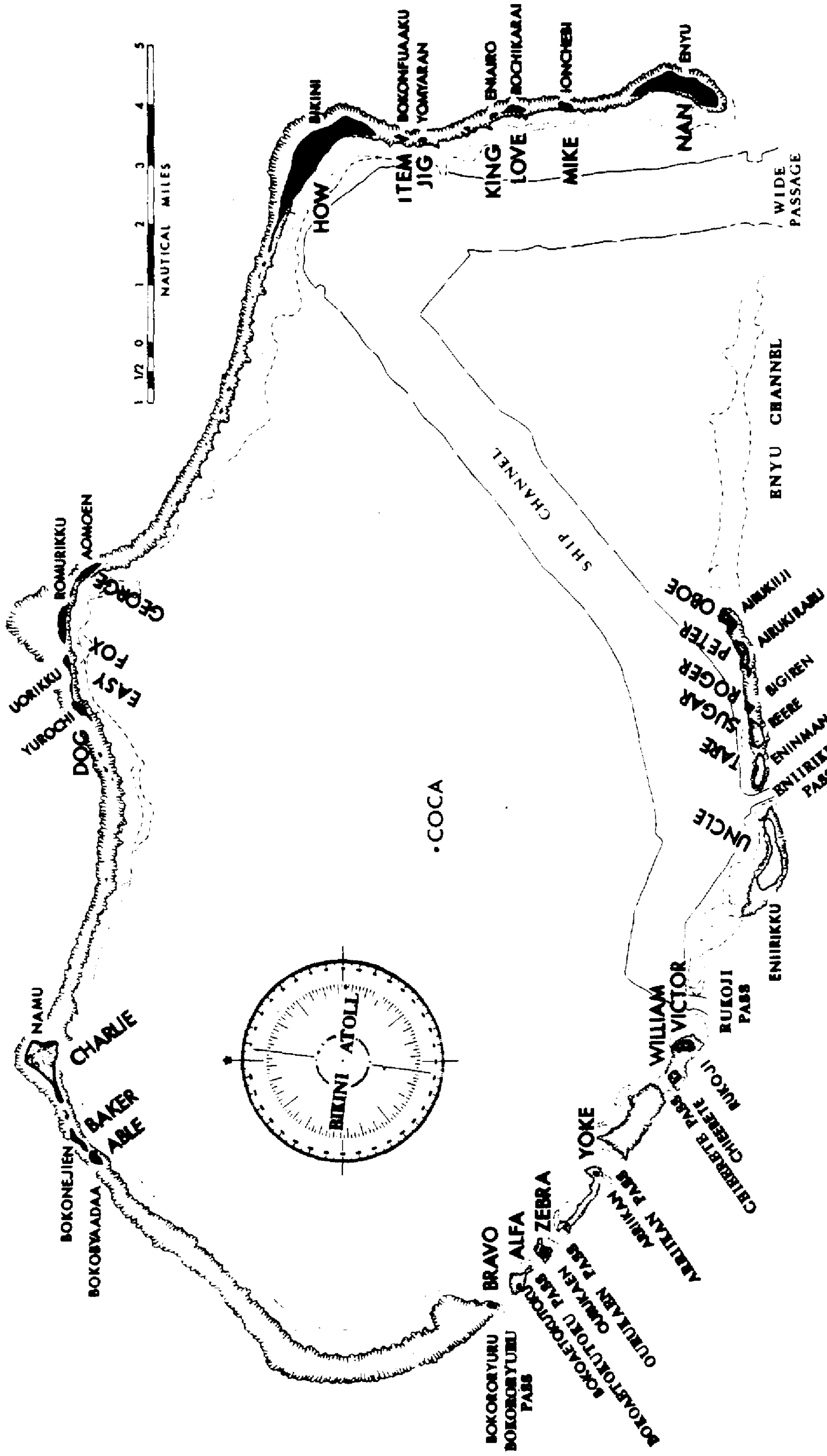
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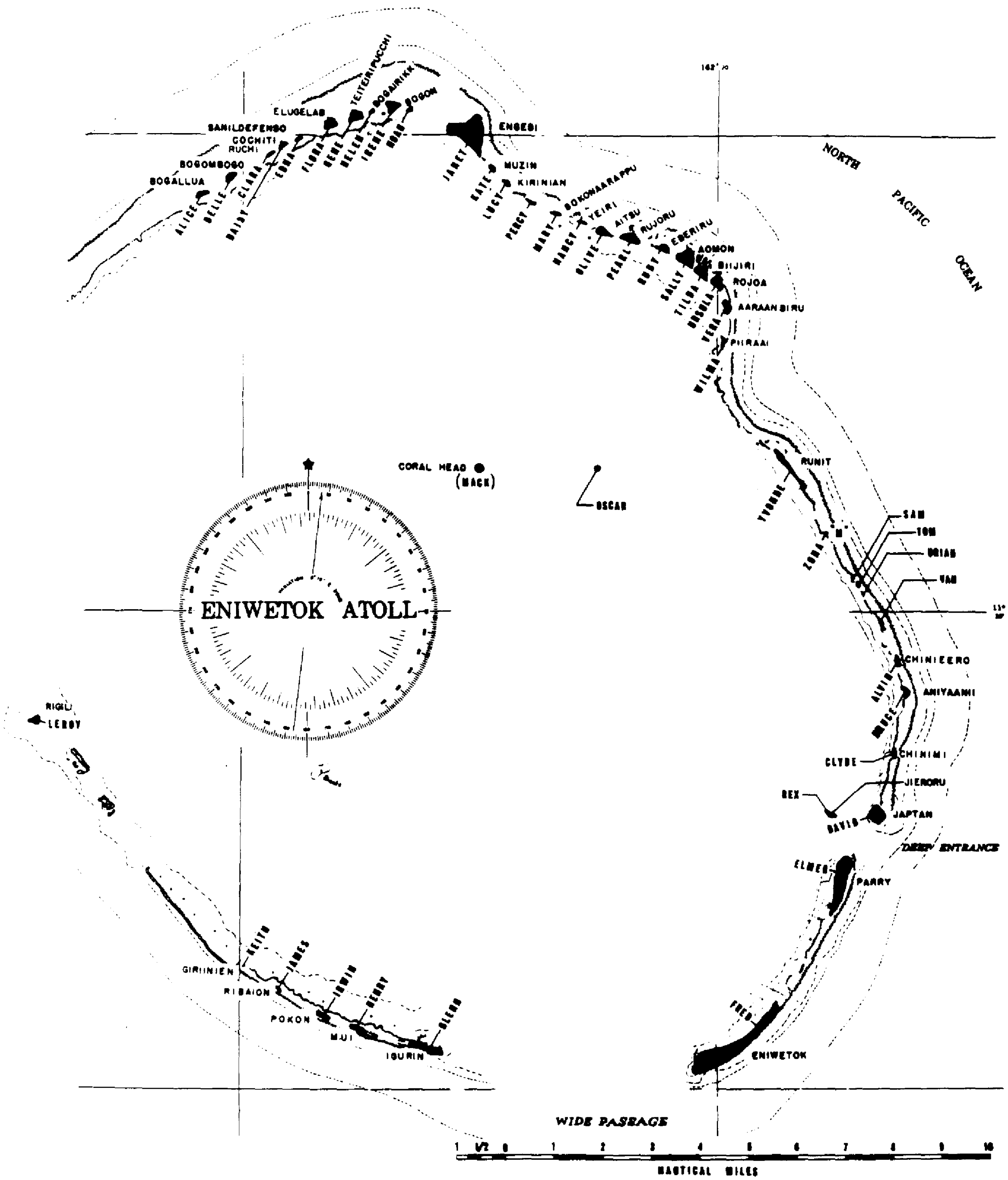
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MUI
IGURIN
RIGILI
LEROY

CHAPTER I
INTRODUCTION

SECTION I
NARRATIVE SUMMARY

BACKGROUND.

Operation REDWING marks the fourth consecutive test series in which Holmes & Narver, Inc. has participated as the Architect-Engineer-Construction-Management Contractor for the Pacific Proving Ground under contract with the U. S. Atomic Energy Commission, during the past eight years. The original criteria established for the guidance of the Contractor in the fall of 1948 covered the development of certain facilities at Eniwetok Atoll, limited in scope and degree of permanence to two Test Operations. From this beginning, subsequent assignments advanced to extensive programs involving the engineering, design, construction, maintenance, and operation of a semi-permanent base; and the engineering and construction of scientific test facilities required to serve four Test Operations - GREENHOUSE, IVY, CASTLE, and REDWING.

The recognition of Eniwetok Atoll as a semi-permanent base in 1952 focused attention on the desirability of a Master Plan for long range improvement of the Proving Ground. Accordingly, the Manager, Eniwetok Field Office, SFOO, later designated Deputy Director, Test Division, Albuquerque Operations Office, requested the Contractor to prepare engineering design studies and cost estimates for a program to meet the then known requirements. This plan was first submitted in October 1952. With each succeeding Test Operation, other requirements developed, and the plan was revised after CASTLE, and now again upon completion of REDWING. Many of the facilities that were proposed have been provided, thus enabling long-term operation of the Proving Ground.

Completion Reports for the GREENHOUSE, IVY, and CASTLE Operations were furnished the Atomic Energy Commission following each Test Operation. This report continues the account of Holmes & Narver's participation in the Pacific Proving Ground activities and covers the REDWING Operation.

INTERIM PERIOD OPERATIONS.

Prior to the first detonation of the CASTLE Operation, the Deputy Director, Test Division, Albuquerque Operations Office (AEC Contract Administrator) requested that studies be made for the establishment of a temporary camp at Nan to serve as an advance base of operations for the next Test Operation in the same manner as the camp on Tare was then serving for CASTLE. Holmes & Narver was requested to consider two alternatives; a complete new camp in a location best suited to future development of the island site, or a camp which utilized existing facilities. Surveys were conducted, camp layouts prepared and, in anticipation of future construction, structural designs of modular expendable frame buildings that could be used as standard designs were made. The camp layouts and the standard plans for the mess hall and utilities provided for expansion from a 250-man to a 500-man camp and then to a 1000-man camp.

As the end of Fiscal Year 1954 approached, the Contractor was furnished a list of basic assumptions for a scientific program for Operation MILLRACE/REDWING, which was to be used in preparing a budget forecast for Fiscal Year 1955. This provided budget criteria for two barge shots in the MILLRACE Operation and two barge shots and three ground shots for REDWING. MILLRACE was later deleted from the program and REDWING underwent many changes. The budget forecast included additional major base camp facilities consisting of eleven barracks for Fred, a deep water pier at Elmer, and a second submarine power cable between Elmer and Fred.

The last detonation of CASTLE took place on 14 May 1954, after which the Contractor continued, until September 1954, a planned program for placing the Proving Ground in a standby condition. During that period particular emphasis was placed on decontamination activities, and on the rehabilitation of equipment. By September 1954, manpower for CASTLE had been reduced from the peak of 2300 men to approximately 700 men. This was the minimum practicable number in view of the existing work load and the anticipated early release of construction for the Nan camp. This force was engaged in completing the Fred airfield improvements program- authorized in July 1954-and in miscellaneous construction and upkeep.

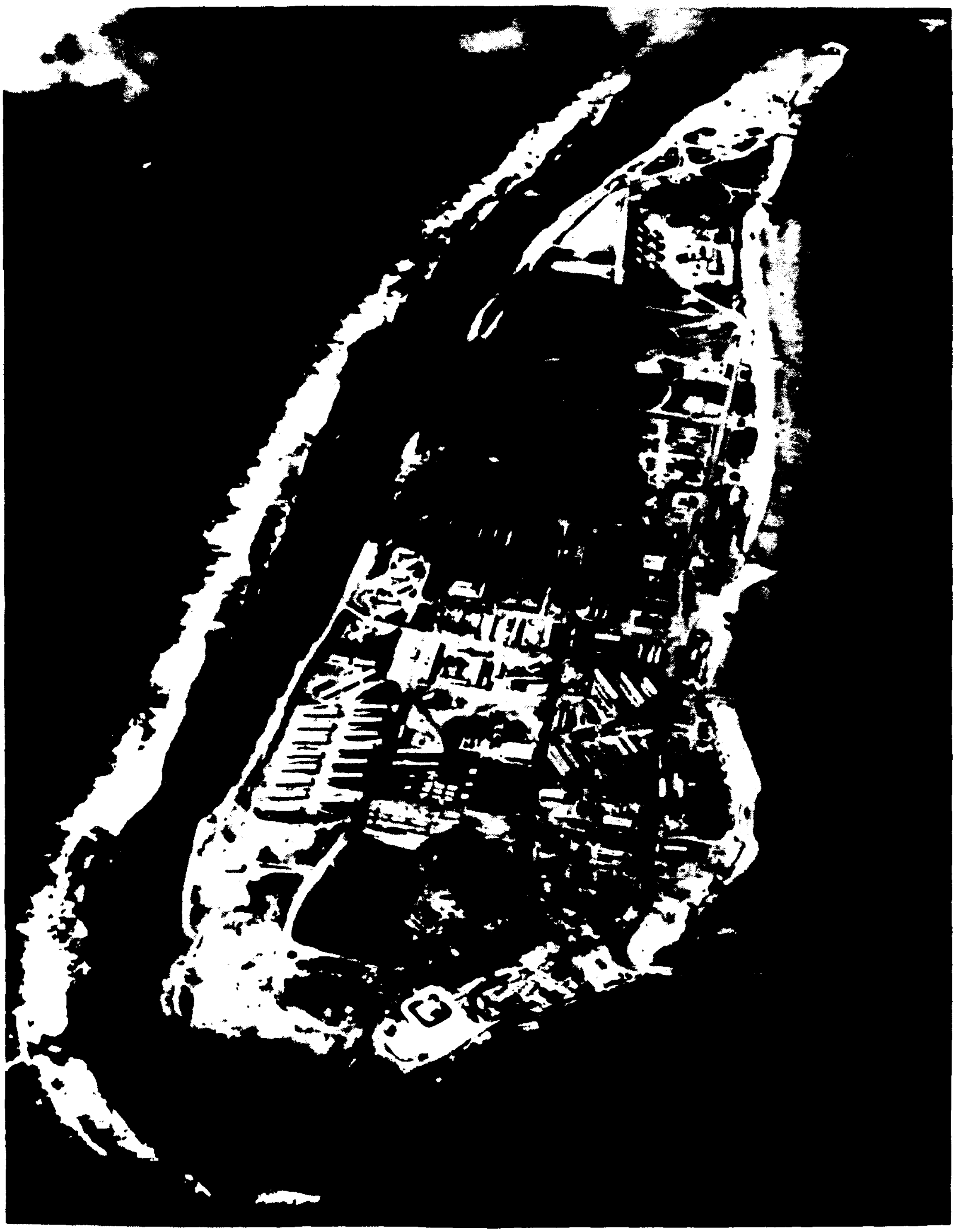


Figure 1-1. Elmer

Approval was received on 26 August 1954, for the preparation of working drawings and original estimates for the temporary camp facilities contemplated for construction at Nan. In September 1954, approval was also received for the plant and equipment projects for Fiscal Year 1955, amounting to approximately $1,500,000.00, the major items of which included the deep water pier at Elmer, and the eleven barracks at Fred. The release of this work permitted a fairly constant level of employment during this transitional period.

Planning for the construction on Nan contemplated advance stockpiling of material and equipment at the site, prefabrication of building assemblies at Elmer, the reactivation of equipment in Station 70 for the early establishment of interatoll communications, the reduction of the existing radioactive hazards at the camp site, rehabilitation of the Peter-Oboe airstrip for limited service, the establishment of a beachhead camp from which the construction program could expand, and priority construction of an airstrip suitable for landing C-47 type planes. To provide the logistic support, arrangements were made through AEC channels for utilizing an LSD type ship for the initial landings and the continued use of an LST thereafter. The LSD was selected for the initial landings inasmuch as heavy equipment, such as cranes, could be transported without being dismantled, and because the tranfer of LCU and LCM craft could be more easily effected. Dismantling of cranes is necessary when an LST or conventional type vessel are used. The continued use of the LST was essential for the establishment of an Eniwetok-Bikini shuttle service, since construction at Bikini was predicated on the fact that the main supply and repair base would remain on Elmer.

On 24 September 1954, construction of Increment No. 1 of the Nan camp (250-man capacity) was authorized with instructions that the housing tents and latrines were to be erected only on an as-needed basis to meet population requirements. The first task group, consisting of 29 H&N employees and two AEC representatives, departed Elmer on 9 October 1954 in the USS Belle Grove (LSD). This task group was supported at Nan by an LCU outfitted as a houseboat during the period when the LSD made three round trips for the movement of material and equipment. The LSD was relieved by LST-618, which arrived at Jobsite on 30 October. During the month of November, the operations preliminary to the establishment of a beachhead camp continued as previously planned. The beachhead camp was ready for occupancy by 5 December and 34 H&N men were landed there on that date. This force was gradually augmented, and by 1 January 1955, there were 150 men employed in Bikini Atoll.

With the authorization for construction of the Nan camp, various studies and appraisals were undertaken to determine the engineering, construction and logistic problems that would be involved in an Operation with a scientific structures program similar to that of CASTLE; these studies were made with the expectations that firm requirements for causeway construction would be available by 1 April 1955, and for scientific stations, by 1 July 1955. Included in these studies were the best means for reducing radioactive levels at probable construction sites; the feasibility of using bases afloat in lieu of shot-island camps; the condition of existing scientific stations, submarine cables, and causeways; and the availability of shot barges and high speed personnel boats.

Because of the widespread destruction and contamination of the land base camps caused by CASTLE detonations, the subsequent difficulties in operating from shipboard, the initial high cost of temporary shot-island camps, and the uncertainty of finding habitable land areas in the vicinity of shot-islands, consideration was given to the practicability of using quarter boats instead of shot-island camps for both the construction and operation phases of REDWING. It was proposed that should such type craft be acquired, they would be anchored fairly close inshore at the major construction sites and would be moved to sea during evacuation. These vessels were to be completely staffed by the Contractor. Investigation and inspection of the U. S. Navy-type barrack vessels indicated that these craft were possibly suitable. Funds were made available in the Fiscal Year 1955 Budget for activation of one of the vessels. Subsequent developments, particularly the ease with which radioactive levels at camp sites were reduced, led to the abandonment of this project.

Through the months of December 1954 and January and February 1955, work progressed satisfactorily on approved items of construction in both Atolls. By the middle of March 1955, construction at Nan was ahead of schedule; the airstrip was 78% completed, and C-47 type planes were landing on regularly scheduled flights. The interatoll teletype and radiophone communication systems had been activated and the work in connection with housing, messing, shop, warehouse and POL facilities was well under way. At Eniwetok Atoll the airfield improvements program had been completed, progress on the Elmer deep-water pier and the barracks on Fred was ahead of schedule, the Elmer and Tilda airstrips had been rehabilitated, and a considerable number of miscellaneous items of construction had been undertaken. On 15 March 1955, there were 850 contract employees at the Proving Ground.

The completion of the construction authorized during the transitional period (CASTLE to REDWING) provided a forward base at Bikini well in advance of the build-up phase of this Operation. The completion of warehouses and added fuel tanks at Eniwetok Atoll provided additional storage facilities as well as protection from climatic conditions. Upon completion of the deep water pier, stevedoring operations were facilitated and more reliable fueling services were available at Elmer. The improvement of the Fred airfield, the construction of additional barracks and other miscellaneous items added to the over-all efficiency of the PPG. The Proving Ground plant was in this way made ready for the construction phase of the next Test Operation.

SCOPE OF OPERATIONS.

The over-all scope of the construction program for the Operation, which was by then designated REDWING/DIXIE, was first outlined broadly by representatives of the AEC in discussions held in the Contractor's Home Office during the week of 28 February 1955. By letter, dated 4 March 1955, the Deputy Director, Test Division, confirmed this scope of work; the Operation was scheduled to be held in the spring of 1956 with a target date for the first shot as of 1 March 1956. This scope of work included the construction of 200-man temporary camps at Ursula, Yvonne, Tare, and Gene, and a 125-man camp at Fox; the reconstruction of causeways from Gene to Irene; the outfitting of zero barges; and construction of shot towers, recorder, photography, and other stations. These facilities were to serve an Operation involving five tower, two ground, and two barge shots. The Contractor at that time was authorized to initiate design and procurement of the materials for the shot-island camps and to proceed with the design of the scientific stations in accordance with details furnished by the University of California Radiation Laboratory (UCRL), the Los Alamos Scientific Laboratory (LASL), and the Department of Defense (DOD).

Before the test program was finalized, it underwent many changes. On 19 April, the concept of the Operation, now designated REDWING, was altered to include five tower, two ground, two barge shots, and two airdrops. On 20 June 1955, information furnished the Contractor indicated that there would be only eight shots but that two barges and two towers would be furnished as spares. On 26 July 1955, these spare barges and towers were placed in the program, increasing the number to twelve shots. Other changes took place and by the end of August 1955, the program called for facilities to service an Operation involving 16 shots with provisions for furnishing and equipping two additional shot barges. Because of this expanded program, the target date for the first shot was advanced to 1 May 1956. Other changes took place and the test program as finally executed consisted of six barge shots, six tower shots, three ground shots, and two airdrops.

To meet the requirements of the test program as finally evolved, the test facilities provided far exceeded those contemplated in the early planning. More than 650 scientific stations were required, of which approximately 75 could be considered major stations from the design or construction viewpoint. A number of existing stations were rehabilitated and in some cases modified. Many of the stations had close location tolerances as they had to be oriented with respect to other stations with unobstructed lines of sight. Particularly significant was the extent of work undertaken for providing protection against blast or radiation, and for keeping settlement of heavily loaded stations within allowable tolerances. Many of the minor stations erected were, individually, simple items of construction but the total required many man-hours of all categories of personnel.

Construction accessory to scientific stations included laying approximately 2,039,500 lineal feet of various sizes of coaxial, telephone, and signal cable both on land and underwater; installing dehumidification units, varying in size from 3930 BTU to 42,800 BTU in 17 different stations; supplying electrical power from the island distribution system, or from approximately 150 small station generators ranging from 10 to 150 KW, many with rigid requirements as to reliability of voltage control; and numerous miscellaneous items.

In order to locate the scientific stations that could be properly oriented with respect to detonation points, it was necessary to provide three man-made islands on the Dog-Charlie reef, an island and two causeways offshore from Yvonne, and an island with a connecting causeway offshore from Sally. These causeways and islands were of standard design, consisting of rail and timber bulkheads backfilled with beach sand and coral. Five shot-island camps were provided to sustain peak populations as follows: Ursula 288; Gene 189; Yvonne 393; Fox 285; and Tare 227. The existing airstrips at Tilda, Janet, Elmer and Yvonne were rehabilitated and modified. A new airstrip (50′ x 1200′) was required on Gene; helicopter landing pads were provided at eleven different sites. Considerable earth moving was necessary to reconstruct the existing causeways: Gene-Helen-Irene, Peter-Roger-Sugar-Tare, Dog-Easy-Fox-George. An effective interatoll communication system of 17 VHF radio circuits was established for both classified and unclassified transmissions of phone and teletype messages, with comcenters at Nan and Elmer, and on the USS Curtiss and USS Ainsworth. Numerous miscellaneous temporary facilities were also required.

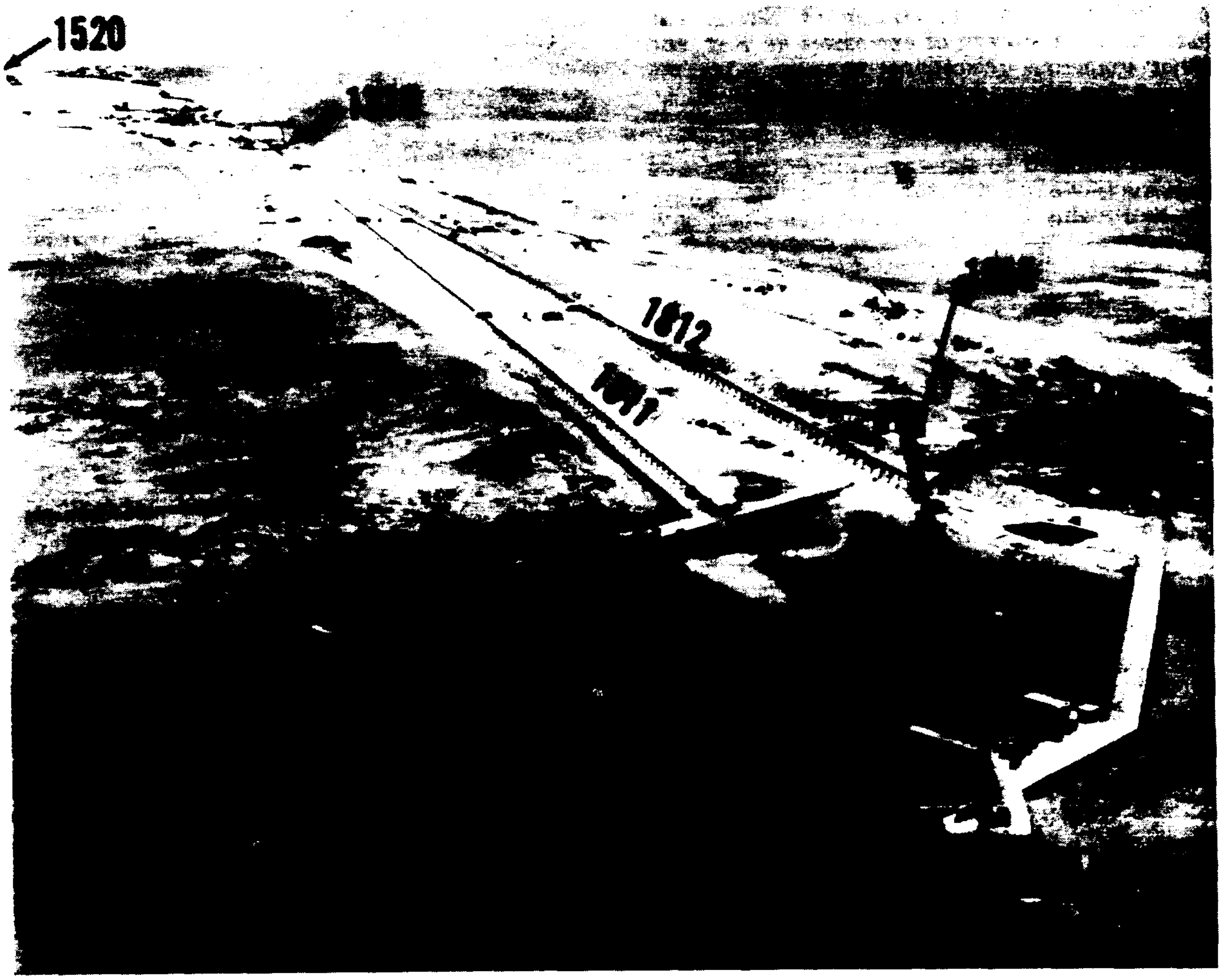


Figure 1-2. Major Scientific Stations - Yvonne

Construction activities with respect to scientific stations and temporary facilities were required on practically all islands of Eniwetok and Bikini as well as on seven other atolls in the Western Pacific Ocean area where four weather station and eight scientific projects were located.

Concurrent with the construction of scientific stations and temporary facilities, expansion and improvement of the Elmer and Fred camps were effected. The principal facilities added during the transitional period under P&E projects for the Fiscal Year 1955, as previously noted, were the deep-water pier, eleven barracks at Fred, and the second submarine power cable between Elmer and Fred. Additional plant and equipment projects approved for construction during Fiscal Year 1956 (P&E Projects 6001 and 6011) included 17 buildings at Fred and 18 buildings at Elmer, with a total building area of 147,494 sq. ft. for barracks, shops, warehouses, administration offices, and other uses. With the exception of the chapel at Elmer and the chapel and guest house on Fred, which were wooden structures, all the buildings added were prefabricated of either the all-aluminum (Pacific Iron & Steel) type or the steel frame with aluminum siding and roofing (Butler) type. To the Fred POL farm there were added two 5,000-barrel and two 10,000-barrel fuel storage tanks, filling and distribution lines, and fire protection and other appurtenances. The Elmer POL farm was modernized with a replacement of tanks and additional fire protection. A Joint AEC-Armed Forces Radio Receiving Station, including a camp to support approximately 20 operating personnel was constructed on David.

A television broadcast station at Elmer, two magazines for storage of explosives on Rex, and other numerous miscellaneous items were approved for the main base in order that REDWING could be adequately supported.

In addition to the engineering, design, and construction of all structures and facilities added to the Proving Ground, the Scope of Operations included the following tasks in connection with its management and operation:

1. All camp services except at Fred, David, and the Weather Station Islands. These included subsistence, quarters, laundry, mail, PX-stores, barber shops, refreshment bars, medical and dental, insect and rodent control, and recreation.
2. Utility services, including salt and fresh water, electric power, sewage disposal, telephone, and certain radiophone and radio-teletype.
3. Warehousing and property accounting for all materials and equipment shipped for H&N or Task Group 7.1 use.
4. Stevedoring and cargo handling except on shore at Fred and David.
5. Photography for H&N, AEC and User requirements.
6. Radiological and industrial safety of H&N personnel.
7. Interisland water transportation.
8. Land Transportation.
9. Maintenance of all fixed facilities.
10. Roll-up of the Proving Ground after the Operation, including preservation of equipment and facilities.

SPHERE OF OPERATIONS.

The Sphere of Operations, Chart 1-1, expanded to encompass the weather station and off-atoll scientific project requirements, presented a greater scope in area than any previous Operation. Eniwetok Atoll, the main base of operations, is located in the northerly region of the Marshall Islands at approximately 11 degrees-20'N latitude, 162 degrees-20'E longitude and lies approximately 4,500 nautical miles from the continental United States. The other Atolls on which construction was accomplished were located and oriented from this main base as shown at bottom of page.

Eniwetok and Bikini Atolls, which together comprise the Pacific Proving Ground, were the sites of the major construction projects. Both of these Atolls are typical of those found in Western Pacific Ocean areas. They consist of numerous small coral islands of little height above the sea, situated on a ring of coral reef surrounding a central lagoon. Both have passages of sufficient depth through the ring of coral reef to permit the passage of large ships to sheltered anchorage in the enclosed lagoon. They are situated in an area dominated by the Northeast Trade winds; the weather is typically tropical with an average humidity of 82% and a fairly uniform temperature averaging 84°F. The Atolls are subject to frequent rains and periodic squalls; there is no regularly defined rainy season. Rainfall averages between 50 and 60 inches a year.

The off-atolls on which work was performed are similar in topography and climatology to those of Eniwetok and Bikini Atolls with the exception of the island of Kusaie, Caroline Islands, which is primarily composed of basalt and rises to heights above sea level of better than 2,000 feet. The water area of these atolls

ATOLL	LATITUDE DEGREES	LONGITUDE, DEGREES	APPROXIMATE NAUTICAL MILES FROM ENIWETOK	APPROXIMATE DIRECTION FROM ENIWETOK
Bikini Atoll	11 - 35'N	165 - 25'E	189	E
Kapingamarangi	0 - 56'N	154 - 46'E	780	SW
Kusaie	5 - 20'N	163 - 01'E	390	S
Tarawa	1 - 21'N	172 - 56'E	925	SE
Rongerik	11 - 30'N	167 - 30'E	300	E
Ujelang	9 - 46'N	161 - 00'E	132	SW
Wotho	10 - 00'N	166 - 01'E	235	E
Utirik	11 - 14'N	169 - 52'E	440	E
Majuro	7 - 10'N	171 - 20'E	605	SE

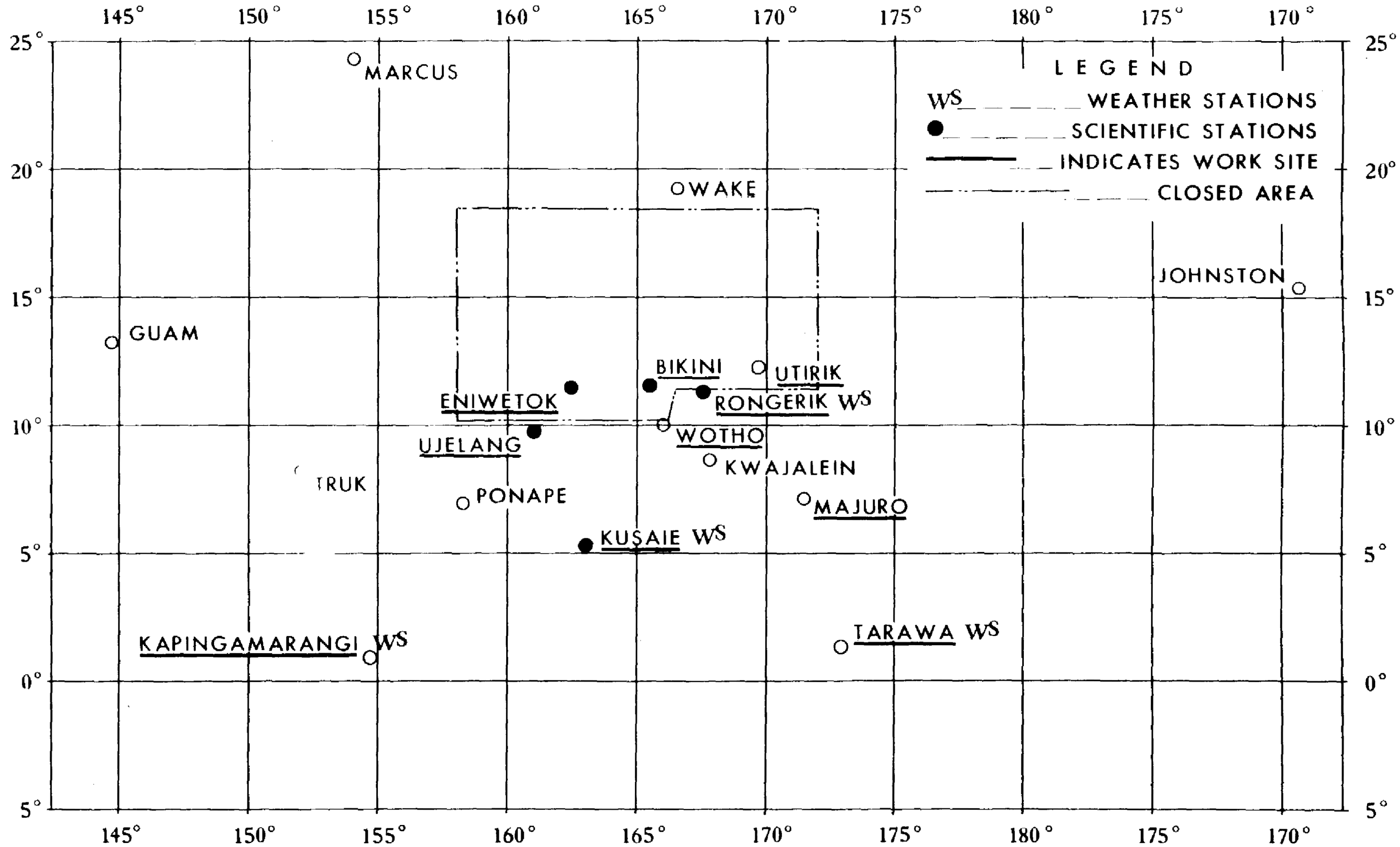


Chart 1-1. Sphere of Operations

were not well charted; the depths were irregular, thereby making boat operations hazardous. Information on the condition of beaches for landing LST-type craft was particularly lacking. Reconnaissance in advance of each mission was necessary to determine how and where construction materials could be landed. Masters of the supporting vessels had to exercise extreme caution in navigating these waters and in landing construction materials. Air support for emergencies and mail during the construction phase was by seaplane; the only available airfield on Tarawa was at too great a distance from the construction site on this atoll to be used to advantage. During the operational phase, the off-atoll projects were supported by both land and seaplanes.

COSTS.

The monthly accrual of the estimated and actual commitment of funds and actual expenditures are shown in Chart 1-2. The magnitude dollar-wise of the effort involved in REDWING from 1 July 1954 through 31 August 1956 is shown in the Program Costs, Table 1-1.

	F/Y 1955	F/Y 1956	2 MOS. F/Y 1957	TOTAL
Full Scale Weapons Test Expendable Test Facilities Pacific Proving Ground REDWING	2,478,130	18,726,183	367,155	21,571,468
Test Site Operations Pacific Proving Ground				
Maintenance of Proving Ground	5,179,231	5,893,021	882,306	11,954,558
Operations of P.G. Facilities (Net)	4,397,131	9,675,919	1,460,673	15,533,723
Scientific Support	890	454,435	91,682	547,007
Total Construction and Operations	12,055,382	34,749,558	2,801,816	49,606,756
Reimbursable Work (Credit)	(120,030)	(2,805,791)	(54,521)	(2,980,342)
Net Total Construction and Operations	11,935,352	31,943,767	2,747,295	46,626,414
Biology & Medicine	5,356	7,082	592	13,030
Total Operating Programs	11,940,708	31,950,849	2,747,887	46,639,444
Plant & Equipment Changes				
Construction	1,577,125	2,514,622	167,734	4,259,481
Equip. not Incl. in Construction Projects	330,178	363,278	2,382	695,838
Total P&E Program	1,907,303	2,877,900	170,116	4,955,319
Total Program Cost	13,848,011	34,828,749	2,918,003	51,594,763

Table 1-1. Program Costs

PROGRAMING.

The engineering-construction tasks connected with test facilities for REDWING, when first outlined to the Contractor in March and April 1955, were delineated only in broad terms. The missing factors had to be anticipated and evaluated in order that a realistic approach to the problems involved could be made. From the experience gained through planning and executing the tasks involved in three previous Test Operations, evaluations were made of manpower, plant, equipment, materials, and camp and other services. With these factors established, a budget analysis was made and a forecast of funds required was furnished the Atomic Energy Commission. As the scope of work and criteria became more clearly defined, the entire construction program was projected on an Estimated Operations Schedule, which programed each item of work from design through procurement, to the completed structure ready for occupancy.

The manpower forecasts were developed to provide for a build-up of Jobsite personnel in phase with the planned availability of working drawings and materials, and within budgetary limitations. The original forecast, based on con-

Figure 1-3. Lele Harbor - Kusaie

struction requirements similar to CASTLE, provided for a gradual build-up to a peak of approximately 1,970 men. This peak was to be reached during February 1956 when the scientific construction program was anticipated to be at maximum activity. Mobilization proceeded on this basis in the early stages. As construction requirements expanded in scope and area, forecasts of manpower were increased accordingly. The build-up in personnel is shown on Chart 1 - 3; the peak of H&N employment at Jobsite, 2,717 individuals, was reached on 30 May 1956.

Because of a concentration of the work load during the latter months of the construction phase of REDWING, shortages arose in certain classifications of personnel and considerable overtime was necessary. Due to the long processing period required for security clearances and the short period of probable employment, it was impracticable to recruit the additional personnel required to eliminate the overtime.

Replacement of construction and other equipment at the Proving Ground was accomplished in accordance with a long range program which was based on anticipated useful life of the equipment. The replacement items and such additions as were considered essential for REDWING were included in budget estimates. The development of the scientific program, necessitating simultaneous construction of many items within a limited time and the widening of the sphere of operations, called for careful evaluation of additional equipment needs and necessitated exact planning for utilizing available equipment. The need for certain additional items became urgent; as funds were available, these items were quickly acquired.

Budget estimates were prepared for use by AEC offices in preparing a Financial Plan. The budget estimates were so formulated as to agree in all details with the Contractor's Chart of Accounts. Cost estimates, prepared when few details were known, were based on cost estimates of similar items during previous test periods. A Mid-Year Review reflected changes in the budget estimates and/or the Financial Plan.

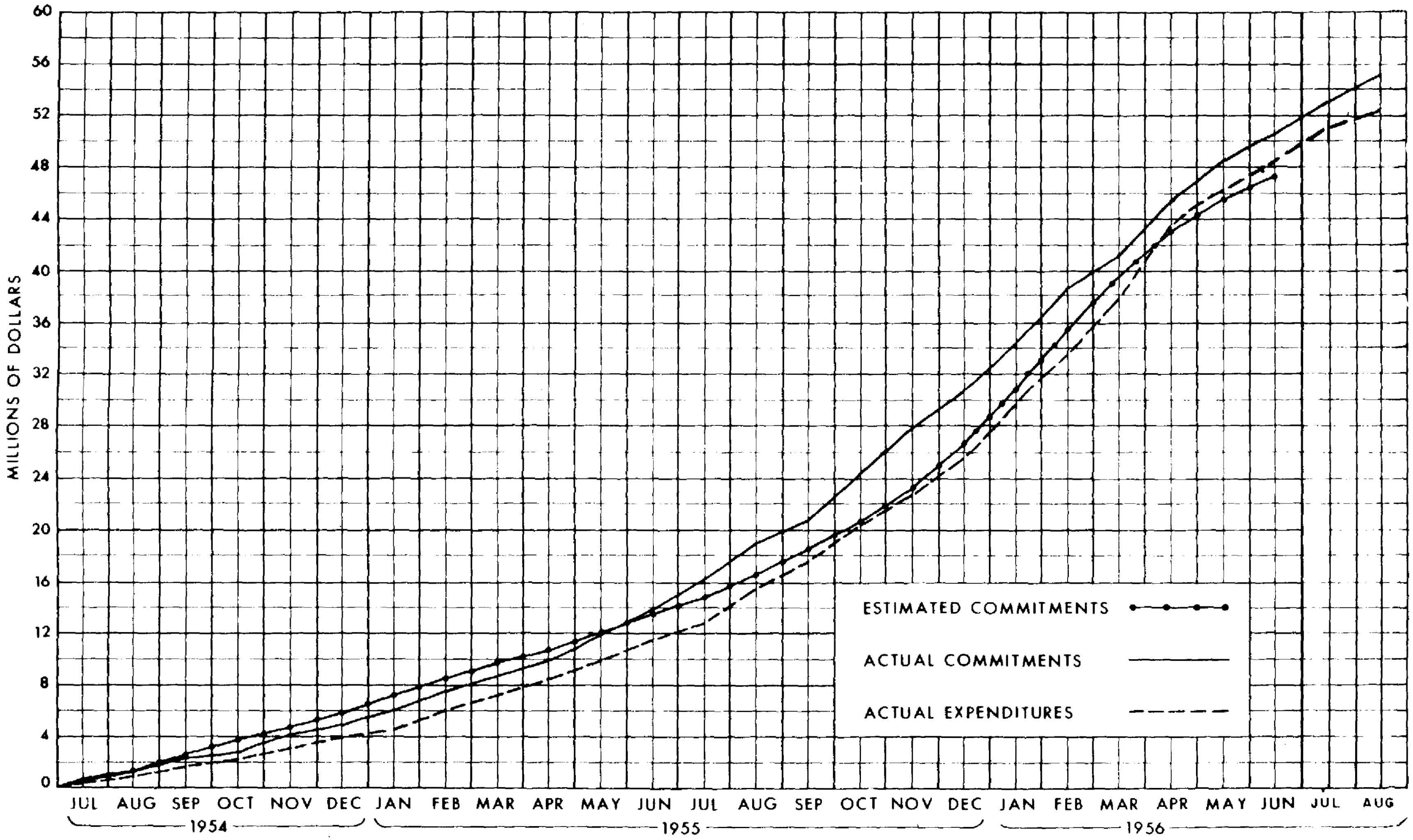


Chart 1-2. Expenditures and Committments

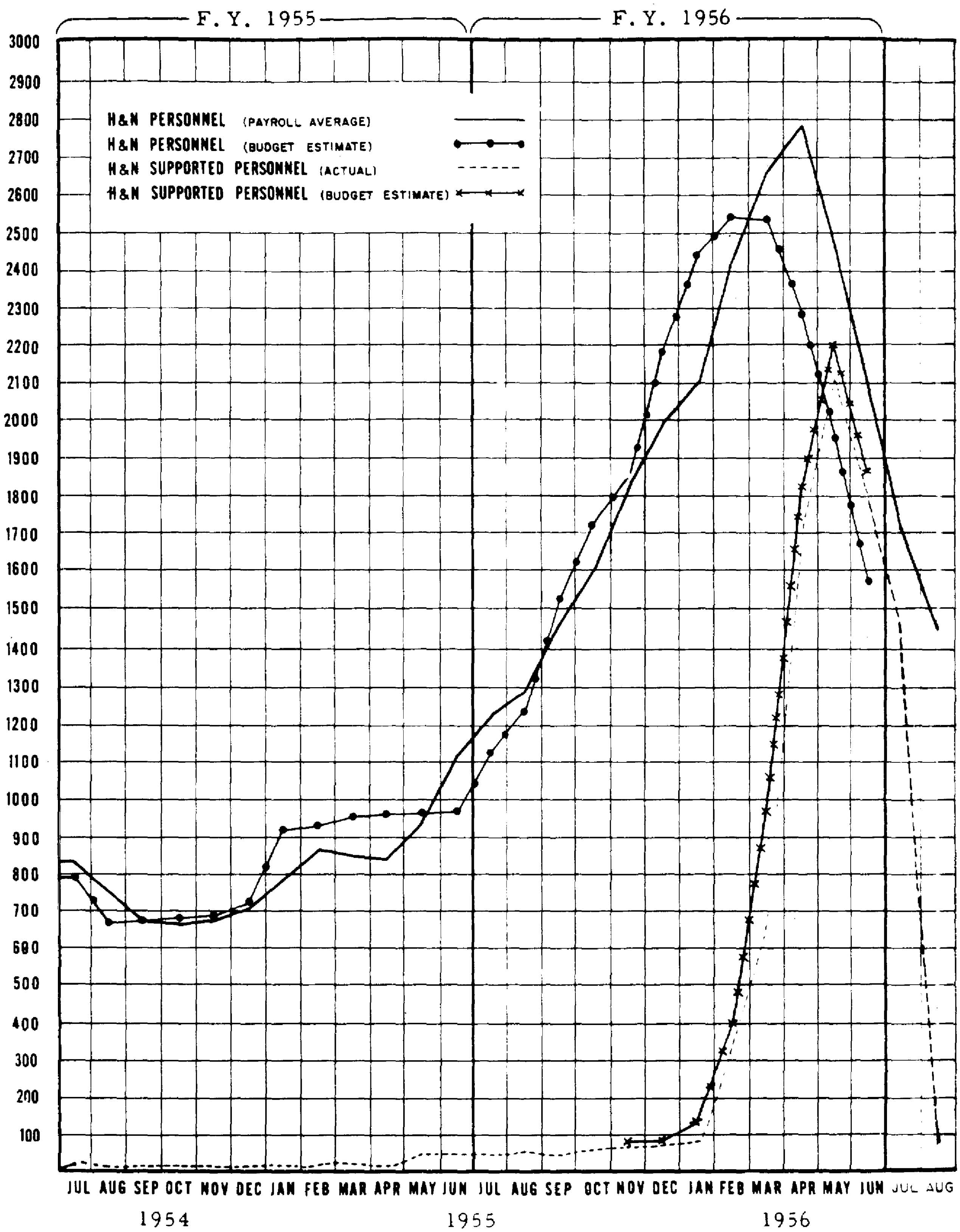


Chart 1-3. Jobsite Personnel Chart

A system of advance material estimates made it possible to initiate procurement of selected materials and equipment at an early stage in the Operation. Construction items of common usage were purchased and shipped to Jobsite as stockpile or warehouse stock. This was accomplished before the completion of, and in many cases before the start of, working drawings. Quantities were determined on the basis of previous usage of similar construction items. As drawings were released, the material-take-off and bills of material provided for the allocation of available materials to specific construction.

The Estimated Operations Schedule for test facilities was first issued on 14 July 1955. Criteria were not firm at this time but a realistic attempt was made to schedule a date when they would be available and the engineering completed. The schedule for procurement was based on anticipated design, experience and judgement. The construction period was determined on the basis of the estimated productive labor required, along with the dates anticipated for release of drawings and receipt of materials. For the effective follow-up of this schedule, key information concerning status of design, material deliveries, and construction progress was closely watched in order to ascertain which critical items required special handling.

To incorporate the latest changes in weapon design or refinements in instrumentation into the test program, changes were made by scientific personnel in the number of events, methods of instrumentation, location of stations, and shot sequence. As a result, firm criteria were not received as early as anticipated. Each addition or change had to be adapted to site planning or other possible conflicting objectives. To cope with changing scientific requirements, the Operations Schedule had to be reviewed periodically and revised so that it reflected the latest information regarding the various aspects of design, procurement, and construction. Round-table discussions between representatives of the Contractor, AEC, and other agencies involved were most beneficial in resolving relevant problems. At a discussion held in Albuquerque on 19 September 1955, the latest revision of this Schedule was reviewed. At that time the design for the UCRL program appeared well advanced; however, little of the criteria for the LASL and DOD programs had been firmed with the result that this design was only 10% complete. Because of the great number of revisions and additions to design criteria in September and October 1955, it was necessary to revise this schedule accordingly. On 4 November 1955, this latest schedule was reviewed in the Contractor's Home Office with the Deputy Director, Test Division, and representatives of the scientific laboratories. This revised schedule indicated that the completion dates requested for several stations could not be met. These completion dates were re-scheduled, and it was later determined that the test programs could be adjusted to accommodate these revised dates.

At this period in the Operation the shot-island camps and other temporary base facilities were practically complete, but little construction progress had been made on the scientific structures program and on 15 October only two per cent completion could be reported. However, design drawings had just been previously released for the construction of three small islands on the Dog-Charlie reef, two causeways and an island off Yvonne, and an island causeway off Sally. With the further release of many drawings in November and December 1955, construction activities on scientific test facilities increased rapidly.

The situation with respect to the possibility of completing many of the scientific stations, particularly on Yvonne for the first event, became extremely critical by November 1955. To evaluate the prospect thoroughly, a conference was held at Eniwetok early in December, during which the Director, Division of Military Application, AEC; Director, J Division, LASL; Deputy Director, Test Division, AEC; and Manager, Construction Division, H&N, visited all construction sites and re-evaluated procurement and construction schedules with the result that it appeared impossible to meet the schedules last established. Although there were incipient shortages in certain labor classifications, the problem of material delivery was paramount and could not be solved under the hitherto allocated air and surface lift.

At this time both the Director, DMA and Director, J Division, stressed the compelling importance of making every practicable effort to meet the required operational readiness dates through the expediting of engineering, procurement, and construction, to the extent of all necessary overtime, premium pay to vendors for faster delivery of fabricated materials and equipment, procurement of materials and equipment on an "off-the-shelf" basis wherever they could be located, and the airlift of any items capable of being airlifted if such was required to meet construction schedules. In turn, AEC and CJTF SEVEN would do everything in their power to obtain extra airlift, and surface lift as required. The Director, J Division, agreed to delay, wherever possible, the station occupancy for setting up and checking out the instrumentation. These principles were confirmed and re-emphasized in a letter dated 22 December 1955 from the Manager, SFOO. In the subsequent months, airlift tonnage was greatly increased and the frequency of ship sailings was stepped up. Considerable credit is due the Transportation Section, JTF-7, for its success in obtaining additional, unallocated lift; the cooperation of all parties to the agreement led to the success in meeting operational dates.

SIGNIFICANT ENGINEERING-CONSTRUCTION.

The major items of construction requiring careful scheduling were as follows:

(1) Shot-island camps.

(2) Permanent base structures.

(3) Large concrete test structures.

(4) Steel shot towers.

(5) Vacuum pipe arrays.

(6) Man-made islands and causeways.

(7) Communication installations.

Because construction of shot-island camps was to be simple and inexpensive in view of their intended short use, and since standard designs for most of the expendable buildings were available, the responsibility for the design of these camps was delegated to the Field Engineering Force. This permitted the efforts of the Home Office Engineering Staff to be directed toward close liaison with the scientific agencies and the design of complex scientific structures. Early in the Operation, the Contractor had been authorized to station representatives at both LASL and UCRL to assist in expediting design criteria.

The engineering necessary for the shot-island camps 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 landing facilities could be provided with a minimum of cost, channel excavation, and 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 recreation, medical and communication facilities were provided. Each camp was provided with an area for landing helicopters and/or L-20 type aircraft and facilities for handling materials and personnel from small marine craft. Because Elmer and Nan, the main bases of operations for their respective Atolls, were provided with considerable warehouse space, only limited warehousing for receiving materials was provided at the shot-island camps.

The construction of the shot-island camps was fairly routine. The procedures and techniques for this type of work had been well established through the years of previous experience at the Proving Ground. Prefabrication at established bases was used extensively for building trusses, wall panels, and assemblies of plumbing items. From the initial undertaking in April 1955 until late October, at which time test facility drawings began arriving at the Jobsite, the construction effort could be directed towards completing these camps as scheduled. Men and equipment were adequate during this period, and schedules, with few exceptions, were essentially met. Shortages of certain construction items in the electrical and plumbing fields prevented 100 per cent completion of a few projects as scheduled, but in all cases the buildings or facilities were ready when needed for operational requirements.

Most of the construction of the permanent base (P&E) projects included in the Fiscal Year 1955 Budget was accomplished without unusual incident during the interim period following CASTLE. In order that those projects which were urgently required for REDWING and initially included in the FY 1956 Budget could be completed in time, it was necessary that material procurement be started as early after 1 July 1955 as possible. Therefore, authority was granted the Contractor on 25 May 1955 to perform advance planning and design so that the necessary approvals from User Agencies could be obtained and purchase orders awarded as early as possible. Preliminary estimates and requisitions for building materials were prepared in June 1955. Funds were made available, and purchase orders for building materials were awarded on 11 August 1955. Approval for site grading and concrete foundations for some of the buildings were received in advance of the approval of completed design, and this preliminary work was undertaken. The approval of the complete designs was received in late September and in early October. About this time it became evident that, due to the expanding test program and the resulting increase in participating personnel, additional billeting facilities and other miscellaneous items beyond those originally contemplated for Elmer would be necessary, and these were then authorized. Though unavoidable under the budgeting program and design approval process, the construction of permanent base projects beginning in late 1955 presented a real problem. Planning of this work anticipated that these projects could be integrated into the over-all construction program and would be accomplished concurrently with scientific structures. Due to the urgency that developed for the construction of these scientific structures, it became necessary to shift men and equipment to this work and to defer those permanent base projects that were not vital to the REDWING Operation. Therefore, the over-all progress attained on these projects was not generally in phase with the predicted progress.

Figure 1-4. Typical Shot - Island Camp

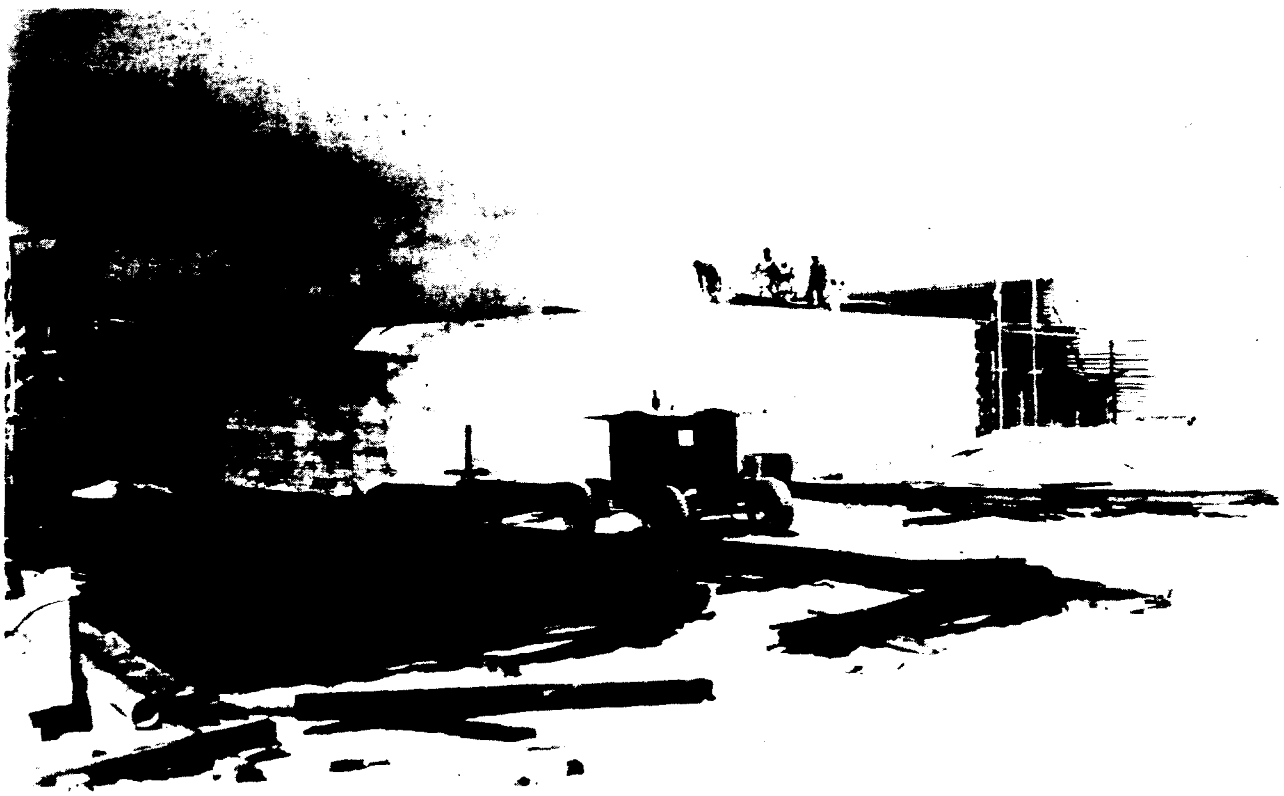


Figure 1-5. Largest Concrete Structure - Station 1310 Under Construction

Exploration was made early in the program to determine suitable sources of coral aggregate, and from samples tested by the Field Engineering Test Laboratory, possible reef locations were selected. As the program developed, estimates were made of the yardage of aggregate anticipated for the various areas and schedules were established for quarry and crusher operations. The quarry operations were governed by the normal difficulties encountered in subaqueous excavations. Frequent shutdowns occurred because of high tides and wave action. The use of wagon drills and compressors mounted on trailers permitted drilling at a much higher tide level than would have been possible if the standard wheel-mounted wagon drills had been used. To ensure maximum production with a minimum of operational interference-and as an added safety factor-all blasting was performed after regular working hours. Stockpiling of aggregate was both logical and economical. For areas requiring quantities of less than 1,000 cubic yards, aggregate was provided from the stockpiles at main production plants. Main batch plant locations were determined by the quantity of concrete required at each site; these plants were established at Elmer, Fred, Yvonne, Ursula, Gene and Janet in Eniwetok Atoll, and at Nan, Tare, Fox and Charlie in Bikini Atoll. Concrete was delivered to the construction sites in transit-mix trucks. Small concrete requirements, such as for anchor blocks and small instrument mounts, were precast at Elmer or Nan or were poured from small mixers. The amount of concrete poured monthly is shown in Figure 2-25, Chapter II. From 1 July 1954 through 1 May 1956, when concrete pouring for scientific structures was practically at an end, 210,000 sacks of cement and 2,757 tons of reinforcing steel had been used.

The shot towers were designed to permit prefabrication of steel components in 25-foot modules and erection on the basis of 100-foot increments to a maximum of 300 feet. This provided for the 200-and 300-foot towers in one design, and simplified steel erection. To assure the proper matching of appropriate parts, a 75-foot section of a typical tower was first erected from parts selected at random by a Contractor's inspector at the fabricator's plant. Because of the time element involved, the drawings of the tower and guy anchor footings were released prior to approval of the completed tower design. The site location of some towers required that several guy anchor blocks be located on reefs. In such cases a pile foundation was mandatory. This work, and the pouring of the concrete anchor blocks, was scheduled in accordance with tidal conditions and measures had to be taken to prevent loss of cement through wave action. The early release of drawings for the footings permitted steel erection to be undertaken immediately upon receipt of the steel components. Completion of the construction of the towers for Stations 5, 6, and 7 was held in abeyance until after the firing of the first shot due to the probability of damage. The tower and guy anchor blocks were provided for these towers, and Station 5 was built to the 75-foot level. After the first event, Station 5 was deleted from the program and construction of Stations 6 and 7 was completed on schedule - though under rigid Rad-Safe control because of the widespread radioactive contamination of the area from the first event.

The problems resulting from the tight construction schedule are well illustrated by those that arose in the procurement of materials for, and in the installation of, the pipe arrays. In the very beginning, procurement difficulties were encountered in obtaining pipe on acceptable delivery dates. After considerable canvassing of steel mills, pipe was found with acceptable delivery dates but a decision had to be made to accept certain sizes which were not in rigid accordance with the specifications but were considered usable. Materials for the support system were late in arriving and substitution of available materials and fabrication at the Jobsite made it possible to maintain progress on this phase without a serious loss of time. Many of the components of the alignment system had to be rushed by air, and there was one case of jettisoning of urgently needed items by a plane in distress. An exceptionally high degree of cleanliness and freedom from rust in the interior of the pipe was required. Special measures taken before overseas shipment to ensure this cleanliness and rust freeness, accomplished during the period of record rainfall in California, proved inadequate and processing of the pipes had to be repeated at Jobsite. To accomplish this, it was necessary to airlift 12 tons of grit. Improvisations and repairs had to be effected at the Jobsite to the project-furnished vacuum pumps to make them operable. Last-minute revisions in the location of a few pipes were required. By concentrating the available competent craftsmen, using overtime and shift work, and with the acquisition of additional welding equipment on a loan basis from Military Agencies at Kwajalein and Eniwetok, the pipe arrays were readied in time, and were integrated into the test program without adjustment.

The island of Yvonne, approximately 8,700 feet long with an average width of 550 feet, was the site of 191 scientific stations. Complexity was introduced by locating so many stations in such a small area, and by the multiplicity of the changes in location and requirements for the stations and the late dates at which these were received. Many of the stations had to be completed as scheduled since they were vitally required for the first test. Continuous surveillance of all factors affecting construction was essential to check possible delays. The availability of drawings, materials, manpower in required categories, special equipment, and the movement of the materials to and within the site had to be closely watched in order to assure orderly construction and the progress required. Sacrifices by scientific project personnel in shortening beneficial occupancy time, and in foregoing some pre-test preparations assisted materially in readying the stations for the first test as scheduled.

Extensive construction activities were required on reefs, which had to be accomplished with all the disadvantages inherent to working in sea water of varying depths. Man-made islands and causeways were among the major items of this type of construction. The design of these called for construction of bulkheads of three-inch timber supported on 60-pound rails driven on five-foot centers; the backfill was of available beach sand and reef coral. Tidal conditions had to be watched closely and frequent shutdowns were necessary. The equipment had to be serviced frequently, and at the end of each working day, all oil cases had to be drained, flushed, and refilled. Men tired quickly, and even with the most thorough preventive maintenance measures salt water action seriously impaired the life of equipment. Weather was an important element. In December 1955, the Proving Ground was subject to especially high seas, which periodically occur in this area. These high seas caused some damage to the construction-in-place of the man-made islands and causeways. This occurred during the period in which the over-all construction schedule was extremely tight. Extraordinary action was taken to speed the flow of personnel to the Jobsite; the damage was repaired and the temporary setback in construction was overcome without a serious effect on the over-all progress.

Experience during previous test operations indicated that the communication facilities for the PPG-ZI system had to be modified and expanded. Expansion of the electrical and other facilities at Fred had increased the interference noise level at that site to such an extent that it reduced the reliability of the receiving operations; also, the locations for new buildings were limited; most critical of all was the lack of area for antenna fields. This led to the selection of David for the location of a new Joint AEC-Military Radio Receiving Station with camp facilities to support operating personnel. With the movement of receiving activities to David, considerable expansion of the transmitting facilities that remained on Fred could be effected.

In conjunction with AEC communication personnel, a series of path proving tests were conducted which determined the feasibility of VHF radio transmission between Eniwetok and Bikini Atolls. Thereafter, for the primary radio link between these Atolls, a multiple channel VHF system was designed with the terminals at Elmer, Nan and in the USS Curtiss and USNS Ainsworth. Joint Task Force SEVEN arranged for the loan of AN-TRC-24 multichannel radio equipment for use in this system, and the antennas and other appurtenances were obtained by purchase. A change in frequency assignments necessitated the redesign of two of the four antennas being manufactured. As a result, delivery of the antennas was delayed three weeks and the system was not activated until 28 April 1956. Prior to this activation, the existing HF telephone channel became overloaded and delays as long as three hours were experienced in completing calls. However, few difficulties were experienced after the activation of the VHF system, which was adequate in all respects and very effective in providing a reliable interatoll communication system.

In planning the submarine cable systems, a complete survey of existing cables was made early in the program. Preliminary estimates of requirements were made, which included the replacement of faulty cables and the estimated cable for additional circuits. Approximately one-half million feet of cable and necessary splice boxes were initially ordered; additional quantities were ordered as requirements became firm, and a total of 814,000 feet was eventually laid in both Atolls. The laying of this cable was accomplished without unusual incident. However there were various incidents of damage to cables by ships' anchors; the entire system between Elmer and David, and three telephone and three signal systems off Elmer were disrupted because of damage by ships.

LOGISTICS.

A large volume of equipment and materials had to be procured and shipped in a limited time. The normal procurement and shipping time of material from the States and particularly of fabricated equipment or specially designed assemblies was three to four months. These lead times had to be drastically shortened as success in meeting desired completion dates depended considerably on the movement of material at an accelerated rate. This had to be accomplished in a stringent material and equipment market during a period in which demands from both industry and the consumer were the greatest in the history of the nation. Aggravating these market conditions were prolonged strikes in key manufacturing plants, plus abnormal weather conditions affecting both manufacturing facilities and transcontinental shipping. In view of these conditions, it was necessary to plan for and take unusual action in all phases of the supply process. Where practi-

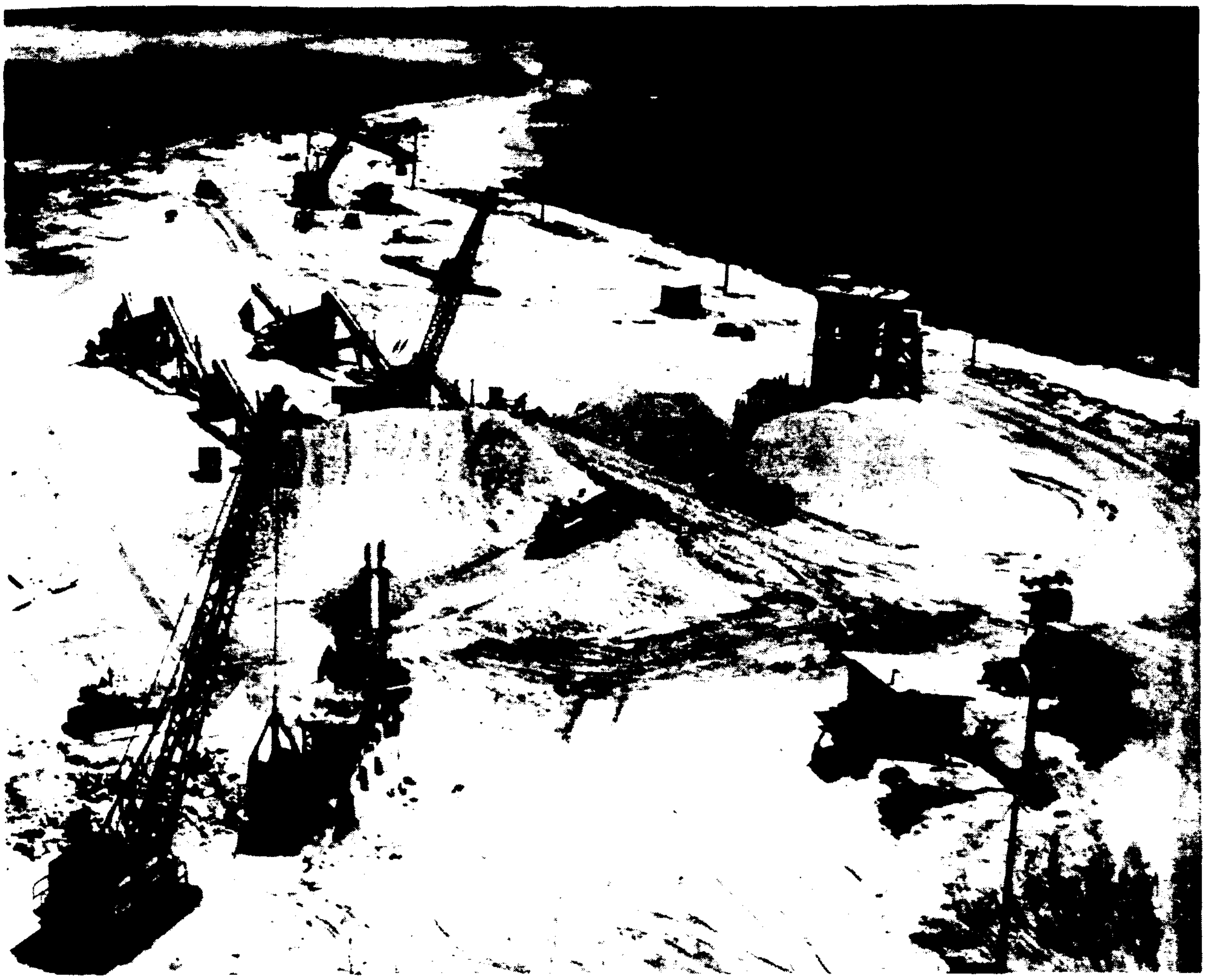


Figure 1-6. Aggregate and Batch Plant - Elmer

cable, bills of material were prepared from design criteria or preliminary drawings. Vendors were canvassed in advance of requisitioning to determine where materials were available. In certain critical cases, premium prices were paid for quick delivery. Splitting of orders was resorted to when this speeded delivery. Vendors who could be depended upon to keep promises of delivery had to be located and persuaded to bid. This generally led to high grade firms who already had heavy backlogs of orders. To break into these backlogs and obtain precedence in delivery, firms had to convinced of the importance of the order. Many fabricators willingly set aside their normal production schedules and made men and materials available for the desired work when informed that the work was of high priority for the Atomic Energy Commission. The priority section of the Supply Office of ALOO assisted considerably through Defense Order Priorities. These procedures, combined with close surveillance by inspectors of the fabrication of critical items, and expediting the movement of these items at all points, made it possible to substantially decrease normal delivery time.

All materials for transshipment to the PPG by surface vessels were delivered to the NSC Oakland, California, where they were manifested and held for loading on vessels under command of the Western Sea Frontier. Task Force standard procedures required that estimates of cargo for shipment be made four months in advance. Space was then allocated aboard the vessels according to the amount of material to be shipped by each agency involved in the Operation. Schedules originally were established to provide all needed surface transport by having one cargo vessel approximately once a month. The increased scope of work and the need for accelerated delivery of construction materials called for more frequent sailings as there was more cargo to be shipped than originally anticipated, and there was a recurrent need to ship certain items as early as possible. A revised schedule was then effected for the period of peak shipping which provided more frequent sailing. Contractor representatives were stationed at NSC to check and supervise all incoming cargo and to coordinate all outgoing cargo with the JTF-7 Transportation Liaison Officer. Even though a close working relationship existed, certain difficulties developed, which were unanticipated and which, because of the crash nature of the construction program, resulted in serious dislocations in the orderly progress of construction. The loading and departure times of vessels were subject to changes, and there were instances of urgently needed cargo deferred to later carriers. The availability of certain materials and equipment became the vital factor in on-site construction scheduling.

Overseas air transportation was provided by the Military Air Transport System with the on-continent terminal located at Travis Air Force Base. With the need for accelerated delivery of materials, a considerable amount of cargo had to be diverted from surface to air transportation. The only items airshipped were those the urgency of which was so great that to hold them for surface transportation would seriously affect construction schedules. Initially, space requirements were estimated four months in advance as required by Task Force Operating Procedures. However, as the amount of cargo that became critical kept increasing, the estimates for space had to be changed to a month-to-month basis. The demands on MATS from all agencies in the operation became heavy and subject to radical variations. During September, October, and November 1955, the Contractor's cargo could not be lifted in accordance with allocations, and backlogs of urgently needed cargo developed. In late December the condi-

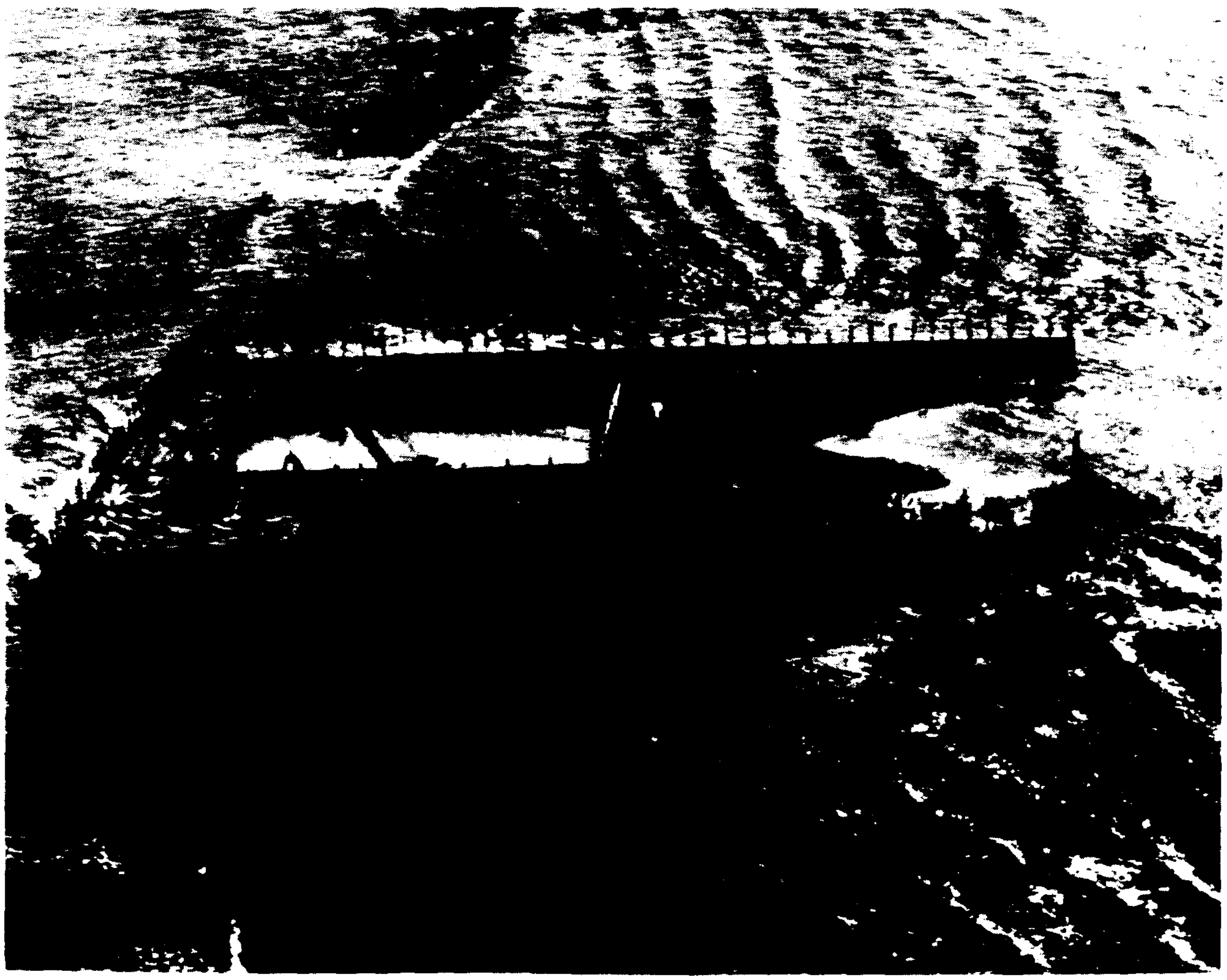


Figure 1-7. Man-Made Island Under Construction at High Tide

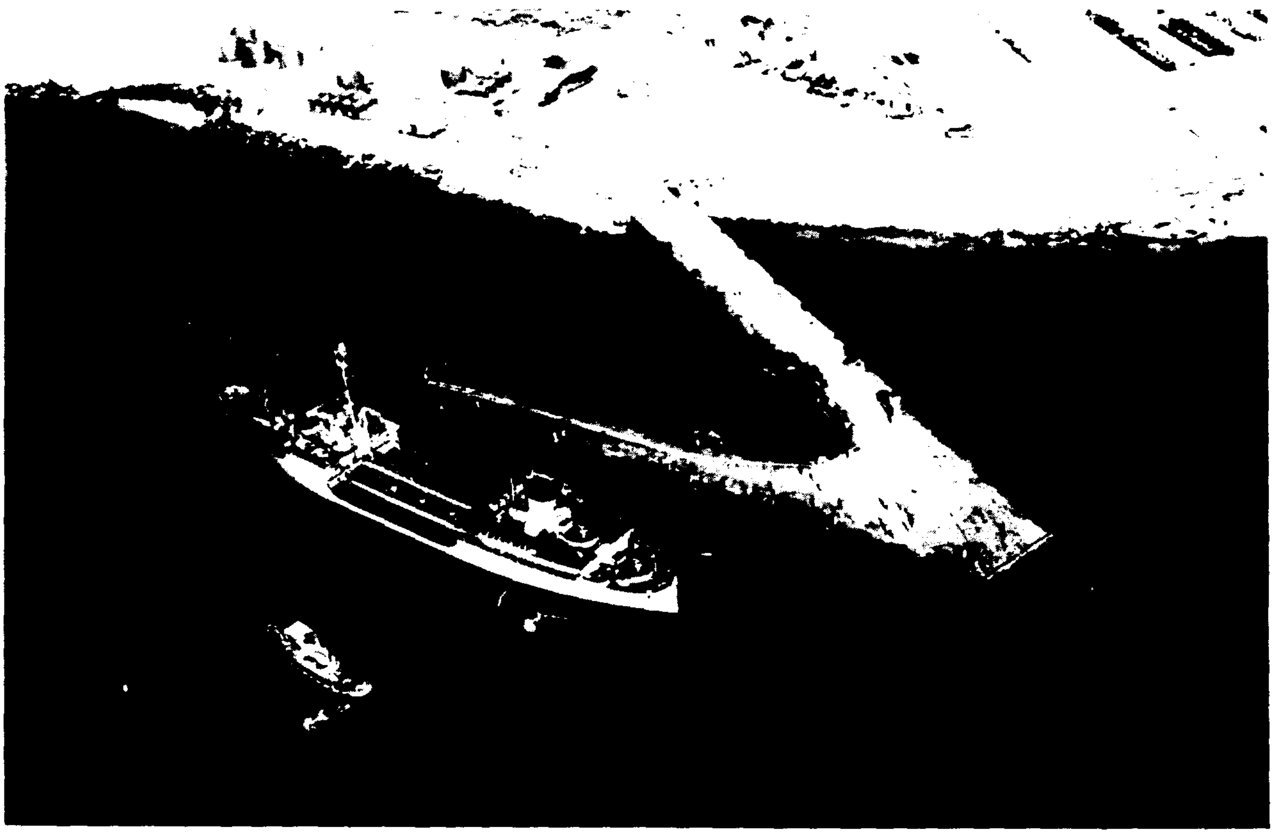


Figure 1-8. Tanker Approaching Deep Water Pier - Elmer

tion worsened. As MATS capabilities for breaking the jam in cargo could not be clearly determined, an investigation was made as to availability of commercial charter planes, with the thought that these might be used as an emergency means of reducing the backlog. This was found feasible, but as the military facilities were thereafter augmented rapidly, the charter planes were not needed. The allocation of space for emergency airlift of heavy tonnages of Contractor's cargo (318 tons during February, March and April 1956) was an important factor in meeting construction schedules and successfully completing Operation REDWING.

Organizing the scientific test structures construction program required a considerable amount of on-site logistic planning because of the large area over which construction activities were conducted. In order to use as few men as possible and to avoid duplication of facilities, all materials and equipment were first received in the Elmer central warehousing and accounting facilities and then transshipped to the more limited facilities set up in Bikini Atoll. The full-time assignment of one LST and the part-time assignment of a second permitted establishing a shuttle service between Bikini and Eniwetok Atolls for the primary means of transporting equipment and materials. In each atoll, materials were transshipped to construction sites in small marine craft operated by the Contractor. For construction at miscellaneous sites away from established camps, boat schedules often had to be arranged in accordance with prevailing tidal conditions. This movement of material from its original point of receipt at Elmer to its final location was always critical due to the tight construction schedule.

On 7 March 1955, the Atomic Energy Commission, in response to requests from the High Commissioner of the U. S. Trust Territories for aid to the ex-Bikini people, authorized the construction of a small camp at Jaluit Atoll and radio stations for Jaluit, Majuro and Kili. Because of inclement weather and resulting unfavorable conditions for landing construction materials for the Kili project, it was deleted from the program. For the support of REDWING, weather stations were authorized in September 1955 for construction on Kapingamarangi, Kusaie, Rongerik, and Tarawa. This construction was scheduled in two phases: the structures and facilities were provided in the first phase, and the equipment was installed in the second phase. Construction of the first phase of these projects was nearing completion in December 1955 when requirements for off-atoll scientific projects became firm. These pro-

Figure 1-9. Unloading LST During Beachhead Phase - Nan

jects required minor construction on the island of Kusaie and the atolls of Rongerik, Utirik, Ujelang, and Wotho. The problems encountered with this off-atoll construction were primarily logistical because of the distances of the sites from the base of operations and the difficulty of landing materials and equipment at construction sites.

Reconnaissance of each site determined the craft most suitable for each mission. Thus it was established that the Kapingamarangi, Utirik, and Wotho projects could best be served by an LSD carrying LCUs-(one outfitted as a houseboat) and that all other sites could be served by an LST. However, extreme caution had to be exercised by the masters of the LST's in beaching because of existing conditions. Schedules for the supporting vessels were first established for weather station projects. With the firming of scientific project requirements, schedule rearrangements were effected so that work remaining on weather stations could be undertaken at the same time as that of scientific projects. Initially, certain difficulties were experienced due to the rigidity of the schedules established. These difficulties were satisfactorily resolved by coordinating the departure of each mission with the arrival of project operating personnel and User-furnished equipment at the Proving Ground. Mail and emergency needs for each mission were provided by sea and land planes; land planes were used only for Tarawa and Majuro missions, at which sites suitable landing fields were available. The completion of certain stations was required in advance of the first test and work had to be accomplished during the period in which construction of the major stations at the Proving Ground was in full swing and, therefore, when a minimum of men and equipment could be spared.

MANAGEMENT AND ADMINISTRATION.

The Contract was a Cost Plus Fixed Fee, Architect - Engineer - Construction - Management contract with the Atomic Energy Commission (AEC), administered by the Manager, Albuquerque Operations Office through the Deputy Director, Test Division. Within the framework of this contract, the AEC had wide latitude to change the scope of work or services to be performed by the Contractor, and at the same time, to protect all the rights and interests of the Government insofar as control of expenditure of funds is concerned. This contract, which was originally executed to provide for the IVY Operation, was first modified and extended for CASTLE and subsequently for REDWING. In general, modifications to the contract represented a continuation of the Holmes & Narver responsibility for engineering, construction, operation, and maintenance of the facilities at the Pacific Proving Ground. The centralization of authority and responsibility for all features of the project permitted simultaneous action on architect-engineering services, procurement of construction equipment and materials, recruiting and processing of manpower, and various elements required for planning a complex operation against a rigid end date.

The Holmes & Narver organizational structure is illustrated in Charts 3-1 and 3-2 Chapter III. This organization provided for the executive and administrative control of all related functions assigned under this contract. The administrative relationships of organizational units were further clarified by a standard system of Home Office and Jobsite procedures and bulletins. These outlined procedures or methods and delegated authority. Of particular importance in this respect, in view of the fact that the responsibility for both engineering and construction resided in one organization, was the necessity of making certain that the engineering service - including inspection of construction, progress reporting and related functions - was effective.

Organizational changes to existing structures evolved from experience and from the assignment of additional functional responsibilities with respect to Proving Ground activities. A significant change effected to strengthen the over-all organization after completion of the CASTLE Operation, established the Pacific Proving Ground as a self-contained unit within the H&N organization under a Project Manager. This change consolidated into one administrative unit all the elements necessary to service completely the requirements of this project and thereby facilitated the manner in which the Home Office participated in the overseas work. The solution of problems encountered in previous operations led to the assignment of the responsibilities for photography, pass and badge office, stevedoring, radiological safety, and communications. To administer these added responsibilities, a regrouping and reassignment of divisional duties of the Jobsite organization was effected and a new Administration Division was established.

Each succeeding Operation develops different characteristics than its predecessor and new problems must be analyzed and resolved. As in previous operations, difficulties were overcome by maintaining close liaison with the representatives of the Commission and the other agencies involved in the Operation. Frequent meetings held at Albuquerque, Los Angeles, and Jobsite, for the purpose of frankly discussing problems and plans, were most beneficial towards effecting a mutual understanding of problems and contributed to a good working relationship.

A separate set of accounting records was maintained in accordance with generally accepted principles and directives issued by the Atomic Energy Commission. Procedures were improved to provide the Contractor and the AEC with more effective control over funds, property, and other assets. A Chart of Accounts was the basis for the recording and reporting of costs and also provided a uniform method of identifying all drawings and/or documents issued or used for authorized work. Since a common account number (identification number) was used on all documents pertaining to a specified item of work, immediate identification, simplified control.

Cost estimates were submitted to the Atomic Energy Commission for each item of work proposed. From these estimates, manpower, plant, equipment, and material requirements were formulated. Physical progress for each item of construction was reported weekly. From these reports, progress charts containing separate bars for the various increments of the project were prepared monthly to indicate predicted and actual progress. A composite curve was then derived from the weighted progress of all items. The progress charts were included in a historical Monthly Narrative Report which covered all features of the project.

The advance scheduling of all expendable construction and the ensuing progress reporting proved to be effective. The follow - up of schedules and the need for revisions were determined from key information assembled in the Home Office Operations Department. This office acted as a clearing house between the Jobsite and Home Office activities on all operation and construction matters. Essential data regarding scheduled and actual progress were closely watched and, where necessary, priorities were established for design, procurement, and/or shipping space. The Chief of Operations kept the Project Manager informed of developments, thereby ensuring the necessary on-continent services including liaison with the offices of the AEC or other agencies. Periodically all data were reviewed by the Project Manager with his staff: necessary revisions were made and appropriate measures taken so that revised schedules could be met.

During the period from 1 July 1954 to 30 May 1956, there were 13,786 requisitions processed, containing 66,439 line items and 14,735 purchase orders awarded with a total value of $18,614,218.47. Within the procurement organization, provisions were made for purchasing these items in accordance with governmental policies for proper documentation, expediting, and traffic control. It was recognized that many intricate problems would arise in supplying such quantities of materials by virtue of the logistics involved. Procurement personnel were stationed at the on-continent freight terminals (NSC and Travis Air Base) to work in close relationship with the representatives of the shipping agencies and with the Transportation Liaison Officers of JTF-7. These representatives kept the Home Office informed on transportation developments. The Home Office determined priorities, expedited the movement of cargo to terminals, determined which cargo was to be shipped by air, and kept the ALOO informed as to transportation difficulties.

Subsequent to mid-1954, shipment of refrigerated cargo was made via commercial carrier to Honolulu, from which point the cargo was transshipped in naval vessels to the Proving Ground. The principal difficulties encountered with shipping in this manner, were related to sudden and unannounced changes in the schedules of commercial carriers. Conditions became so uncertain that a procedure for "sight buying" of perishable items was introduced. This procedure provided quality merchandise at low cost and kept food losses due to spoilage at a minimum during the long period between purchase and delivery at the Jobsite.

An inspection force directly under the Chief of Operations ensured that all materials, supplies, and equipment furnished were in accordance with the purchase order specifications, or that deviations from design specifications were acceptable to the Engineering or Operations Departments as applicable.

On 1 July 1955, Holmes & Narver was assigned the responsibility of conducting all stevedoring operations in the Proving Ground except on shore at David and Fred. The responsibility for the Port Operation with related activities remained vested in the Atoll Commander. The organization established for this function provided for four gangs. However, to meet the urgent demands for cargo from incoming vessels and to fulfill tight shipping schedules, it was necessary to augment the organization with an additional gang of men from the Construction-Maintenance Division during the period of peak activity. It was impracticable to provide personnel for more than one shift; therefore, considerable overtime was necessary.

For the period between CASTLE and REDWING, rehires of former employees provided most of the replacement personnel. Extensive recruiting for REDWING was initiated in April 1955 and general recruiting continued until March 1956, at which time advertising was discontinued. Throughout this period, the demand for labor was strong and expanding and shortages were encountered in engineering, estimating, clerical and other categories of personnel. Mobilization of personnel was accomplished through offices at Los Angeles and Honolulu, augmented by recruiting teams at San Francisco. Advertising was extended to practically all West Coast Metropolitan areas and to papers of the Midwest. Special trips were made to Mid-Western cities by recruiting personnel in search of specific skills. Processing of applicants for assignments to the Proving Ground required detailed work involving a pre-employment check of work history and medical records and included arrangements for immunization; processing for transportation including Government Travel Orders, and keeping Honolulu and Jobsite informed of personnel in travel status.

The analyses of wage trends, employment conditions, job descriptions and general labor policies were a continuing process, enabling the company to maintain wage rates, sound personnel practices, and employment conditions equivalent to those prevailing on-continent. It was imperative that all contingencies be provided for, in order to recruit the required personnel in the highly competitive labor market. The extraordinary requirements imposed by the personnel security program combined with the pre-employment check of each applicant's work and health histories, led towards the hiring of above average employees who could adjust themselves to conditions prevailing at the Proving Ground. Exceptionally gratifying was the high percentage of former employees who were rehired. The number of men who failed to complete their employment contracts was below the average of other overseas construction jobs. Considering the isolation of the project and the lack of normal community life, the small turnover in personnel was an outstanding achievement.

Throughout the period of the operation, the general health of all personnel was good and compared favorably with normal standards. The program for the promotion of the general welfare and health of the personnel took into

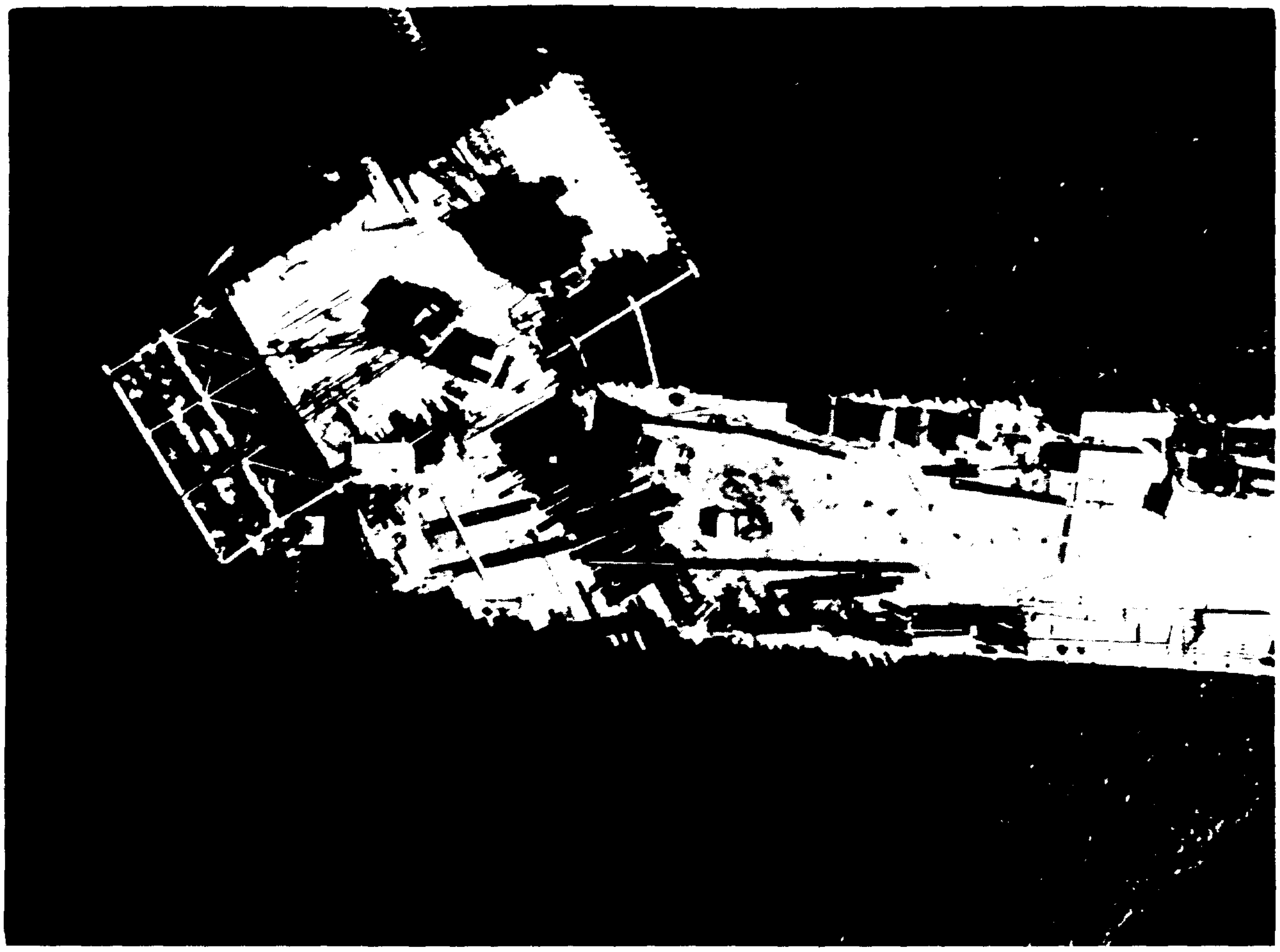


Figure 1-10. Deep Water Pier Under Construction - Elmer

account living conditions, the need for adequate medical and dental services, recreation facilities, insect and rodent control and other sanitary measures, and industrial and radiological safety.

Clarification of the administration of criminal jurisdiction at the Proving Ground was effected through discussions held by representatives of the Contractor and the AEC with Federal and Trust Territory Authorities. Procedures have been established to cover arrest, hearings, bail and confinement. Certain Contractor personnel were granted, as Deputy Sheriffs of the Trust Territories, police powers needed in connection with this administration.

Experience during previous operations indicated the need for more direct control by the Contractor over their employees in the matter of radiation exposure. As an outcome of this, the AEC assigned to Holmes & Narver the responsibility for the AEC-Contractor radiological safety at the Proving Ground. This was first assumed on 15 October 1955. The functions assigned the Contractor were photodosimetry, issuance and accountability of protective clothing and equipment, monitoring, and repair and calibration of instruments. The AEC Radiological Safety Officer retained policy direction for the Rad-Safe program. To provide qualified personnel to staff the Rad-Safe unit, a course of study and indoctrination was undertaken. The head of the Contractor's unit was sent to Fort McClellan, Alabama, and to Los Alamos, New Mexico, for a three weeks training course. Other personnel were trained on the job. This staff then conducted courses in monitoring, accredited 42 monitors for the REDWING Operation, and undertook the safety education of all supervisory personnel. With the arrival of TU-7 of TG 7.1 at the Proving Ground, the Contractor's unit was integrated on 15 April 1956 into this organization for operational purposes. The participation by Contractor personnel in the radiological safety activities during the operational phase of REDWING materially increased the effectiveness of the Contractor's safety program. The use of Contractor personnel provided more direct control in the matter of radiation exposure than was possible during previous operations.

When the Contractor assumed the responsibility for radiological safety at the Proving Ground, radioactivity levels were such as to require film badges to be worn by all personnel at most work sites in Bikini Atoll and a number of sites in Eniwetok Atoll. Rigid Rad-Safe control and decontamination by removal of four to eight inches of the contaminated area surfaces permitted operations to proceed without serious threat of overexposure throughout the construction phase. With the firing of the REDWING shots, practically all sites at Eniwetok Atoll and those at Bikini Atoll, except Nan, became contaminated. Recovery and roll-up missions were accomplished as required and a few men received cumulative dosages above the standard of 3900 mr within a thirteen week period. The overexposures prior to the Tewa event were not excessive. As a result of this event held in Bikini Atoll on 21 July 1956, fall-out occurred at the permanent base camps on Eniwetok Atoll at 1500 hours on that date and continued until 0800 hours on 22 July at which time the reading above background was 110 mr/hr. This was the cause of considerable concern as a large number of personnel received dosages above the established maximum and might have to be evacuated. Therefore, on 24 July, CJTF-7 authorized an increase in the operational tolerance from 3.9r to 7r and the Director, Test Division later authorized Holmes & Narver to retain, during the post operational period, those personnel who had exceeded the 3.9r limit for a thirteen week period provided the average quarterly dose for the last three quarters of 1956 would be less than 3.9r. A check made on 27 July revealed that approximately 100 men then at the Jobsite had received dosages between 3.9r and 8.0r, and there was a possibility that this number would be substantially increased. The change in permissable exposure limitations relieved an unsatisfactory situation. The termination, because of radiation exposures, of a large number of men whose contracts had not been completed could have caused strong resentment and undesirable publicity. By keeping the men on the job the possibility of ensuing claims was reduced. Also, the possibility of the rehire of key personnel was greater. The responsibility of the operational control for radiological safety at the Proving Ground reverted to the Contractor on 6 August upon the departure of TU-7 of TG 7.1. The seriousness of the situation at Elmer was well recognized by Management. Decontamination and rigid control measures will be continued until the radioactive level presents no serious problem. This is expected to be about 1 October 1956.

The security requirements of the Atomic Energy Commission included specific provisions concerning unauthorized disclosure of information, the safeguarding of classified material and the clearance of personnel. Close liaison was essential between the Contractor and AEC security representatives for the establishment of workable procedures to resolve the problems arising from these requirements. Consideration was given to overcoming measures which slowed up action in assignment of personnel because of clearance requirements. These included changes in the authority for issuance of travel orders by concurrence of CJTF-7 and Cincpac. This eliminated time losses by the delegation of authority to certain contractual employees to execute functions formerly performed by the Port Control Director, Long Beach Naval Station. In addition, a modified clearance program permitted the assignment of Good Security Risk (GSR) personnel to the PPG. The use of GSR permitted earlier assignments for the build-up phase. Processing for GSR during peak activity averaged eight days, whereas the time for a Q averaged 94 days; for an L, 52 days; for a P, 43 days; and a QR, 24 days. As the P approval and GSR certification did not authorize access to information classified "Restricted Data", a cutoff date of 15 March 1956 - after which all personnel at Jobsite had to be either "Q" or "L" cleared - was established. Because of pressing work, this was delayed until 7 April with permission to retain P and GSR personnel at Fred until 20 April 1956. During the period from 1 July 1954 through 30 June 1956, there were 1,228 Q requested, 865 granted; 2,660 L requested, 2,197 granted; 865 P requested, 657 granted; 1,692 GSR requested, 1,386 granted; 1,388 QR requested, 1,335 granted.

The responsibility for the operation of the Pass and Badge Office involving the issuance of identification media was first assumed on 1 July 1955. Policy direction of this office was retained by the AEC.

Dependable teletype communications between Eniwetok, Hawaii and the Continental United States were provided through the U. S. Army "ACAN" world-wide teletype network augmented by a Los Alamos-Eniwetok circuit. The Los Alamos circuit provided the Contractor an alternate route when the ACAN net was jammed, which frequently occurred during the operational period. Radio-phone service between the Home Office and Jobsite was first initiated on 6 December 1955 but because of security requirements and transmission difficulties this system was seldom used. Prior to the activation of the VHF interatoll system, the communication link between Bikini and Eniwetok consisted of an HF radio telephone and a teletype circuit. During the build-up phase, traffic became heavy and delays in communication resulted but with the activation of the VHF circuits, satisfactory service was provided. Within each atoll, good telephone service was maintained. During the build-up phases, exchanges were operated on a nine-hour per day basis with provisions for emergency calls after working hours. This was gradually increased and during the operational phase, 24-hour service was provided. During the period just prior to LaCrosse, the Elmer switchboard became overtaxed as the telephone operating positions were insufficient to enable the operators to keep ahead of the incoming calls; disconnected calls were handled by relief men standing behind the duty operators.

Radio networks were established for the transmission of unclassified traffic in marine operations, construction-maintenance, and air dispatching. An innovation during REDWING was the establishment of one base and one mobile radio station for the H&N guards which operated on the same frequency as that of the military police network. This resulted in better control of guard activities.

SERVICE 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 David and Fred, the weather station islands, and in naval vessels. To accomplish this, temporary camps were provided at Yvonne, Ursula, Gene, Fox, Tare and Nan and the permanent camp at Elmer was expanded. Each of these camps contained the necessary facilities for housing, messing, PX store, barber shop, refreshment bar and mail. A completely outfitted laundry was located at Elmer and home-type washing machines for spun-dry service were provided at all temporary camps. Limited camp facilities were operated to support off-atoll scientific project personnel on Ujelang, Wotho and Utirik. LCU's outfitted as houseboats provided limited camp services for beachhead landings before camps were established and also supported scientific groups in various areas after the shot-island camps were dismantled. For a short period, a scientific barge was temporarily diverted to camp use and moored off Ursula after roll-up.

Because of overlapping of the peak construction activity with the extremely high instrumentation, several camps had to accommodate more men than the number for which they were designed. It was necessary to utilize spaces intended for recreation and office use for temporary housing, to billet ten or more men in the 8-man tents, to provide temporary quarters in the new machine shop building and the day room at Elmer. This overloading presented many operating problems and resulted in living conditions which were lower than normal Jobsite standards. These problems, however, were overcome without any serious threat to the health and safety of the personnel.

An element of importance in Camp Operations was the supply of the large amounts of the consumable supplies required. The REDWING Operation was a severe test of the effectiveness of the system. No serious shortages or overages occurred despite changes in the camp population and the inadequacy of storage facilities for a population as large as that of REDWING.

The total H&N and supported personnel at each camp are shown in Charts 4-1, 4-2, 4-3, 4-4, 4-5, 4-6 and 4-7 of Chapter IV. The peak population at each camp is listed as follows:

CAMP	DATE ACTIVATED	DATE OF PEAK POPULATION	PERSONNEL AT PEAK POPULATION	DESIGNED CAPACITY	DATE EVACUATED
Elmer	Base Camp	*5 May 1956	*2,751	**2,208	
Yvonne	17 May 1955	20 Mar. 1956	393	300	30 May 1956
Ursula	3 May 1955	24 April 1955	288	350	29 April 1956
Gene	23 Aug. 1955	6 April 1956	189	125	29 April 1956
Nan	11 Dec. 1954	24 May 1956	891	1,000	15 Aug. 1956
Fox	8 June 1955	20 April 1956	285	200	9 May 1956
Tare	19 July 1955	21 April 1956	277	200	26 May 1956
Wotho	15 Feb. 1956	May 1956	12		6 Aug. 1956
Ujelang	3 April 1956	May 1956	15		31 July 1956
Uterik	12 April 1956	May 1956	10		5 Aug. 1956

* During evacution of Ursula, Yvonne and Gene

** Without double bunks.

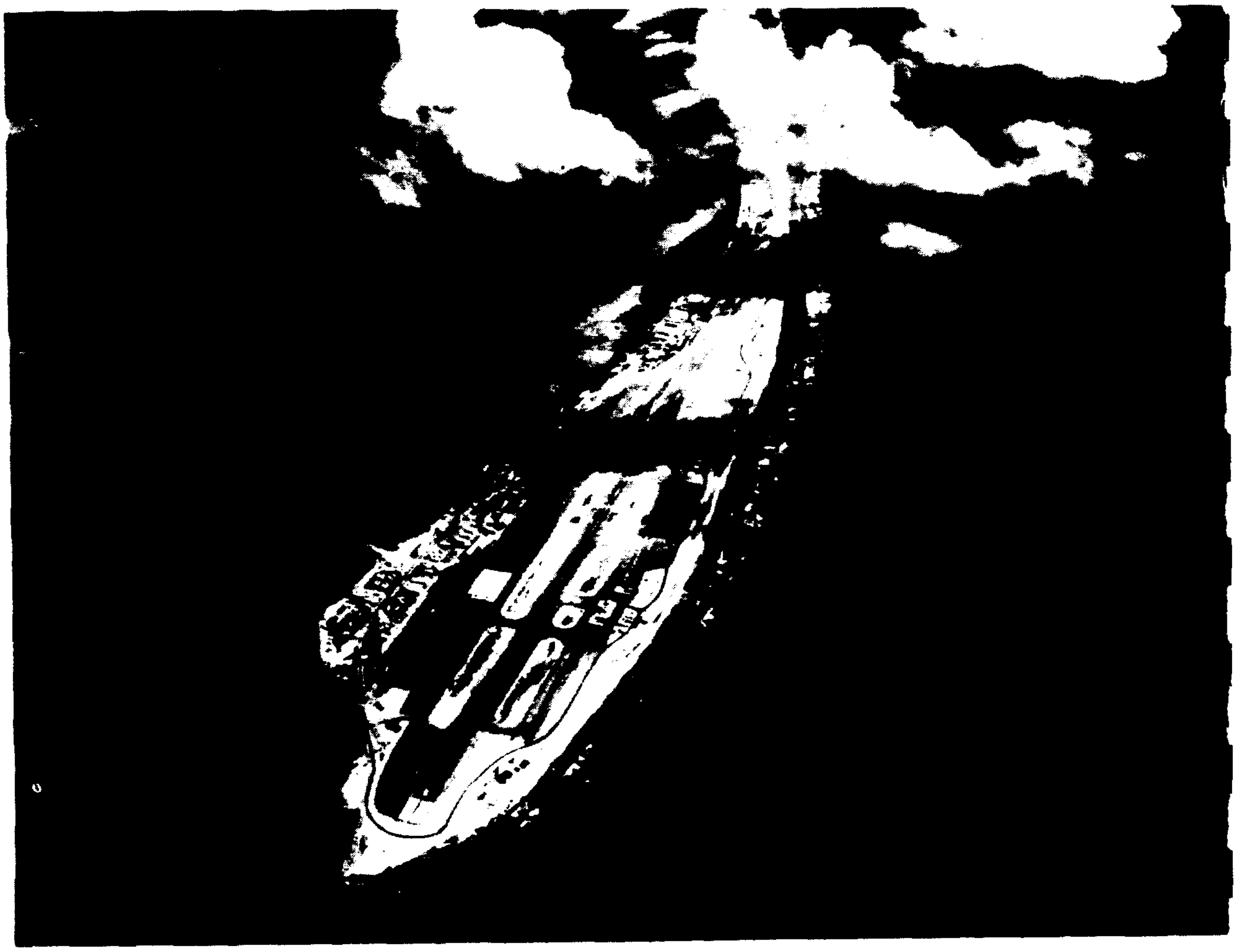


Figure 1-11. Southern Half of Fred

MARINE OPERATIONS.

A marine facility was operated and maintained for intra-atoll water transportation of men, materials and equipment and for other marine services such as cable laying, houseboats and those connected with the movement and mooring of the Zero barges. During the peak of operational activity the boat pool consisted of 101 floating craft, such as landing boats, DUKWS, water taxis, tugs and barges. These were augmented for operations in Bikini Atoll by craft from the TG 7.3 boat pool. Close liaison with the Navy Boat Pool Officer was effective in meeting all water transportation requirements.

POWER AND WATER.

Utilities for the production of power, distillation of water, and for disposal of sewage were important components of service operations. The Contractor operated and maintained the power and water plants at all camps in the Proving Ground and at Wotho, Ujelang and Utirik. The plants at the weather station islands were operated by TG 7.4 personnel but service calls were made by Contractor men via aircraft at scheduled intervals. Of particular significance in power generation was the operation, refueling and other services required for approximately 150 small generators used for scientific purposes. In general, the requirements for continuity of power through zero time for various test facilities were met. To meet peak demands for power and fresh water at Elmer and Fred it was necessary to temporarily install additional units to augment the existing plants.

LAND TRANSPORTATION.

Available land transportation vehicles were allocated to the various sites according to their actual needs. Except at Elmer, vehicles were permanently assigned to individuals. In addition to permanently assigned vehicles at Elmer a motor pool furnished vehicles required for

Figure 1-12. Northern Half of Fred

short-term usage. Daily bus service was provided at this site with the route passing the administration compound and the main installations. Five 2-½-ton personnel trucks were required for transportation of personnel to and from the air terminal at Fred. During the peak activity there were 233 light vehicles for H&N use at the PPG.

AIR TRANSPORTATION.

Shortly after the Nan camp was activated, the rehabilitation of the Peter-Oboe airstrip for limited service was authorized. This airstrip was used as one terminal of the Bikini-Eniwetok air run until the middle of March 1955 when the Nan airstrip was activated. The inter-atoll service was provided through regularly scheduled C-47 flights, initially, with approximately four flights per week. This schedule was gradually expanded to a frequency of two flights per day for seven days a week during the operational period. From 1 April through 29 April 1956, a period of peak activity, 1,462 passengers were carried between the Atolls. The cargo airlift to Bikini Atoll which, during the months of the build-up phase was 4,000 to 6,000 pounds, increased for April 1956 to 26,197 pounds.

Eniwetok intra-atoll air transportation was furnished by TG 7.4 with regularly scheduled L-20 and H-19 type aircraft. Landing strips were available at Elmer, Yvonne, Tilda, Janet and Gene. TG 7.5 and 7.1 passenger control was maintained through TG 7.5 dispatchers located at each site. Special flights were provided on occasion for such missions as aerial photography or reconnaissance and medical evacuation. During the week ending 29 April 1956, a period of intense activity, 710 L-20 flights carried 1,282 passengers and 22 H-19 flights carried 31 passengers.

The Bikini intra-atoll airlift was initially provided by TG 7.4 primarily through the use

Figure 1-13. All Aluminum Prefabricated Building (PI&S Type)

of H-19 helicopters with occasional L-20 flights between Nan and Peter. During the operational phase TG 7.3 assumed primary responsibility for this service which was furnished through the operation of a Marine Corps helicopter squadron. During the week ending 29 April, 419 HRS flights carried 1,023 passengers and 80 L-20 planes carried 214 passengers.

Airlift to support the weather stations and off-atoll scientific projects was furnished to all atolls by SA-16 and PBM flights with occasional trips by C-47 type craft to Tarawa where an airfield was located. On 27 March 1956, the Jobsite Supervisor of Procurement was delegated the authority of Transportation Control Agent to control the movement of cargo and personnel by both boat and airlift to these off-atoll sites. Air flight schedules were arranged for emergency needs, replacement personnel and for the re-supply of subsistence items.

MAINTENANCE.

The problems of preservation and maintenance of facilities and structures were intensified by the rapid corrosion and deterioration of substantially all ferrous metals due to the tropical atmosphere and salt spray prevalent at both atolls. Frequent chipping or sandblasting and painting of metal surfaces were necessary except on aluminum buildings which were comparatively maintenance-free. Preventive maintenance programs established during previous years were followed. Operating periods of equipment were recorded and overhaul was placed on a scheduled basis. Of particular significance in the REDWING Operation was the extent of work required on reefs where the salt water action impaired the life of the equipment used. Due to the distance of the Jobsite from the source of supply it was essential that an adequate number of spare parts be maintained. Climatic conditions necessitated special protective maintenance for spare parts in storage.

TEST OPERATIONS AND ROLL-UP.

The operational phase of REDWING was entered on 15 April 1956 when the Commander, Joint Task Force SEVEN, assumed operational control of all forces in the Forward Area. On 25 April 1956, a directive was issued to make preparations for the initial shot (LaCrosse) to be fired two days in advance of the scheduled target date of 1 May 1956. The stations and facilities were readied by this new target date but, because of technical considerations, this first detonation was delayed until 5 May 1956. as shown on Chart 1-4, a total of 17 events took place with the last detonation on 21 July 1956.

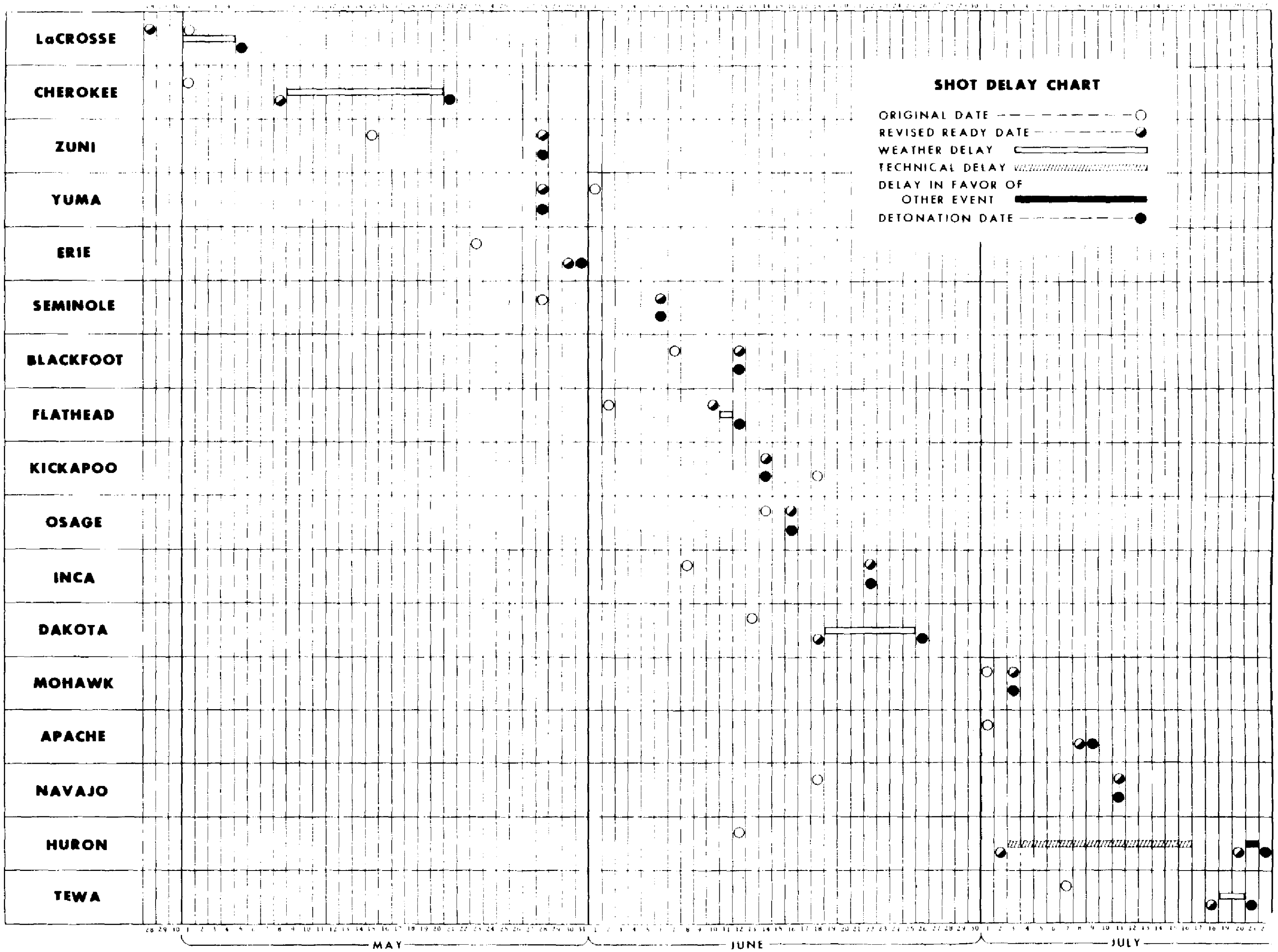


Chart 1-4. Schedule of Events

The preparation 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, facilitated the placing of all facilities in a state of readiness for each test. These lists indicated when facilities could be secured, equipment moved, and which utilities were to be serviced for operation during the event. Similar lists covering re-entry provided for rapid reoccupation and re-establishment of vital support services.

Fourteen evacuations to sea of the personnel in Bikini Atoll were required for seven events scheduled in that area. Of these seven events one was re-scheduled, after evacuation had been completed, to take place in Eniwetok Atoll. Evacuation to sea of personnel at Eniwetok Atoll was not required; however, the capability of accomplishing this task was maintained.

Measures taken for the protection of personnel, equipment and property were governed by predictions of overpressures, thermal energy, radioactive contamination and the extent of inundation as furnished by Task Group 7.1. With respect to camp and other service facilities, two conditions of test readiness were applicable. Where damaging pressures were probable, camps and facilities were completely rolled-up; where damaging pressures were considered remote, they were left intact. In this latter case, limited precautions against blast, fall-out, or inundation were taken as deemed advisable for each event. With respect to scientific structures and facilities, the measures for test readiness were as requested by scientific personnel.

The roll-up of a camp was generally scheduled to commence on D-5 and to be completed by noon of D-1 day. The roll-up consisted of removing all equipment, materials and supplies worth saving for shipment to Elmer from Eniwetok Atoll camps and to Nan for further transshipment to Elmer for Bikini Atoll camps. The roll-up was accomplished according to schedule and in phase with personnel reductions at each site, with provisions for continued meal service through an early lunch on D-1 day. Only those buildings in temporary camps that could be moved bodily and tent canvas in good condition were salvaged. As scheduled, the roll-up of the Yvonne camp was effected prior to the LaCrosse event, the Fox camp prior to Cherokee and Tare prior to Zuni. The camps at Gene and Ursula were left in a condition for rapid reoccupancy after the LaCrosse event. As a result of the radioactive contamination of these sites by this event, roll-up commenced shortly thereafter.

It has been the practice in previous operations to remove most of the installed equipment in scientific stations to Elmer for storage during the interim period. For the roll-up following REDWING, a decision was made to preserve in place all such equipment except electric motors. All electric motors were moved to Elmer where they were overhauled and tagged with station and equipment numbers, then placed in dehumidified storage. When the motors were removed the corresponding driven equipment was also tagged with the motor number to ensure proper reinstallation when required. During the interim period following REDWING periodic inspections of installed equipment and maintenance measures will be performed as necessary.

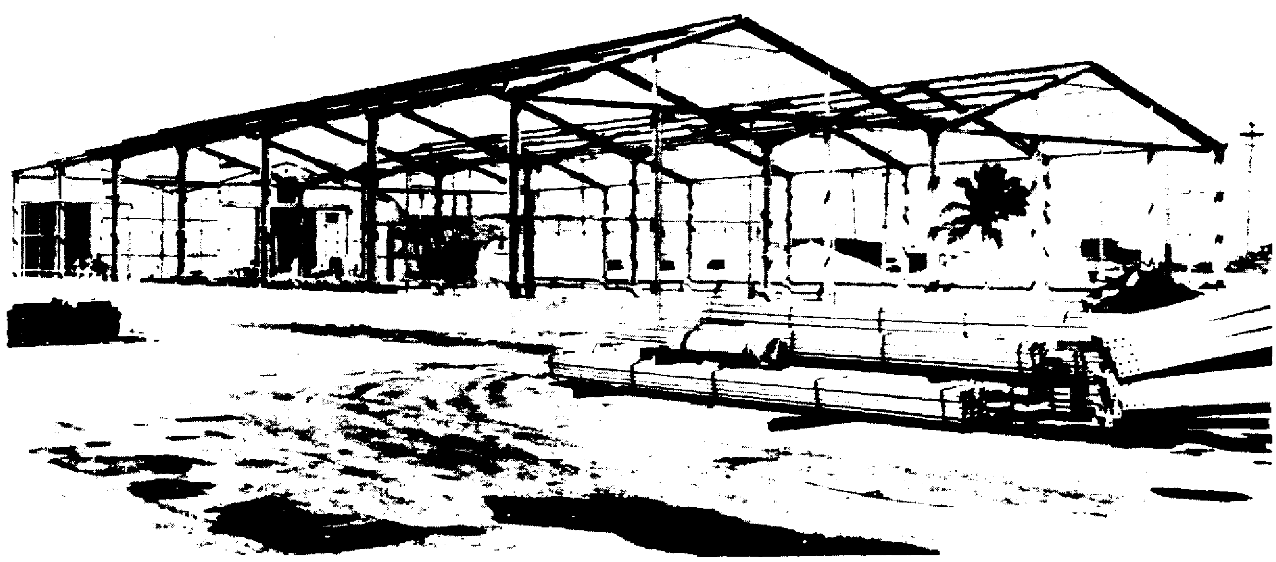


Figure 1-14. Structural Frame for Warehouse

SECTION 2
CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

1. All facilities, equipment and utilities under custody of the Contractor were taxed to capacity during REDWING.
2. The schedule on which construction was actually accomplished made it necessary for the Contractor to request unusually heavy support from all the elements of Joint Task Force SEVEN, particularly in the areas of surface and airlift.
3. In general, available land areas were utilized to their maximum capacities.
4. Operational readiness dates could have been delayed a minimum of six weeks, for reasons beyond the Contractor's control, had it not been possible for Task Group 7.1 to abridge its pre-shot schedules drastically, had it not been possible to secure unprecedented airlift capability, and had not every element of JTF-7 cooperated to the fullest in the agreements on priority of requirements.

RECOMMENDATIONS.

It is recommended that:

1. No Operation larger than REDWING be undertaken on a similar time scale, using existing facilities.
2. Every effort be made to avoid scheduling the FY 1958 Plant and Equipment program during the peak of activity of the next scientific program by:
   A. Authorizing engineering and design during Fiscal Year 1957;
   B. Authorizing procurement and construction at the start of Fiscal Year 1958.
   (NOTE: Previously, engineering and construction on Plant and Equipment has been authorized three to four months after the start of the Fiscal Year.)
3. Contractor be allowed to maintain higher levels of inventory on construction items, thus permitting stockpiling of larger quantities of material and equipment in advance of design.
4. More efficient methods be developed for handling the flow of information between all parties during development of design criteria.
5. Standardization of equipment be explored to its fullest extent. The Contractor has effected standardization of most common items required for construction, but it is believed that further study will indicate that savings in design and procurement time could be realized in other areas.

Figure 1-15. Warehouse - 95% Complete (Butler Type)

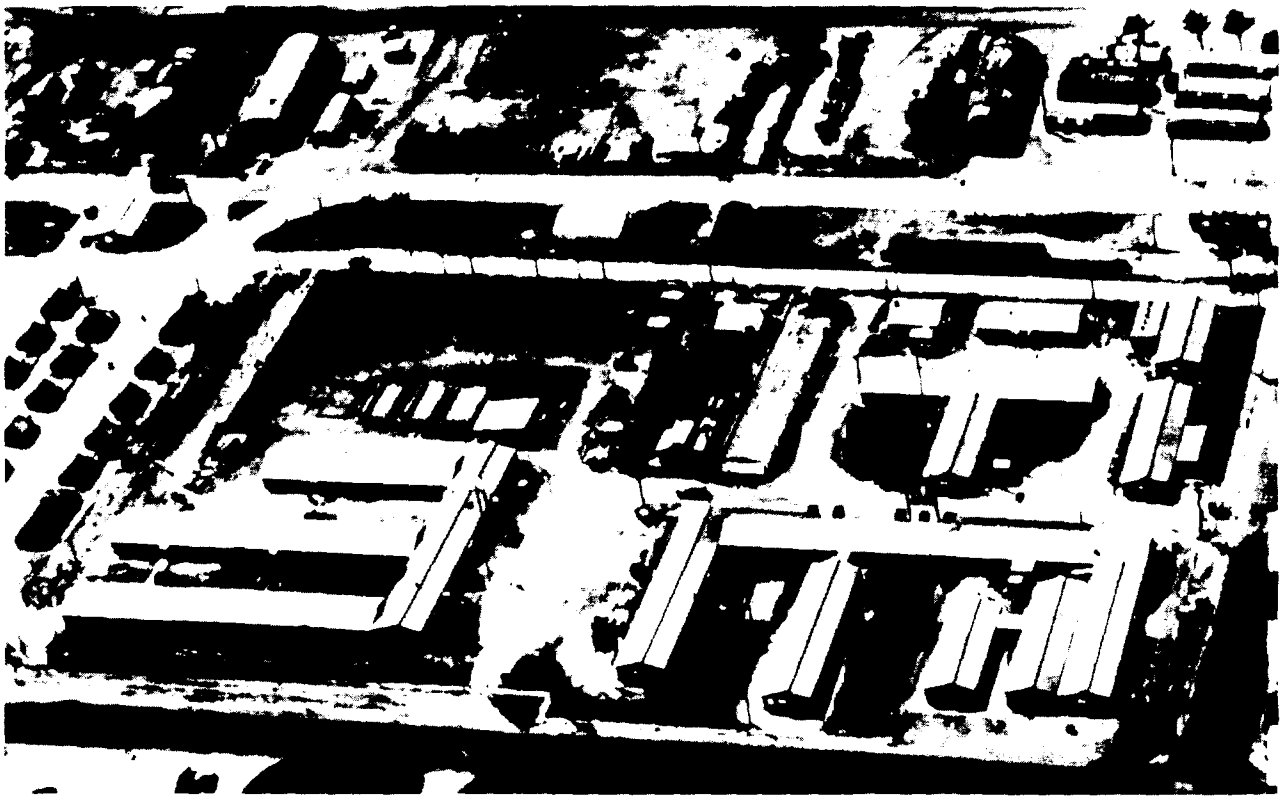


Figure 1-16. Administration Compound - Elmer

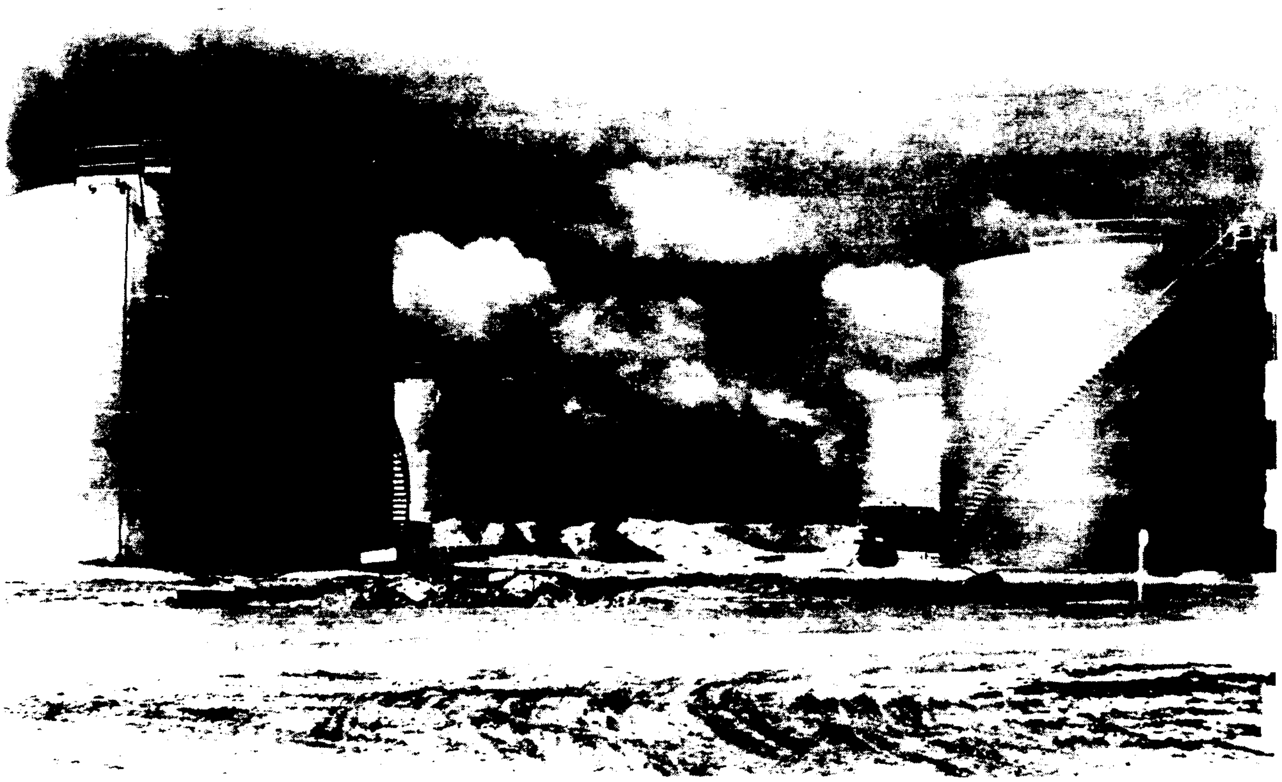


Figure 1-17. POL Facilities - Fred - 65% Complete

SECTION 3
CONTRACT HISTORY

Contract AT-(29-2)-20 was entered into on 18 October 1951 in the form of a letter contract and was negotiated into a formal architect-engineer-construction-management contract on 18 February 1952. During the IVY and CASTLE Operations, the contract was modified 36 times and during the REDWING Operation (1 July 1954 through 30 June 1956) was modified 21 times.

The contract as constituted for REDWING was divided into three main jobs, as follows:

Job 1 - Engineering, Design, Inspection, Construction and Procurement.

Job II - Operation and Management of the Pacific Proving Ground.

Job III - Maintenance of the Pacific Proving Ground.

Effective 1 July 1954, Jobs IV and V Support and Roll-up, which had been specific jobs under the contract for previous operations were eliminated and the services performed under these Jobs were included in Jobs I, II and III as applicable.

The various modifications to the contract which were applicable to Operation REDWING were as follows:

Modification 37, dated 30 August 1954, effective 30 August 1954, extended the contract through 30 September 1954.

Modification 38, dated 23 September 1954, effective 1 July 1954, restated the entire contract with new appendices A & B.

Modification 39, dated 1 November 1954, effective 1 July 1954, included salary and wage schedules.

Modification 40, dated 20 December 1954, effective 1 July 1954, revised Appendix "A". It firmed and enlarged the scope of work as well as increased the obligated funds under the contract.

Modification 41, dated 6 January 1955, effective 1 January 1956, changed the fringe benefit policy date. It outlined a new policy by which "Off Continent" employees were permitted Payroll Advances and outlined the methods of repayment. Additional Bonus payments were authorized for completed contracts.

Modification 42, dated and effective 10 March 1955, revised the "Nondiscriminating" clause in the contract.

Modification 43, dated 1 March 1955, effective 6 December 1954, revised certain overseas wage schedules.

Modification 44, dated and effective 22 March 1955, increased the amount of obligated funds available for use under the contract.

Modification 45, dated 20 April 1955, and effective 1 January 1955, changed the per cent of fringe benefits permitted under the contract.

Modification 46, dated 13 June 1955 and effective 1 July 1954, revised, restated and added to the scope of Appendix "A". It also increased the Obligated Funds.

Modification 47, dated and effective 15 July 1955, amended the contract to change the requirements for hiring certain personnel above the minimum scale.

Modification 48, dated 8 December 1955, effective 14 November 1955, restated and replaced the Wage Schedule II of Appendix "B".

Modification 49, dated and effective 29 December 1955, increased the obligated funds available for use under the contract.

Modification 50, dated 6 February 1956, effective 1 July 1954, revised, restated, and added an additional scope of work to Appendix "A". It increased the obligated funds available for use under the contract.

Modification 51, dated 20 March 1956, effective 6 February 1956, revised parts of Wage Schedule II, Appendix "B" and changed certain methods handling and paying fringe benefits.

Modification 52, dated and effective 30 April 1956, increased the obligated funds available for work under the contract.

Modification 53, dated 21 May 1956, effective 7 May 1956, revised portions of Wage Schedule II, Appendix "B."

Modification 54, dated 18 June 1956, revised and replaced Wage Schedules I and II of Appendix "B". Changes in Wage Scedule I were effective 2 April 1956 and in Wage Schedule II, 1 July 1956.

Modification 55 and 56, were not applicable to the REDWING Operation.

Modification 57, being processed and to be effective 1 July 1954, completely revises and restates the scope of work covering the period of 1 July 1954 through 30 June 1956.

Figure 1-18. Ursula Complex

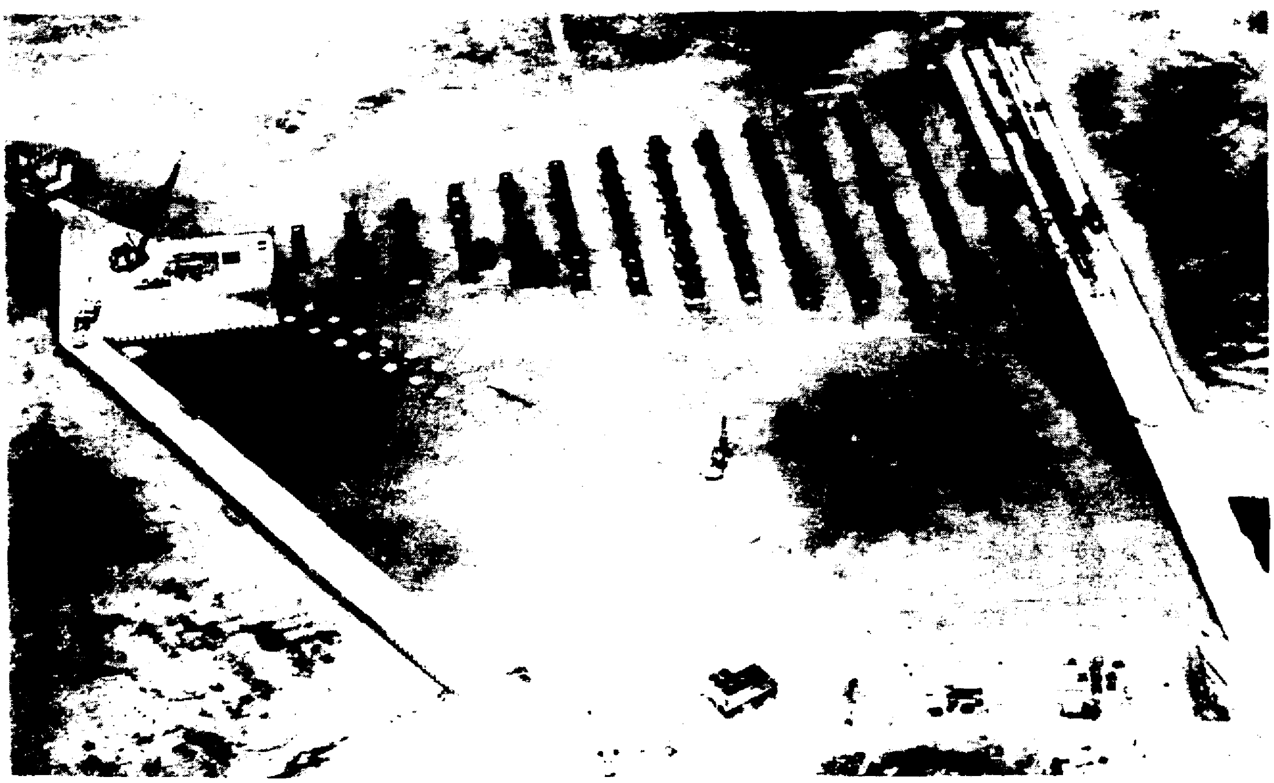


Figure 1-19. Causeways at Yvonne for Stations 24, 1524 and Program 18 Pipe Array

CHAPTER II
ENGINEERING — CONSTRUCTION

The general scope of the work performed by Holmes & Narver in the development of facilities at the Pacific Proving Ground for REDWING has already been discussed. It is the primary purpose of this chapter to record the engineering - construction effort accomplished under Job I of the contract. This record is presented in five sections. Sections 1 and 2 present a general discussion of Engineering and Construction, respectively, and cover over-all problems and progress. Sections 3, 4 and 5 provide the significant engineering-construction details involved with each item of work undertaken; Section 3 covers scientific stations; Section 4, those facilities other than scientific stations constructed under the Expendable Test Facilities program; and Section 5, facilities provided for the permanent base under P & E projects.

SECTION I
ENGINEERING

DESIGN.

On 4 March 1955, the Contractor was authorized to initiate the design of shot-island camps and to proceed with the design of scientific stations in accordance with details furnished by UCRL, LASL, and DOD. As the shot-island camps were to be simple, and as standard details for most of the expendable buildings to be used in shot-island camps had been prepared, the responsibility for the design of these camps was delegated to the Field Engineering Staff. This permitted the efforts of the Home Office Engineering Staff to be directed toward the design of complex structures, close liaison with the scientific agencies, and priority of design for scientific structures. To assist in expediting design criteria for scientific facilities, the Contractor was authorized to station representatives at both LASL and UCRL. This proved effective in keeping the Contractor abreast of criteria development at the scientific laboratories and in clarifying early design problems.

Coordination of the scientific station designs for the various agencies involved, was effected through J-6 of LASL. Criteria were generally received through letters and sketches, and in some cases preliminary information was received by phone. The letters and sketches were distributed to appropriate Project Engineers, who prepared rough draft Engineering Orders indicating the required design and drafting work. As soon as preliminary drawings were available, they were transmitted directly to the scientific agency involved for review and comments in order to effect agreement on the interpretation of the criteria furnished. This procedure was effective in establishing firm criteria as early as possible. As the User's comments were received, drawings were developed to final design and then submitted for estimates to the Contractor's Estimating Department and for construction authorization to the AEC Contract Representative in the H&N Home Office.

The Engineering Order was used to disseminate criteria to the design staff; in addition it served as a record of changes made during the design development and kept the Field Engineering Force informed of the work in progress. It also authorized work by the field forces which, because of its nature, was not defined on the drawings. All Engineering Order numbers were indicated on drawings for cross reference with the criteria received from the Users. The Engineering Order was issued on receipt of initial criteria; then as additions and alterations were made, the Order was revised to reflect the changes along with the work already in process.

As a result of the many changes incorporated into the test program, criteria for many of the Stations were not firmed as early as had been anticipated. The lack of firm criteria in late September 1955, was the cause of concern as it appeared probable that completion dates could not be met. All possible expediting action was taken to speed design as soon as criteria were firmed and to permit procurement processing of long-delivery items. Where practical, preliminary drawings were released to permit the start of construction, for example, preliminary drawings were released for tower and guy anchor footings of the shot towers. By the end of 1955, a major portion of the criteria had been firmed and a number of drawings could be released to the field forces. The design of the facilities and systems for Irene and Yvonne was critical at this time and represented the governing element in the completion of the design program. The final completion of design for the DOD program was complicated by the long period of time that ensued from the mailing of preliminary drawings until receipt of their approval. However, very satisfactory progress was made in January 1956, and by the middle of February 1956, the design of scientific stations was practically completed. By the first of March 1956, all drawings which had not been approved by the J-6 Division of LASL had been forwarded to Jobsite for review and approval by the J-6 representative in the Proving Ground. Authorization for construction in such cases was obtained from the Manager, Eniwetok Branch Office, and signed reproducibles were forwarded to the Home Office for distribution. All original tracings of scientific facilities were forwarded to Jobsite so that revisions and "as-built" changes could be made directly thereon by the field forces.

The major structural problems encountered in the design of the scientific stations were concerned with settlements and movement

Figure 2-1. Erecting Antennas

tolerances of critical structures; effects of wave action and preventive measures against inundation; special blast doors; and particularly, interpretation of mode of blast loading under various circumstances, which frequently resulted in the requirement of heavy blast resistant walls and earth covers.

The electrical problems included providing dependable power supply at remote installations capable of a continuous unattended operation, with precise voltage regulation for instrument power; shielding instrument rooms against transient currents to ensure accurate readings and records; and providing signal and telephone distribution networks, both submarine and subterrainian, for the coordinated timing of all devices and equipment associated with an event, and for reliable communication systems.

Mechanical problems included furnishing facilities for the removal of heat generated by scientific equipment in areas with inherently impaired circulation; humidity control; air conditioning; blast protection through self-latching devices for exterior openings; quick closing shutters actuated by explosive or electrical releases; precise alignment and tight vacuum retention of pipe arrays; pressure water systems to maintain water supplies for an extended period; hydraulically actuated opening devices and snubbers; high pressure air and fuel systems; tower elevators, elevator hoists and trailers for portable elevator hoists; ventilation for the removal of fumes and explosive vapors; and expendable and nonexpendable equipment.

The major Civil Engineering problems primarily consisted of those connected with close location tolerances, the over-all relation of station positions with each other, the extension of the primary triangulation net and soil stabilization.

A concept of the size of the engineering effort is conveyed in the following record of drawings and sketches issued: civil - 110; architectural - 136; electrical - 407; mechanical - 241; structural - 631.

When the design of scientific stations was first authorized in March 1955, a total of ten men from the Home Office base engineering staff were employed on the Proving Ground Project. Personnel were added as the work load increased and during the peak of activity there were 78 men assigned to this work. During the peak of activity, it was necessary to place this engineering staff on a 50-hour week; in a few instances, it became necessary to place part of the staff on a 58-hour week. Due to the relatively short peak load period and because of the serious shortage of engineering personnel throughout the country, it was impracticable to recruit clear and hire additional personnel to eliminate the overtime involved.

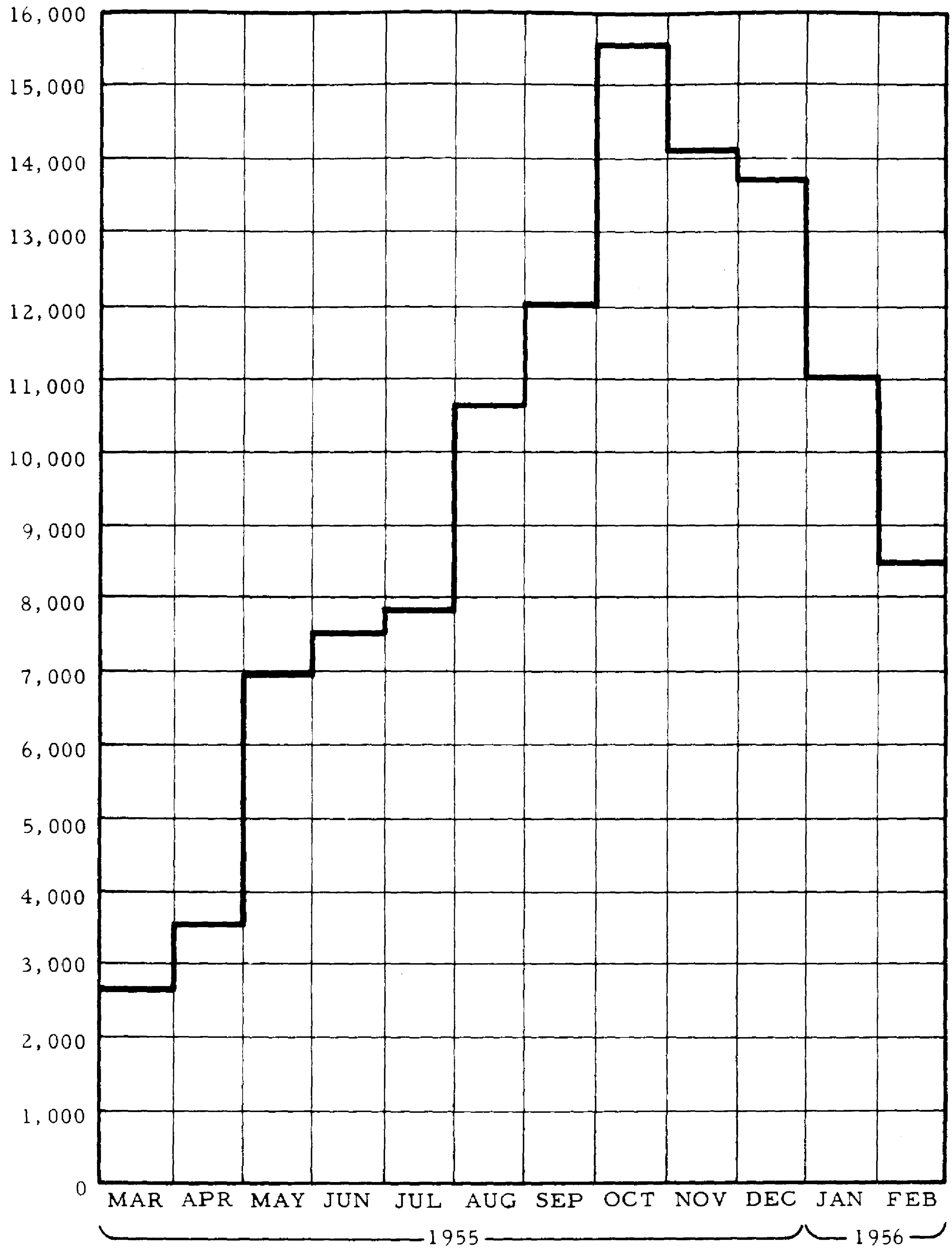


Figure 2-2. Home Office Engineering Man-Hours

FIELD ENGINEERING

The Field Engineering Division at the site for this Operation was headed by a Resident Engineer with a staff of assistants. This Division included four departments, functioning parallel to their Home Office counterparts:

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

The Jobsite Engineering Division was responsible for furnishing complete local engineering supervision and inspection of construction; making topographic, hydrographic control and construction surveys; preparing designs and drawings for projects originated in the field; interpreting plans and specifications; designing and approving alterations and substitutions due to field conditions; estimating field- approved alterations; inspecting construction for compliance with plans and specifications; inspecting and testing construction materials; preparing as-built drawings; submitting historical, progress, and damage reports; and for maintaining a complete file of all drawings and other engineering data.

All drawings, work orders, and reports were prepared and issued at the Engineering Office, Elmer, where the Resident Engineer and an Assistant Resident Engineer were located. Activities of engineering personnel assigned to Bikini Atoll were coordinated through on Assistant Resident Engineer at Nan. During the critical stage of construction at Yvonne and Ursula, an Assistant Resident Engineer was stationed at Yvonne to coordinate activities in that area and to expedite engineering services to both Contractor and User personnel. As the work load varied from the interim period through the construction and operational phases, the force varied from a total of 24 individuals to a total of 119. All departments of the Division were effective throughout all phases of the Operation, though some difficulty was experienced due to the shortage of qualified engineering personnel.

The engineering Order furnished Field Engineering by the Home Office proved effective in maintaining liaison between the two offices.

All field changes in the design of scientific structures or facilities were cleared through the Chief Project Engineer in the Home Office until User personnel that were authorized to approve design arrived at Jobsite. Because of the time element involved, approval was then granted Field Engineering to make needed revisions, provided these revisions were approved by the Users and the Manager, Eniwetok Branch Office. Construction drawings and original cost estimates for projects originated in the field and not directly related to the scientific program, were approved by the Resident Engineer and the Manager, EBO. Reproducibles of all drawings and revisions to drawings originated in the field, together with original cost estimates or information needed to revise current estimates, were sent to the Home Office in order that interested parties could keep abreast of engineering developments.

The Field Estimating Department, under policy direction of the Chief Estimator in the Home Office, reported directly to the Resident Engineer. Therefore, the discussion of field estimating has been consolidated with that of the Home Office Estimating Department in Chapter III Section 3.

Justification for each item of work and the availability of funds were established through work orders which required both AEC and H&N approval. Cost control was maintained by reviewing monthly accrued costs on all open work orders. For items of work over $10,000 in value cost-estimates-to-complete were prepared at various stages of construction progress in order to reflect the current and projected costs of construction for use in budgetary control. Progress, reported weekly, was based on visual inspection of the various categories of construction, (plumbing, electrical, concrete, etc.).

Preparation of as-built drawings was placed under the direction of an Assistant Resident Engineer with a staff of engineers, draftsmen and survey personnel. This organizational setup made it possible to prepare as-built drawings shortly after completion of each station. This was important since sites were used for a number of test events and as-built conditions had to be recorded prior to each succeeding event. The original tracings were sent to the field for revision, which allowed an original as-built drawing to be made available as early as possible.

Representatives of Field Engineering accompanied the reconnaissance parties to all off-atoll sites to gather information necessary for engineering and construction planning. This information included such items as the availability of aggregate for concrete, the approximate number and height of trees that had to be removed, beach conditions for landing materials with marine craft, ground height above high tide, and the slope of the beach. A sketch and detailed report for each proposed site was prepared and submitted to the Home Office.

Figure 2-3. POL Farm and Deep Water Pier - Elmer

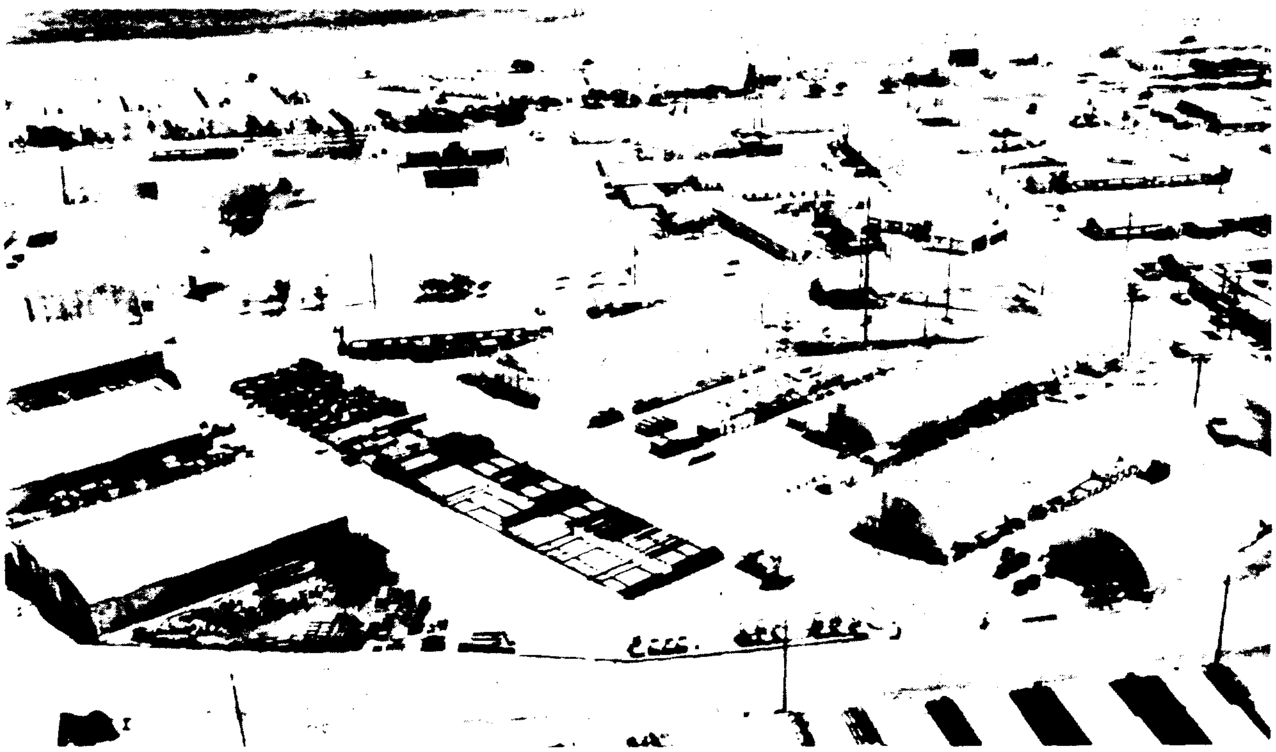


Figure 2-4. Warehouse Area - Elmer

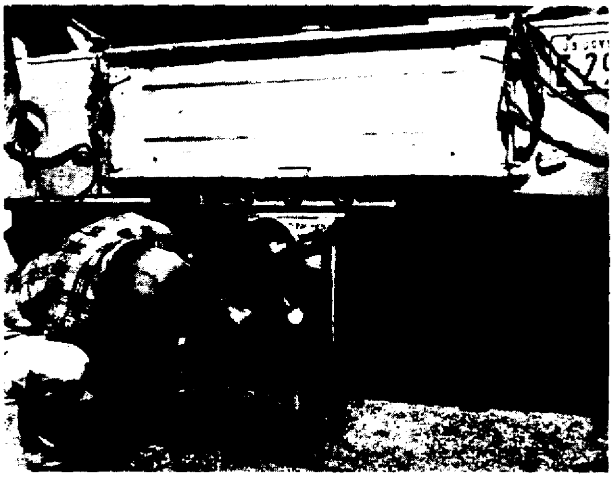


Figure 2-5. California Bearing Ratio Test

TEST AND INSPECTION

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

The Test Section was composed of a Test Engineer and from one to three Test Laboratory Assistants, depending on the work load. This staff was responsibile for operating the Test Laboratory at Elmer for the testing of such materials as aggregate, cement, concrete, and other materials requiring control in construction.

Aggregates for concrete mixes were composed of crushed coral rock with the addition of fine coral beach sand. Past experiences at the Proving Ground showed coral deposits had wide variations in their specific gravities and in their percentages of absorption. The testing of these two factors and control of mixes were important in the economical production of 2500 and 3500 psi concrete. Tests, during the REDWING Operation, of approximately 250 samples bore out these wide variations as indicated in the following results.

A. ENIWETOK ATOLL

Type of Aggregate	Unit Weight Pounds Per Cubic Foot (Dry)	Per Cent of Absorption in Saturated Surface (Dry)	Specific Gravity of Saturated Surface (Dry)	Fineness Modules
Course	78.5 to 86.5	3.76 to 5.4	2.49 to 2.60	—
Fine	91.5 to 102.0	2.4 to 7.77	2.28 to 2.67	2.71 to 3.71

B. BIKINI ATOLL

Type of Aggregate	Unit Weight Pounds Per Cubic Foot (Dry)	Per Cent of Absorption in Saturated Surface (Dry)	Specific Gravity of Saturated Surface (Dry)	Fineness Modules
Course	81.0 to 85	2.10	2.60	—
Fine	77 to 91.5	3.60 to 5.90	2.45 to 2.55	2.54 to 3.48

SPECIFICATIONS FOR AGGREGATE GRADATION WERE AS FOLLOWS:

Laboratory Sieve Square Openings	Percentage by Weight Passing
2″	100
1½″	70-100
1″	55-85
¾″	50-80
⅜″	40-70
#4	30-60
#10	20-50
#40	10-30
#200	0-15

Variations in the physical properties of coral rock, as noted above, required the preparation of 14 design mixes for concrete in Eniwetok Atoll and 27 design mixes in Bikini Atoll.

Concrete cylinders were carefully packed in wet sawdust for a period of 48 hours, which allowed the required initial period after casting before they could be shipped to the Test Laboratory. It was found that wax-paper cylinder molds could not be easily stripped from concrete cylinders and, therefore, the one-use sheet metal cylinder molds were used. The use of these sheet metal molds was justified by the amount of time saved and the uniformity achieved in the quality of concrete cylinders. A total of 1,450 cylinders was taken from approximately 28,500 cubic yards of concrete placed during 1 July 1955 to 1 July 1956, amounting to one control cylinder for every 20 cubic yards of concrete placed. The average results obtained from these tests as shown below.

Figure 2-6. Sand Density Test

Specified 28-Day Breaking Strength	Average 28-Day Bikini Atoll	Average 28-Day Eniwetok Atoll
2000 psi	3166 psi	2984 psi
2500 psi	3177 psi	2718 psi
3000 psi	4145 psi	3914 psi

The average concrete mix as used at Jobsite contained approximately the following:

1800 lbs. course aggregate
1200 lbs. fines
6 sacks of cement
42 gallons of water

The above average mix was varied to conform to the characteristics of the aggregate used at the place and time of the concrete pour.

The high values obtained in the average strengths were primarily due to the large amount of concrete poured in water because, as a safety factor, additional cement was added to mixes that were poured in water and the actual strengths of the concrete were therefore much higher than specified in such cases. The coral aggregate obtained at Bikini was characteristically more consistent; this was due to a denser coral thus resulting in a more uniform ratio between coarse and fine aggregate producing a concrete mix of higher strength.

A total of 15 tests of cement (Ideal, Santa Clara, and Santa Cruz) were made for normal consistency and time of set. Normal consistencies were about 25 per cent and the time of set varied from one to four hours, which confirmed the difference in set qualities of the various cements observed in the field.

Included in a variety of other activities of the Test Section was the making of CBR tests, Bitumen content tests, moisture tests of various mixes, strain gage tests on tower cable, tension tests on marine rigging and paint durability tests.

The Inspection Department was organized with individual site Inspectors assigned to each major site, working under a Chief Inspector at each Atoll. This department inspected all phases of construction work from the first clearing and grading stage until final completion and acceptance. Preliminary work consisted of studying plans, specifications, bills of material, and any special conditions. Materials were then checked for conformance with specifications. With the commencement of work, inspection was continuous. Excavations and foundations were checked for location, dimensions, and orientation; forms were checked for adequacy and alignment; reinforcing rods were checked for size, bends, spacing, ties and rigidity of support; embedded fixtures were checked for location and size. Concrete was inspected during placement to ensure that it was well-compacted and bonded, and of proper mix. Inspection after placement for the removal of forms and backfilling was likewise continuous. With the structure formed, inspection on electrical, sanitary, and mechanical items followed.

Such active inspection was deterrent to careless workmanship, since it was backed by management and respected by supervision. One of the Inspection Department's functions was to be a reporting agency to the superintendent, who rectified unsatisfactory conditions directly and promptly. Authority to correct deviations from plans and specifications was not, however, limited to this level because, if conditions warranted, the Resident Inspector could refer a matter through the Chief Inspector to the Resident Engineer, who would then investigate and recommend action to be taken by the Resident Manager.

Safety inspection was assigned to all Field Inspectors as an additional responsibility. The Safety Engineer gave all Inspectors a series of lectures defining required safety standards, operating practices, and working conditions. He also provided various types of 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 conditions were rectified.

With work in progress at so many sites and locations, it was necessary to establish detailed standard procedures in regard to reporting, and these included the following:

(1) "Weekly Progress Work Sheets," summarizing the week's activities by work order with the current percentage of completion for incorporation in the "Weekly Progress Report" by the Reports Section.

(2) "Concrete Placement Approval," which notified the site superintendent that the inspector had checked and approved form work and embedded items prior to a concrete pour.

(3) "Concrete Pour Data," which gave all pertinent information concerning a concrete pour as it was accomplished, and which was for the use of the Test Laboratory and for future investigation if cylinder breaks or structural failure should occur.

(4) "Weekly Inspection Report," which was prepared by the Inspector for each scientific station and other large facilities.

(5) Special reports to cover tests and unusual conditions were submitted when warranted. Such reports included operating tests for tower elevators, mechanical and electrical facilities in scientific stations, pile driving, earth compaction, etc.

SURVEY.

Surveys at the Pacific Proving Ground were initiated at Eniwetok Atoll in 1949 and expanded to include Bikini Atoll in 1952. Activities have followed the same pattern at both atolls and included the establishment of horizontal and vertical control networks, topographic and hydrographic mapping, construction layouts, and special surveys to satisfy scientific requirements and provide assistance to Users. The survey of both Bikini and Eniwetok Atolls is recorded in the Completion Reports for Operations GREENHOUSE, IVY, and CASTLE. The following is primarily a description of survey activities during Operation REDWING.

HORIZONTAL CONTROL - ENIWETOK ATOLL.

The horizontal control scheme consists of a primary network of second order triangulation stations supplemented with third order stations at locations of lesser importance. The original scheme, established in 1949-50 and expanded in 1951 and 1952 to include the entire atoll, utilized some of the earlier surveys conducted by Joint Task Force SEVEN and the USS Bowditch. Since the CASTLE Operation destroyed portions of the primary network, new stations were established as required by expanding the remaining portions of the network. Two new stations were established at the north end of the Atoll; at Alice (triangulation station Alice), and another at Gene (triangulation station Gene), for the use in tieing Scientific Stations 10, 12 and 23 into the primary network. One new station was established at Yvonne for use in the location of Scientific Stations 6, 7, 24, 1524, 1590, 1811, 1812 and 1813, all of which required a high degree of accuracy in their location. A station was also established on coral head Mack for use in determining, with second order accuracy, the location of the 75′ photo tower, Station 1514. Fig. 2-11 shows the Horizontal Control Network for Eniwetok Atoll and Table 2-1 lists the Horizontal Control Stations.

HORIZONTAL CONTROL - BIKINI ATOLL.

The horizontal control scheme at Bikini Atoll was essentially the same as that established in Eniwetok Atoll. Requirements included a primary network of second order accuracy according to specifications established by the U. S. Coast and Geodetic Survey, supplemented by third order stations in locations of lesser importance. Previous surveys of Bikini Atoll consisted of Chart 6032 published in 1944 by the U. S. Hydrographic Office, and adjusted data of third order surveys completed in 1946 by the USS Sumner and USS Bowditch. Certain portions of the 1946 survey were tied into the original survey made in 1953 by Holmes & Narver, Inc. Operation REDWING necessitated the establishment of a new control due to the effects of the previous test operation. It was necessary to establish new second order stations on Charlie, Dog, and George and also to replace triangulation station Coca in the lagoon. These new stations were tied into the remaining portion of the primary network of second order stations. Figure 2-12 shows the Horizontal Control Network for Bikini Atoll and Table 2-1 lists the Horizontal Control Stations.

VERTICAL CONTROL.

After Operation CASTLE, it was evident that some absolute method for determining the data for all sites was needed. Two portable automatic recording tide gages were purchased, one each for use at Bikini and Eniwetok Atolls. These tide gages were set up at all major operational sites and a datum was established for the construction of scientific structures.

TOPOGRAPHIC MAPPING.

Topographic maps of sites Charlie, Dog, Easy, Fox, and George in Bikini Atoll and Yvonne in Eniwetok Atoll were required by the Users. High tide line surveys of many islands were also provided.

HYDROGRAPHY.

Various hydrographic surveys were accomplished during Operation REDWING. As the need for hydrographic surveys has increased with each Operation, a Raytheon portable recording echo depth sounder was purchased. To date it has been used for checking depth at the deep water pier, sounding the various craters, locating channels, and charting the lagoon from the south edge of Fred to the north end of Elmer for the possible location of dredge material. This instrument has eliminated the slow and uneconomical lead line sounding method formerly used.

CONSTRUCTION LAYOUT.

Layout of all scientific structures and stations constituted a large part of Survey Department requirements. This consisted of preliminary staking for clearing and rough grading, followed by accurate layout of the particular station or facility. Normal survey procedures were used for most of the scientific construction. Due to the isolated locations of a few stations, such as the Man-Made Islands and Stations 130.01 and 131.04, special survey methods had to be used.

Pipeline Stations 1811, 1812, and 1813 located at Yvonne were long single-pipe arrays which presented little difficulty in alignment.

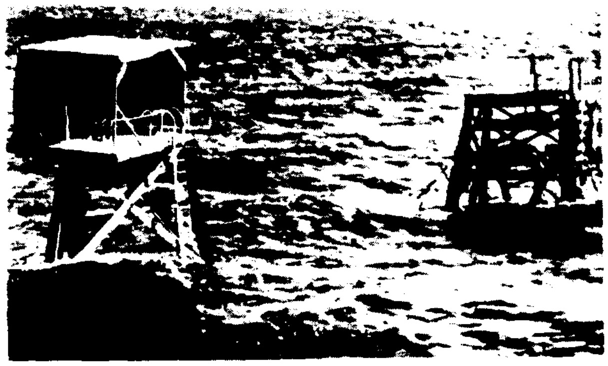


Figure 2-7. Station Coca - 2 (Left)
Old Station Coca (Right)

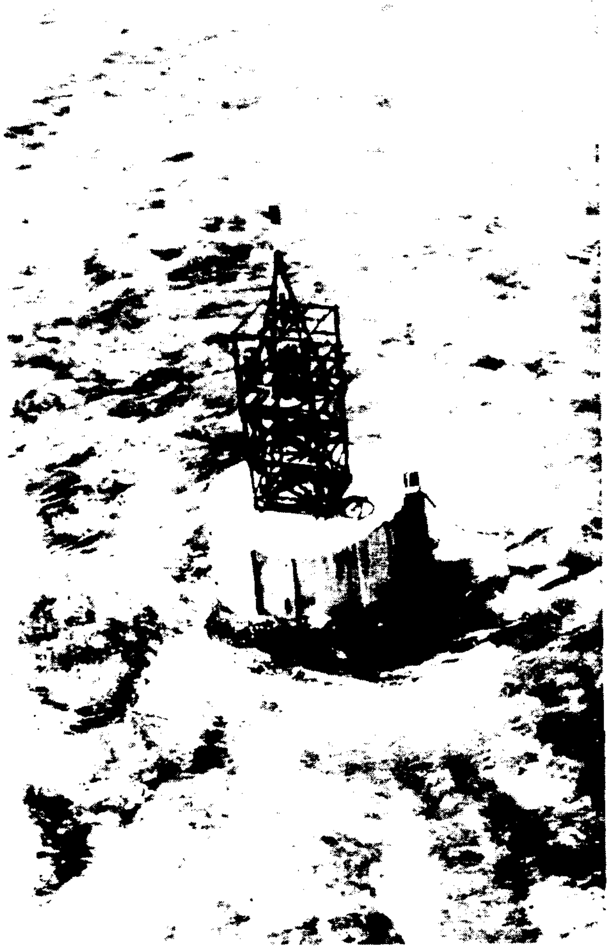


Figure 2-8. Station Oscar

Normal tight survey procedures were used in all cases with a curvature correction applied in accordance with Home Office drawings. Fabri-

Figure 2-9. Early Construction Staking - Nan

cation of the pipe supports in the field made it possible to set supporting channels to grade before being welded. On the final alignment, adjustment screws had to be used on only one of the 470 supports. One contributing factor to this ease of alignment was the steel support, which had insignificant deflection when loaded.

Station 1524 was a fan-shaped array of 38 pipes, 500 feet long. At the mirror house end, the pipes were equally spaced 7′-9″ apart and were at the same elevation. At the Station 24 end they converged with no two pipes on the same grade or line. A coordinate system established on the structural drawings made this layout comparatively simple; consequently, normal survey methods were used. Practically all the work was accomplished in waist deep water on the ocean reef. This station alignment was accepted by the using agency with no subsequent adjustment necessary. Barge Stations 10 thru 15 were all scheduled for positioning in the lagoon off the Dog-George area. Stations 11, 13 and 14 occupied this area but Stations 10 and 12 were later moved to the Flora crater at Gene, and Station 15 was located off the lagoon reef between Charlie and Dog. The procedure for positioning Stations 11, 13 and 14 consisted of mooring the barge at the intersection of predetermined theodolite angles from two known stations. One was a triangulation station located on the roof of Station 1528 and the other a control point located on the reef west of Station 1320 whose precise interrelation was known. Marker buoys for anchor points were set by an LCU, which was directed via radio by instrumentmen using theodolites. The Marine Department then installed the anchors. After the barge was moored, instrumentmen directed the mooring line adjustments until the working point of the barge station was at the planned position. Simultaneously, orientation of the barge station was accomplished by aligning sight points on the barge with Station 1320. The other barge stations were located by the same method: control points for Station 15 were located on Man-Made Islands 1 and 2, and those for Stations 10 and 12 were established on the perimeter of the Mike crater. After each barge was positioned and oriented, stability checks for position were made through simultaneous observations by theodolite instrumentmen. Determination of roll and pitch, veer and yaw was made aboard the barge station.

Figure 2-10. Windbreak Used in Chaining Base Line Station 1310 to Station 24

OFF-ATOLL SURVEYS.

All off-atoll construction of weather stations and scientific facilities at Kapingamarangi, Kusaie, Tarawa, Wotho, Ujelang, Uterik, Rongelap and Rongerik was supported by the Survey Department. Location layout and time and grades were furnished to the Construction Division. As-built plot plans were prepared that included all available information on utilities, sewers, and other underground installations.

At Lele Harbor, Kusaie, the harbor was dragged to a depth of 9′ to facilitate its use as a seaplane landing area, and marker buoys were placed indicating shallows, obstructions, etc. These buoys were located by a survey from shore. The buoy locations were subsequently recorded on a harbor chart.

LOCATIONS OF SECOND ORDER HORIZONTAL CONTROL STATIONS

ENIWETOK ATOLL

STATIONS	PLANE COORDINATES		GEOGRAPHIC POSITIONS	
	NORTH	EAST	N. LATITUDE	E. LONGITUDE
ALICE	138,931.4	52,852.2	11-38-46.348	162-09-16.507
AITSU *	134,162.9	103,130.1	11-37-59.151	162-17-42.440
ANIYAANII	25,713.9	140,549.3	11-28-19.253	162-23-58.730
AOMON	129,741.5	113,580.0	11-37-14.283	162-19-27.584
BOKON	135,470.8	96,441.7	11-38-22.046	162-16-35.139
ENGEBI	144,527.9	86,506.2	11-39-41.964	162-14-55.151
ENIWETOK	36,618.3	124,250.7	11-21-51.469	162-21-14.730
GENE	148,434.2	71,023.6	11-40-20.683	162-12-19.334
ISLET	90,288.2	133,963.1	11-30-43.856	162-22-52.543
IVY	52,534.1	132,451.9	11-24-29.334	162-22-37.224
JAPTAN *	59,804.8	135,874.9	11-25-41.449	162-23-11.664
LILAC *	59,482.0	131,019.3	11-25-38.264	162-22-22.842
MACK	103,791.2	86,389.6	11-32-57.854	162-14-54.033
MUZIN *	142,332.6	88,009.0	11-39-20.189	162-15-10.277
OSCAR	100,000.0	100,000.0	11-32-20.254	162-17-10.944
PIIRAAI	119,601.0	117,554.5	11-35-34.682	162-20-07.557
RIGILI-2	71,860.5	32,190.0	11-27-40.883	162-05-49.036
RUCHI *	143,872.8	61,078.6	11-28-26.544	162-10-50.892
RUJORU *	132,714.7	107,327.3	11-37-44.783	162-18-24.672
RUNIT	99,583.3	128,897.5	11-32-16.080	162-22-01.621
SAND	87,781.7	135,388.3	11-30-18.986	162-23-06.870
YEIRI *	135,047.6	100,567.0	11-38-07.928	162-17-16.650
YVONNE	106,354.5	123,753.6	11-33-23.264	162-21-09.895

BIKINI ATOLL

STATIONS	NORTH	EAST	N. LATITUDE	E. LONGITUDE
ALFA *	124,153.1	59,003.9	11-33-45.872	165-13-32.361
BRAVO *	127,257.2	56,787.3	11-34-16.650	165-13-10.041
CHARLIE	DESTROYED 1953			
CHUCK	171,848.1	82,886.2	11-41-39.135	165-17-32.403
COCA	DESTROYED 1953			
COCA-2	132,475.8	106,257.8	11-35-08.636	165-21-27.706
DACHSY	168,620.1	116,733.6	11-41-07.204	165-23-13.062
FIRE	170,574.8	127,200.6		
FOX	DESTROYED 1953			
GOBELS	167,338.0	131,702.2	11-40-54.490	165-25-43.708
N. HOW	148,398.0	167,092.4	11-37-46.528	165-31-39.801
S. HOW	139,649.2	175,275.8	11-36-19.705	165-33-02.103
JIG *	134,031.4	174,623.8	11-35-23.979	165-32-55.516
LOVE *	124,579.8	177,992.7	11-33-50.203	165-33-29.362
MIKE *	119,842.4	178,173.8	11-33-03.207	165-33-31.160
NAN	105,668.1	178,321.5	11-30-42.595	165-33-32.574
OBOE	103,279.6	127,028.4	11-30-19.029	165-24-56.671
SALT	100,421.6	113,966.8	11-29-50.670	165-22-45.305
UNCLE	99,856.5	99,188.1	11-29-45.033	165-20-16.670
VICTOR *	108,346.5	82,865.3	11-31-09.198	165-17-32.469
YOKE	116,536.8	70,016.8	11-32-30.383	165-15-23.190
ZEBRA *	122,050.7	62,328.9	11-33-25.036	165-14-05.823

* THIRD ORDER STATION

Table 2-1. Location of Second Order Horizontal Control Stations

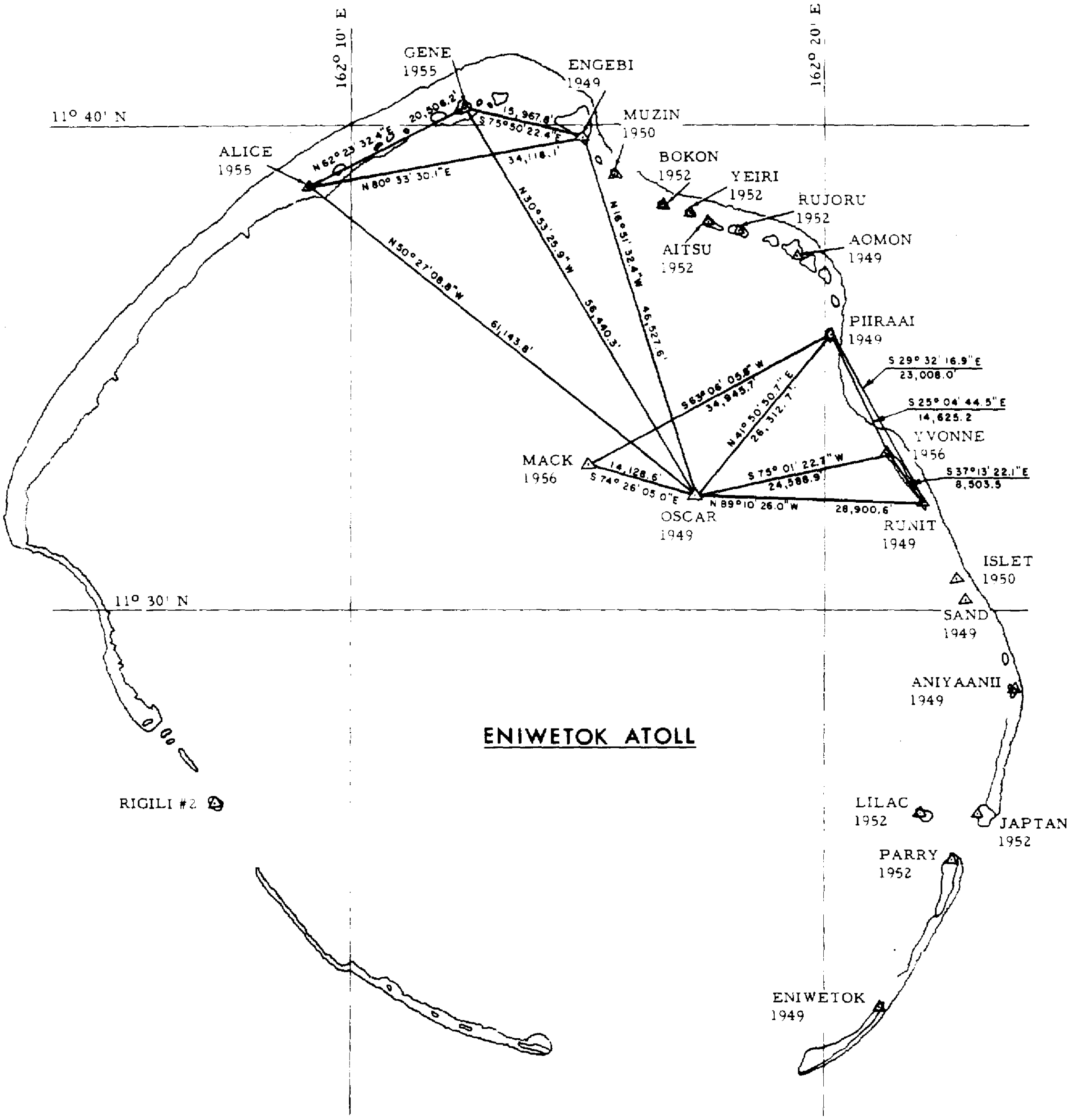


Figure 2-11. 1955 Expansion of Second Order Horizontal Control Network - Eniwetok Atoll

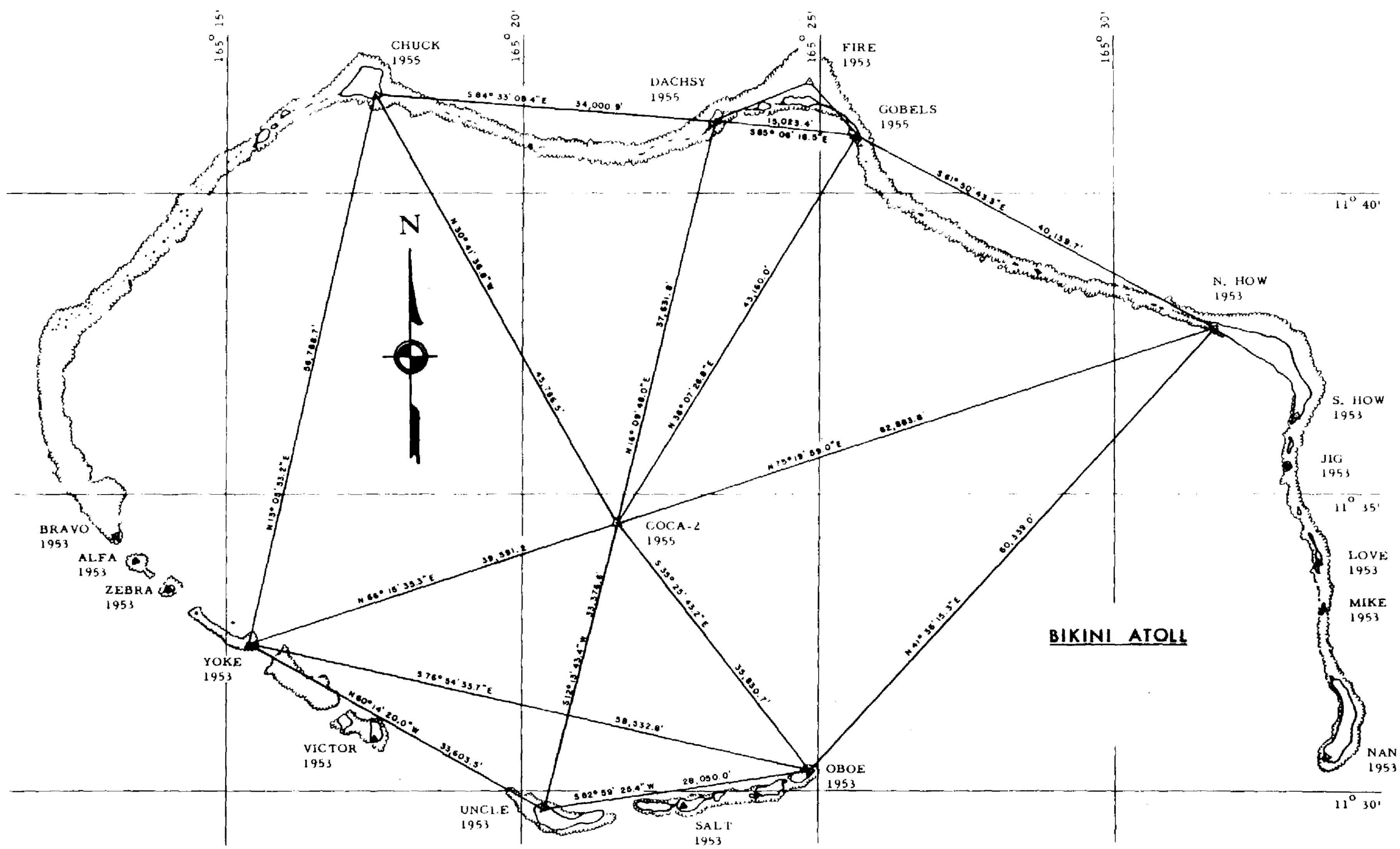


Figure 2-12. 1955 Expansion of Second Order Horizontal Control Network - Bikini Atoll

Figure 2-13. Nan

SECTION 2
CONSTRUCTION

The last detonation of the CASTLE Operation took place on 14 May 1954; thereafter, the construction force was occupied with the recovery of scientific equipment and with placing the Proving Ground in a stand-by condition. In July 1954, the Fred Airfield Improvements Program was authorized, which involved asphalt paving of approximately 300,000 square yards of apron, and seal coating approximately 114,000 square yards of runway. The roll-up phase extended to approximately 1 September 1954 due to the great amount of decontamination and equipment rehabilitation work required. By this date, the reduction of personnel surplus to the needs of the Proving Ground had been affected; there were approximately 700 contractual employees at Jobsite, of which approximately 260 were assigned to the Construction-Maintenance Division.

Shortly thereafter, approval was received for Plant and Equipment projects of Fiscal Year 1955 amounting to approximately $1,500,000.00, the major items of which included a deep water pier for Elmer and eleven barracks for Fred. This approval was followed by authorization for constructing the camp and airport at Nan and miscellaneous other items. The Commission's approval of this work at that particular time permitted full employment of the available men and eliminated the need for further reduction in personnel, thereby assuring a good nucleus of experienced men which could be expanded to meet Operation REDWING requirements.

Construction planning for the Nan camp contemplated the early establishment of logistic and communication lines, advance stockpiling of equipment and construction materials, removal of existing radioactive hazards, establishment of a beachhead camp from which construction activities could expand, early construction of the airstrip, and construction of the camp in three increments. The first increment was to provide the capability of accommodating 250 men, the second was to increase this capability to 500, and the third increment to 1,000 men. To provide for early air support, the Peter-Oboe airstrip was rehabilitated to permit limited air operations until the Nan airport could be placed in operation.

Construction of increment No. 1 of the Nan camp (250-man capacity) and the Nan airstrip was actually authorized on 21 September 1954 with instructions that housing tents were to be erected only on an "as-needed" basis to meet population requirements. The first task group of 29 H&N employees and two AEC representatives departed Elmer in the USS Belle Grove (LSD) on 9 October. This vessel made three round trips, through which equipment and materials were stockpiled at Nan as previously planned. This task group, supported by an LCU outfitted as a houseboat, was engaged in preparation of the area for occupancy. The reuse of the old Nan camp site had been contemplated in order to utilize existing concrete slabs and utility lines, but attempts to decontaminate the concrete slabs were not satisfactory since most of the readily removable or soluble irradiated particles had been previously washed off by normal rains, and further decontamination was impracticable; therefore a new camp site was selected.

With the arrival of LST 618 at the PPG on 30 October 1954, the Eniwetok-Bikini LST shuttle service was established. On 5 December, 34 H&N employees were landed at Nan for permanent assignment. This force was gradually augmented, and by the end of 1954 there were 150 men employed at Nan. Construction of all approved items proceeded in a routine manner in the early months of 1955. Reconnaissance of other probable construction sites was made during this period to determine logistics and problems involved in an operation with a scientific structures program similar to CASTLE. Checks of radiation levels indicated that rad-safe control measures were required at practically all sites in Bikini Atoll and in the northern islands of Eniwetok Atoll until levels could be satisfactorily reduced through normal clearing and grading operations. By the end of March 1955, the operating force had been increased to 850 men; the second increment of the Nan camp had been approved and was nearing completion and satisfactory progress was made on approved work in both Atolls. Interatoll communication and logistic lines were well established; the first plane had landed on the airstrip at Nan on 15 March; the deep water pier and barracks construction were ahead of schedule; a camp-issue building and an electrical overhaul shop were completed at Elmer; the Tilda and Elmer airstrips had been rehabilitated; and numerous miscellaneous items had been undertaken.

In March 1955, the Contractor undertook the construction of a small camp, radio station, and appurtenances on the islands of Jabor, Kili, and Majuro. Reconnaissance of the proposed construction sites to determine the best approaches and beaches for landing materials had been made in November 1954. The Majuro and Jabor missions were completed by 6 April. Inclement weather prevented landing men and materials on Kili Island; the materials for this project were therefore landed at Jabor for use by Trust Territory personnel in accordance with an agreement between the AEC and Trust Territory authorities.

In early March 1955, the scope of work involved with scientific stations and other facilities needed in support of these stations was delineated sufficiently to permit planning camps, locating sites for aggregate quarries and concrete batching plants, establishing material stockpiles of construction items, and projecting manpower, equipment, and marine craft requirements. This planning contemplated those problems that are characteristic of operations at the PPG. The need for flexibility in plans was essential because of the program changes that would inevitably occur. These changes in scope of work, combined with budgetary requirements and limited transportation, called for careful checks and balances to assure adequate anticipation of manpower, equipment, and materials. Because the extent of work ultimately far exceeded the original scope, hurried increases in manpower, equipment, and construction materials had to be effected late in the construction phase of the Operation.

Construction of 200-man camps at Yvonne and Ursula was authorized on 15 April 1955, a 125-man camp was authorized at Fox on 30 April, and 200-man camps were authorized at Tare and Gene on 9 June 1955. The construction of these shot-island camps was routine and followed along well-established lines.

Figure 2-14. Dredging

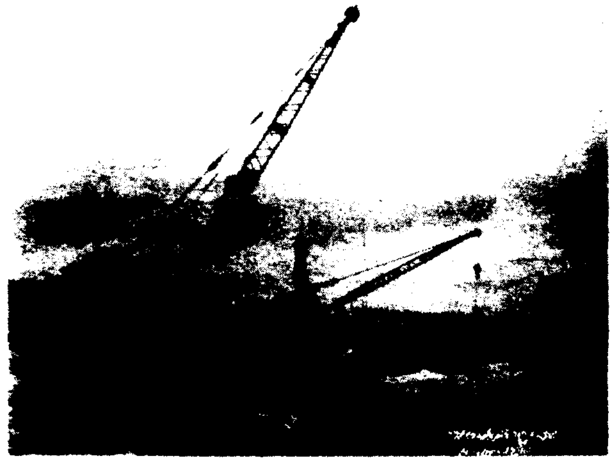


Figure 2-15. Bulkhead Construction

From April 1955 until early October 1955, the construction force was primarily engaged in work on these camps and other temporary base facilities needed in connection with the scientific test program. The airstrips at Elmer, Yvonne, Ursula, and Janet were placed in operable condition, and the causeways linking Dog-Charlie, Ruby-Sally, Gene-Irene and Sugar-Tare were reconstructed. An LST ramp and mole was built at Nan and the facilities at all sites for landing men and materials by marine craft, were improved or rebuilt. In August, funds were made available for construction of the warehouses, shops, and the Administration-Operations building as well as the expansion of POL facilities at Fred; construction on several of these structures was started in September 1955. On 9 September, the first mission for the establishment of weather stations departed Elmer for Kapingamarangi.

During this period very little could be accomplished with respect to scientific structures because criteria had not been firmed sufficiently to permit release of drawings, with the result that by 15 October construction progress in this phase was estimated to be only 2 per cent complete. In early October, drawings were received and work was started on the construction of three man-made islands on the Dog-Charlie reef, two causeways and an island off Yvonne, and a causeway off Sally, all of which were required in connection with scientific projects. About this time work was also started on bases to be used as zero stations and on tower and guy anchor footings for zero towers. Shortly thereafter, working drawings for the various other stations started to arrive at Jobsite. By the end of December 1955, the construction effort had been shifted mostly to scientific structures work.

Figure 2-16. Gene - Helen - Irene

A tight construction schedule developed, resulting in an extremely high production requirement. The compressed timetable was primarily due to the receipt of approved working drawings later than had been anticipated. This also affected the material situation, since specially designed items could not be ordered until drawings were well advanced or at least until design criteria were firm. Construction on several stations was further complicated by receipt of changes in approved drawings after construction had started. In order to complete stations as scheduled, it was necessary to work more overtime than was expected. Two shifts were required in the construction of vacuum pipe arrays at Yvonne. Substitution of materials available at the Jobsite and some improvisations, combined with the expeditious supply of critical items through greatly increased use of air transport, made it possible to maintain satisfactory progress. Over-all progress of Job 1 construction is illustrated in Chart 2-1.

Construction progress of Expendable Test Facilities, based on the Estimated Operations Schedule is shown by Chart 2-2, and 2-3. Previous discussion noted the need for revising the operations schedule as the scope of work increased. By 4 November, the majority of criteria was considered firm and progress was then reevaluated based on the revised schedule issued on this date. This is reflected in Chart 2-3 which shows a drop in the predicted progress from 43 per cent in November 1955 to 36.93 per cent in December 1955. Basically, this indicated that a large portion of the work load was shifted to the latter months of the construction phase of the Operation. Throughout the early months of 1956, very satisfactory progress was achieved. Every effort was made to complete various construction projects early enough to permit beneficial occupancy by the Users so that their instrumentation could be accomplished in time to meet target dates. Considerable overlapping of construction and instrumentation activities occurred. Through some sacrifices by User personnel in shortening beneficial occupancy time and partially eliminating their pre-test dry runs, all stations were readied in time. This may be noted from Figure 2-3, which indicates that by 1 May 1955 much of the lag in progress had been overcome and that the schedule for scientific Test facilities was essentially met.

The construction progress of permanent base projects is shown in charts at end of this discussion. Due to the urgency that developed in construction of expendable test facilities, it became necessary to concentrate men and equipment on this work and to defer the construction of less vital permanent base projects. Therefore, the actual progress attained on over-all permanent base construction was not in phase with predicted progress. However, when men and equipment could be spared from work on scientific facilities, the work on deferred projects was undertaken again.

Figure 2-17. Placing Planking for Bulkhead

One of the most difficult problems experienced was that of scheduling the use of construction equipment, since sufficient equipment was not always available to adequately outfit the construction crews at each site. This was especially true of concrete-placing and welding equipment, trucks, cranes and trailers. Of particular significance in this respect was the requirement for such equipment at off-atoll construction sites. This equipment had to remain away from the main bases throughout the construction period as the supporting vessels made only one call at each site. The over-all problem was overcome by carefully planning equipment usage for the construction phase of each structure with the idea of utilizing all equipment. This involved a considerable movement of equipment between sites in order to meet requirements. It also necessitated rigid scheduling of the various crafts in order that placement of reinforcing steel, and electrical, mechanical, and other related items would fit the plan for equipment usage.

Extensive construction activities were required on the reefs at both Eniwetok and Bikini Atolls. Tidal conditions and weather were important factors. To overcome the difficulties inherent to working in sea water of varying depths, various measures were employed. Concrete was precast where practicable. In some cases forms were prefabricated, then set at low tide, and concrete was poured using tremies. Equipment had to be serviced frequently and even with the most thorough preventive maintenance, salt water action seriously impaired its life. To reduce shutdowns because of breakdowns, mixers of two transit-mix trucks were removed from their chassis and installed on trailers. Wagon drills and compressors used in aggregate production and a crane used for pile driving were similarly mounted. This not only reduced breakdowns but permitted work to proceed on the reefs for longer periods. During December 1955, the Proving Ground was subject to heavy seas, which periodically occur in this area. This caused considerable damage to construction in place on the reefs, the deadlining of some heavy equipment, and the loss of a number of small tools. These conditions occurred during a period of intense activity. By concentrating men and equipment on the affected projects, the temporary setback in progress caused by these high seas was overcome without a serious effect on the over-all program.

Exploration was made early in the program to determine suitable sources of coral aggregate; possible reef locations were selected from samples tested by the Field Engineering Force. As the aggregate was generally obtained from these reef locations, the rate of production was necessarily slow due to normal difficulties encountered in subaqueous excavations. The use of wagon drills and compressors mounted on trailers permitted operations to proceed at higher tide levels than normally possible had standard wheel-mounted wagon drills been used. To ensure maximum production with minimum operational interference, all blasting was performed after the regular working day. Stockpiling of the aggregate was both logical and economical. The testing laboratory made two gradation checks on each day's operation to ensure that aggregate was within specified gradation limits.

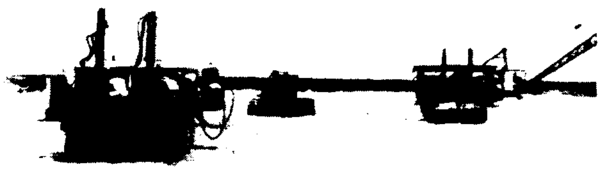


Figure 2-18. Trailer Mounted Drills

Figure 2-20. Aggregate Stockpile - Elmer

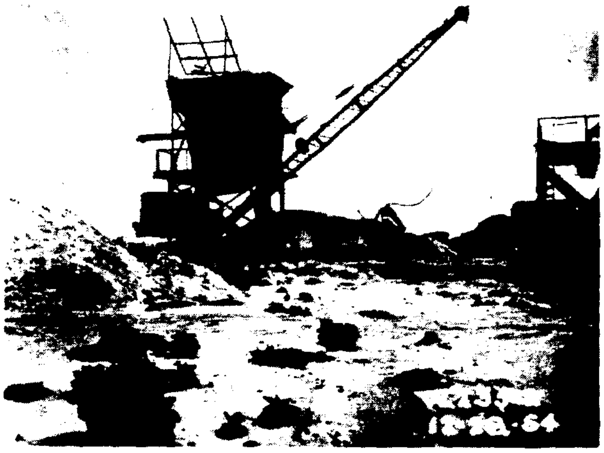


Figure 2-19. Batch Plant - Nan

Figure 2-21. Grading and Rolling - Airfield

Main batch plant locations were determined by the quantity of concrete required at each site. Main plants were set up on sites Elmer, Fred, Yvonne, Ursula, Gene, Janet, Nan, Tare, and Fox. Small concrete requirements were met by precasting where practicable or through the use of small mixers. The time-consuming operation of hand-loading cement into the main batch plant hopper was eliminated by using a conveyor belt that dropped the racks of cement on a short roller above the mixing box. A sharp knife projecting above the rollers, automatically ripped open the sacks and the cement then passed through a large mesh screen into the hopper, after which the sacks were retrieved. This reduced the number of personnel that operated the cement batcher from six to three and also eliminated the need of a special platform for the men and cement.

Unusual care was necessary in pouring concrete for those structures designed with great amounts of reinforcing steel. Physical characteristics of the concrete used and the inspection of construction have been discussed under Tests and Inspection, Section 1, of this Chapter. The concrete poured monthly in Eniwetok and Bikini Atolls is shown in Figure 2-25. Approximately 205,000 bags of cement and 2,700 tons of reinforcing steel of various sizes were required for Operation REDWING.

Mobilization of manpower was effected to provide a build-up of personnel in phase with the planned availability of working drawings and materials and within budgetary requirements. Personnel requirements had to be periodically re-evaluated to keep abreast of the changing program. In January 1956, it was apparent that because of the late receipt of working drawings, it would be necessary to accelerate scientific station construction beyond that originally planned. Emergency increases in personnel were effected. However, because of the long period required for recruiting, the relatively short period of probable employment of new employees, and a tight labor market, it was impracticable to hire all the additional men required to effect this acceleration.

The authorized work week was 54 hours. Any requirements for work in excess of 54 hours were carefully scrutinized by management and had to be justified before approval was granted. Prior approval of overtime in excess of 8 hours per week was obtained from the Manager, Eniwetok Branch Office and all cases of overtime were documented. The need for acceleration in construction also affected personnel engaged in services collateral to construction, and overtime was required at intermittent intervals in unloading ships, for marine, camp, and warehouse operations, and administrative services. The entire overtime pay in excess of 54 hours during the period of 1 July 1955 through April 1956, a period covering most of the construction phase, average six per cent of the total payroll. Maximum use of overtime was required during the critical month of April 1956. Overtime pay during this month rose to 17 per cent of the gross pay for the month. In view of the conditions that existed with respect to the tight construction schedule, this overtime was not excessive.

In a project of such complexity and magnitude as Operation REDWING, all eventualities could not possibly be anticipated and rapid scientific advancement during the planning period required a constant modification of plans. With the cooperation of the representatives of AEC and the various other agencies involved, the project was carried through to the successful tests of 1956.

Figure 2-22 Clearing for Airstrip - Nan

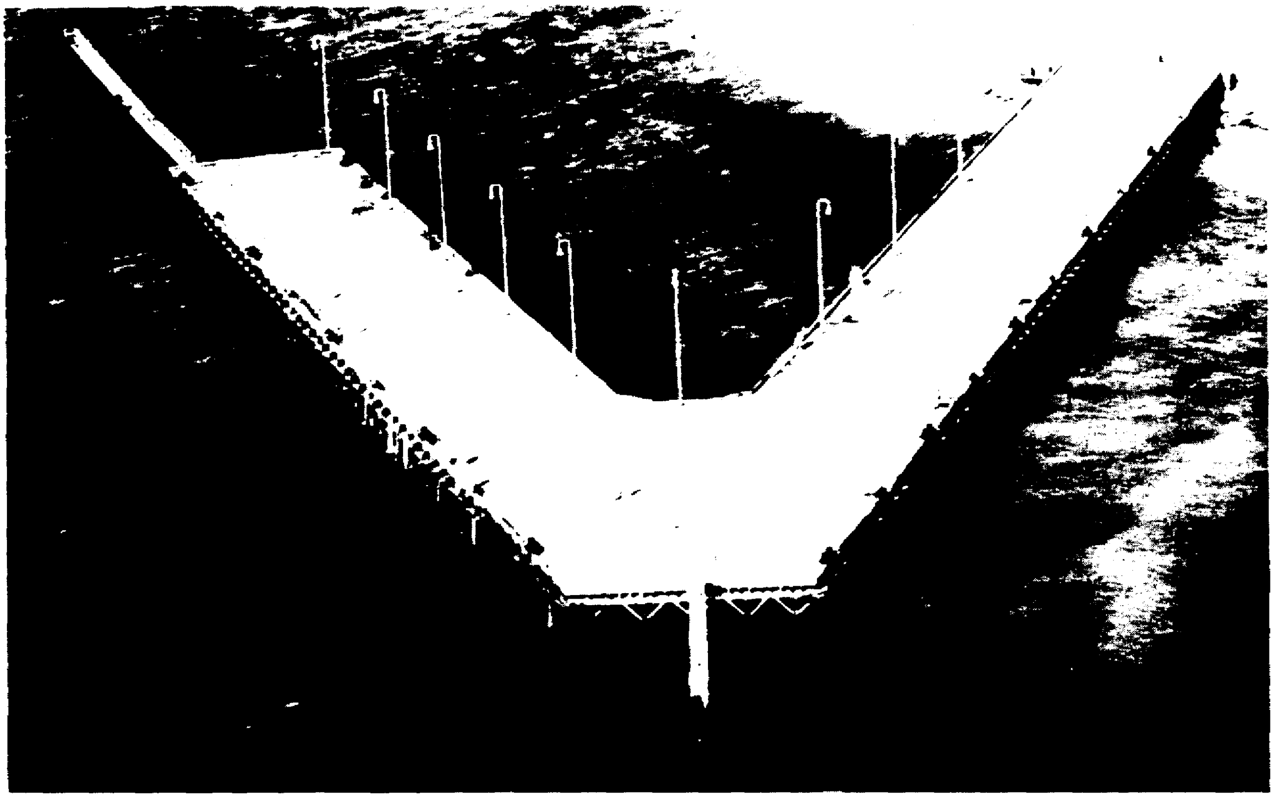


Figure 2-23. Deep Water Pier - Elmer

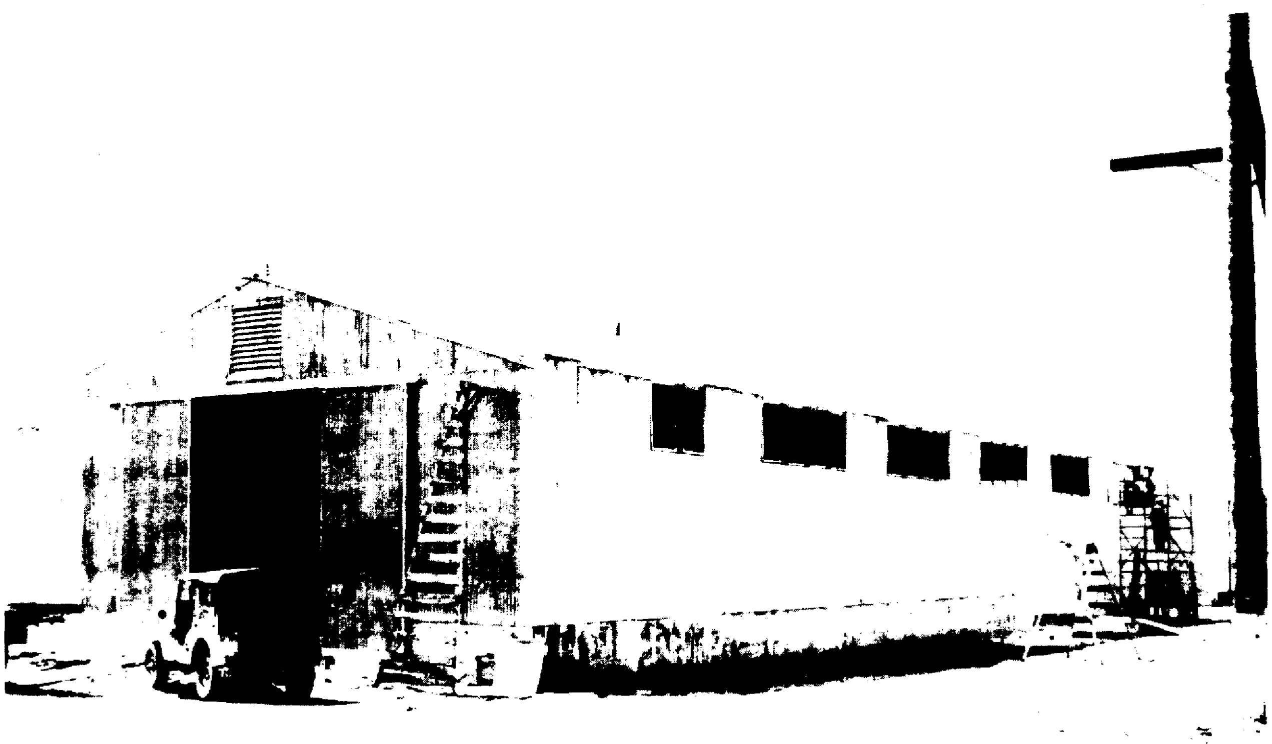


Figure 2-24. Typical Warehouse Construction - Fred

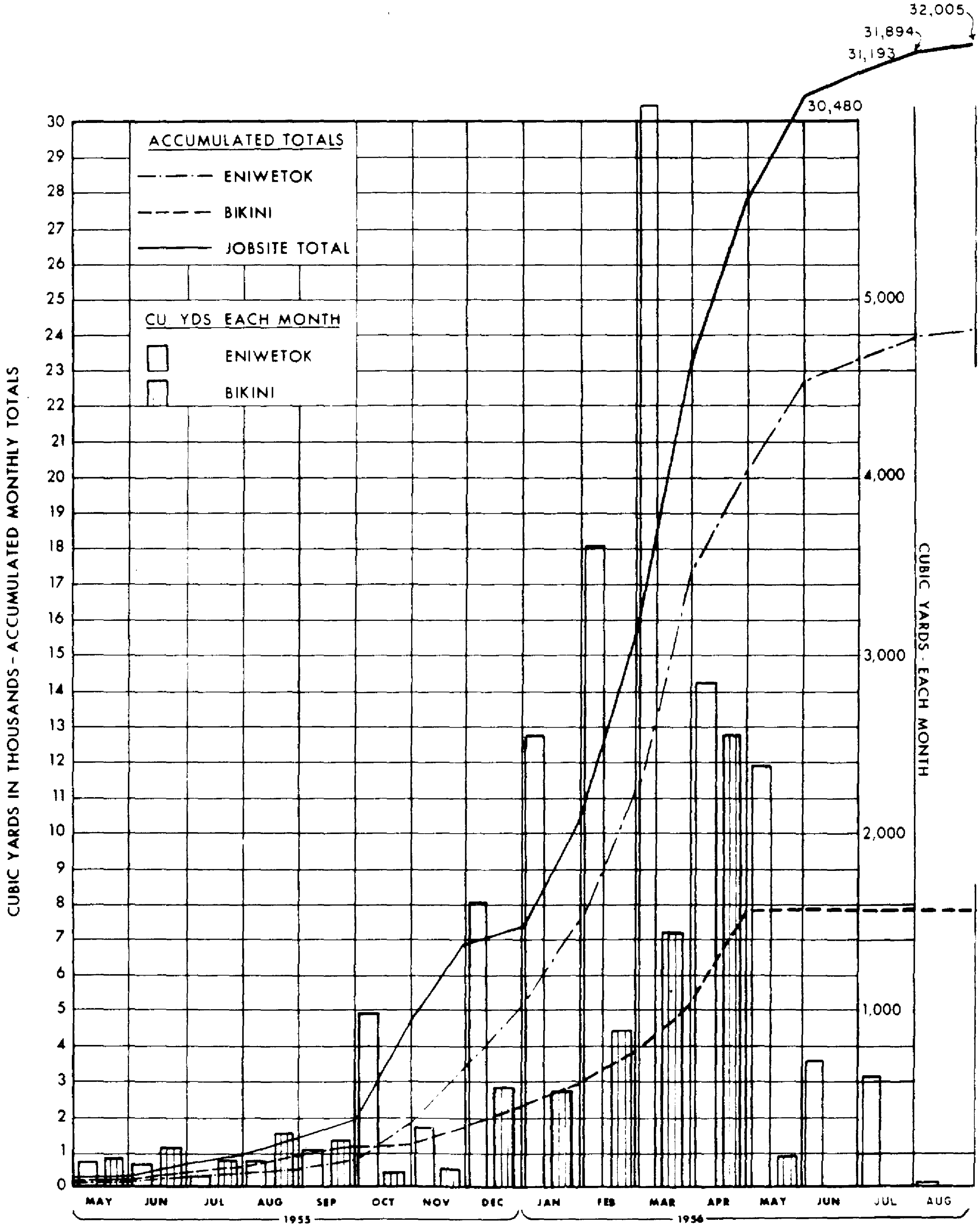
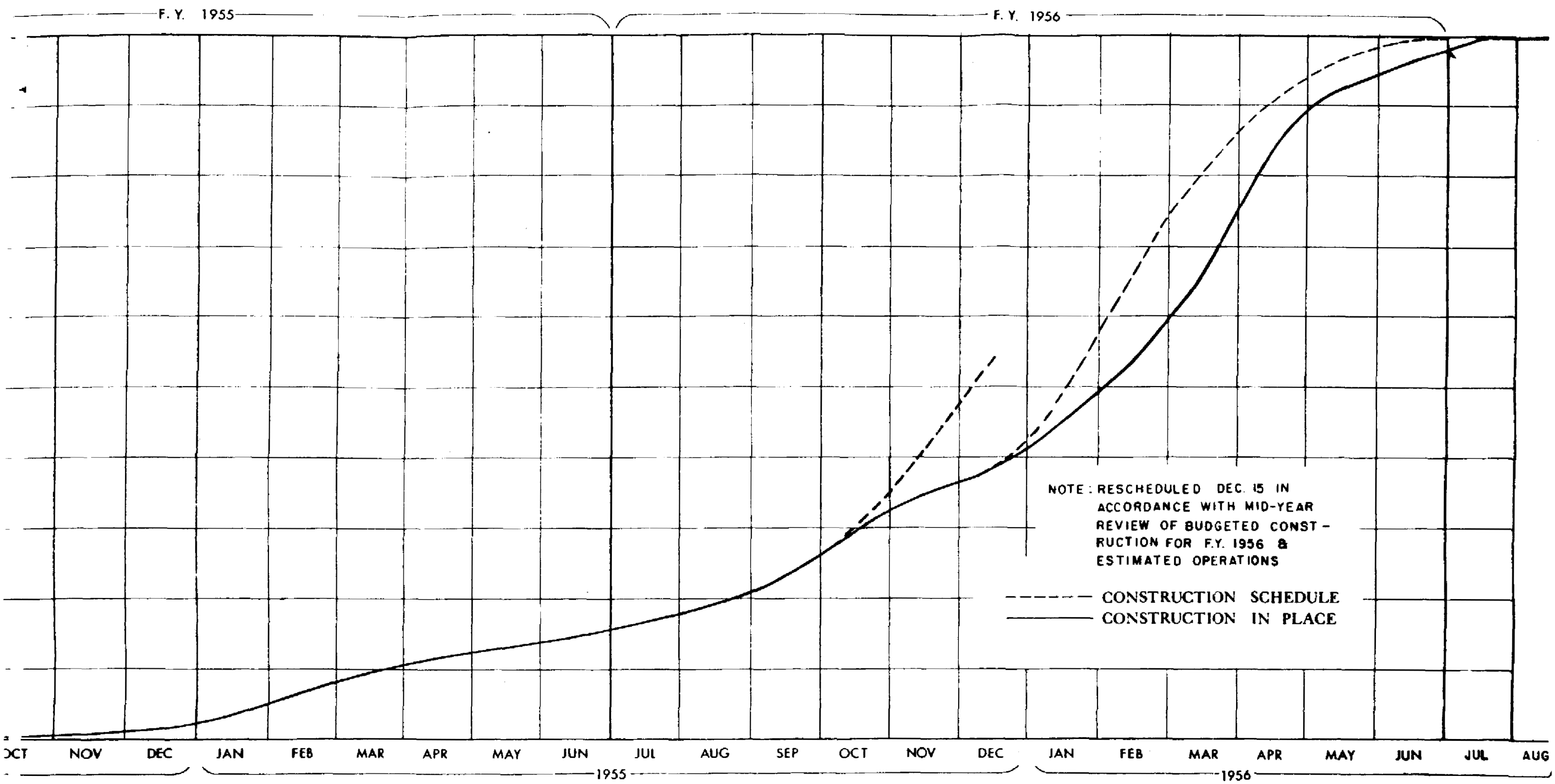
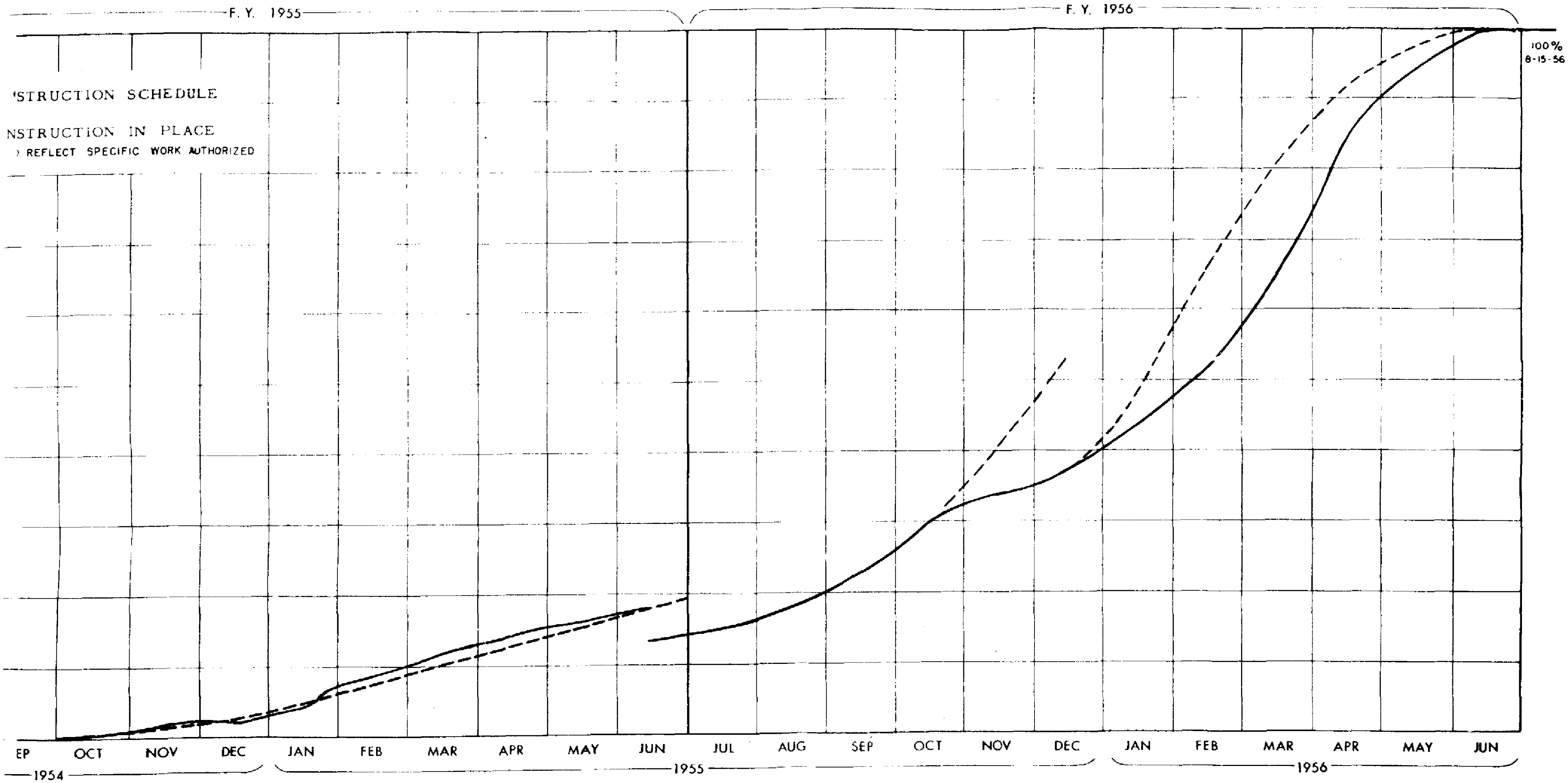


Figure 2-25. Concrete Poured - Both Atolls



ction Progress Composite Curve
and FY 1956 Funds



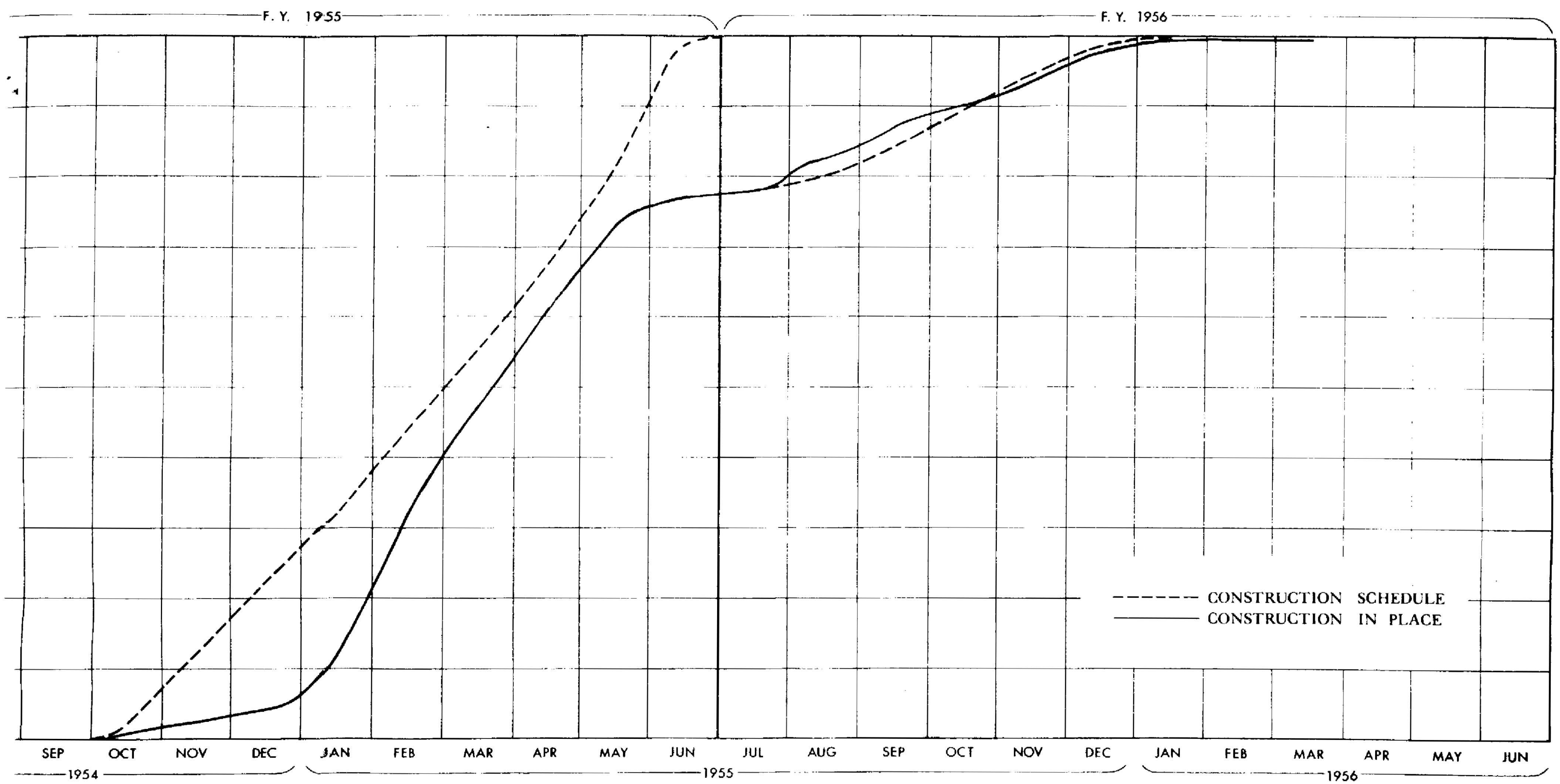
2. Total Budgeted Construction Program
ıdable Test Facilities FY 1955 and FY 1956

CONSTRUCTION ITEM	1955 JUL	AUG	SEP	OCT	NOV	DEC	1956 JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
SCIENTIFIC STATIONS - AEC			.57	6.00	24.00	16.33	33.50	57.27	76.85	92.26	98.78	100.00			
			.57	2.10	6.04	16.33	25.65	39.68	60.87	80.15	90.55	99.40	100.00		
SCIENTIFIC STATIONS - DOD				6.00	24.00	13.66	26.75	50.98	72.72	86.48	98.56	100.00			
				.20	2.83	13.66	17.16	22.73	44.00	83.22	91.23	100.00			
CAUSEWAYS	16.00	24.00	34.00	52.00	68.00	85.00	100.00								
	23.74	29.25	34.26	38.38	76.92	85.00	86.00	95.40	98.00	99.50	100.00				
INTERATOLL COMMUNICATIONS				5.88	30.00	81.40	100.00								
				5.88	43.67	81.40	81.40	81.40	85.67	85.80	99.50	100.00			
SUBMARINE CABLE							50.00	100.00							
							5.00	5.00	21.88	85.00	100.00				
ELECTRICAL POWER, COAX CABLE, TELEPHONE & SIGNAL							10.00	54.92	84.92	100.00					
							0.00	0.00	32.30	72.00	99.01	100.00			
USERS TEST FACILITIES			.40	6.00	18.00	12.60	20.76	29.32	40.40	91.25	100.00				
			.40	2.08	6.75	12.60	20.76	29.32	40.40	91.25	98.00	99.50	100.00		
MISCELLANEOUS TEST CONSTRUCTION OTHER THAN SCIENTIFIC STATIONS	3.65	4.66	14.09	24.27	44.84	54.08	67.76	76.79	91.18	100.00					
	3.65	4.66	14.09	24.27	44.84	54.08	67.76	76.79	91.18	95.00	99.00	99.50	99.50	100.00	
MISCELLANEOUS EXPENDABLE CONSTRUCTION INCLUDING REIMBURSABLE	28.00	35.00	45.00	47.00	49.00	51.59	53.03	61.57	71.87	78.98	86.92	100.00			
	20.12	22.60	28.01	34.30	39.91	52.00	53.03	61.57	71.87	78.98	86.92	99.00	99.50	100.00	
TEMPORARY CAMPS	64.98	72.50	78.46	91.18	96.80	99.00	100.00								
	64.98	72.50	78.46	91.18	96.80	99.00	99.77	99.87	99.90	99.95	99.95	100.00			
TOTAL EXPEND. CONST. FY 1956	15.15	19.00	21.00	29.00	43.00	36.93	48.00	65.65	79.78	90.67	97.44	100.00			
	15.15	19.00	22.00	29.00	34.00	36.93	42.82	51.09	64.61	84.43	92.75	99.44	99.92	100.00	

75.00 CONSTRUCTION SCHEDULE ESTIMATED PERCENT

75.00 CONSTRUCTION IN PLACE PERCENT COMPLETED

Chart 2-3. Construction Progress, Expendable Test Facilities FY 1956



-4. Total Budgeted Construction Program - Plant & Equipment Funds FY 1955 Project 5026

CONSTRUCTION ITEM		OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	REMARKS
		1954			1955												1956						
SECOND SUBMARINE CABLE - ELMER/FRED	Schedule										79.00	85.00	100.00										
	In place										79.00	79.00	79.00	84.00	85.00	97.00	99.0C	100.00					
FIRE PROTECTION - ELMER	Schedule										4.00	22.00	38.00	61.00	80.00	100.00							
	In place										4.00	16.00	49.00	57.00	79.00	94.00	98.00	99.50	99.50				
BARRACKS - FRED	Schedule	6.00	13.00	21.00	29.00	37.00	49.00	64.00	78.00	92.00	99.00	100.00											
	In place	0.00	0.00	5.00	26.00	45.00	56.00	65.00	98.00	99.00	99.00	100.00											
MILITARY POLICE HDQTRS. - FRED	Schedule							25.00	75.00	100.00	98.00	100.00											
	In place							0.00	14.00	87.00	98.00	99.00	100.00										
DEEP WATER PIER - ELMER	Schedule	0.00	17.00	34.00	51.00	68.00	85.00	95.00	100.00														
	In place	1.14	2.00	2.00	6.00	34.00	61.00	[illegible]	100.00														
GUEST HOUSE - FRED	Schedule										99.00	100.00											
	In place										99.00	99.00	99.00	99.00	100.00								
CAMP & COMMUNICATIONS FACILITIES - DAVID	Schedule										13.00	20.00	50.00	85.00	100.00								
	In place										13.00	56.00	76.00	78.00	87.00	99.60	100.00						
MACHINE SHOP - ELMER	Schedule													15.00	45.00	85.00	100.00						
	In place													22.00	59.00	77.00	81.00	83.00	83.00				
MISC. CONSTRUCTION - FRED/ELMER	Schedule	6.00	10.00	14.00	18.00	22.00	26.00	30.00	70.00	100.00	84.00	87.00	89.00	92.00	95.00	97.00	100.00						
	In place	6.00	10.00	14.00	18.00	22.00	26.00	30.00	36.00	45.00	84.00	87.00	89.00	92.00	95.00	97.00	100.00						
SUMMARY OF PROJECT 5026	Schedule	2.80	11.96	23.73	33.14	44.91	56.36	68.06	80.53	100.00	77.90	80.31	84.91	87.84	95.07	98.70	100.00						
	In place	1.21	1.16	4.29	13.76	32.00	48.00	61.00	73.00	77.00	77.90	83.00	87.01	89.90	94.00	97.80	98.71	98.93	98.93				

75.00 CONSTRUCTION SCHEDULE ESTIMATED PERCENT

75.00 CONSTRUCTION IN PLACE PERCENT COMPLETED

Chart 2-5. Construction Progress of Project 5026 - Plant & Equipment Funds FY 1955

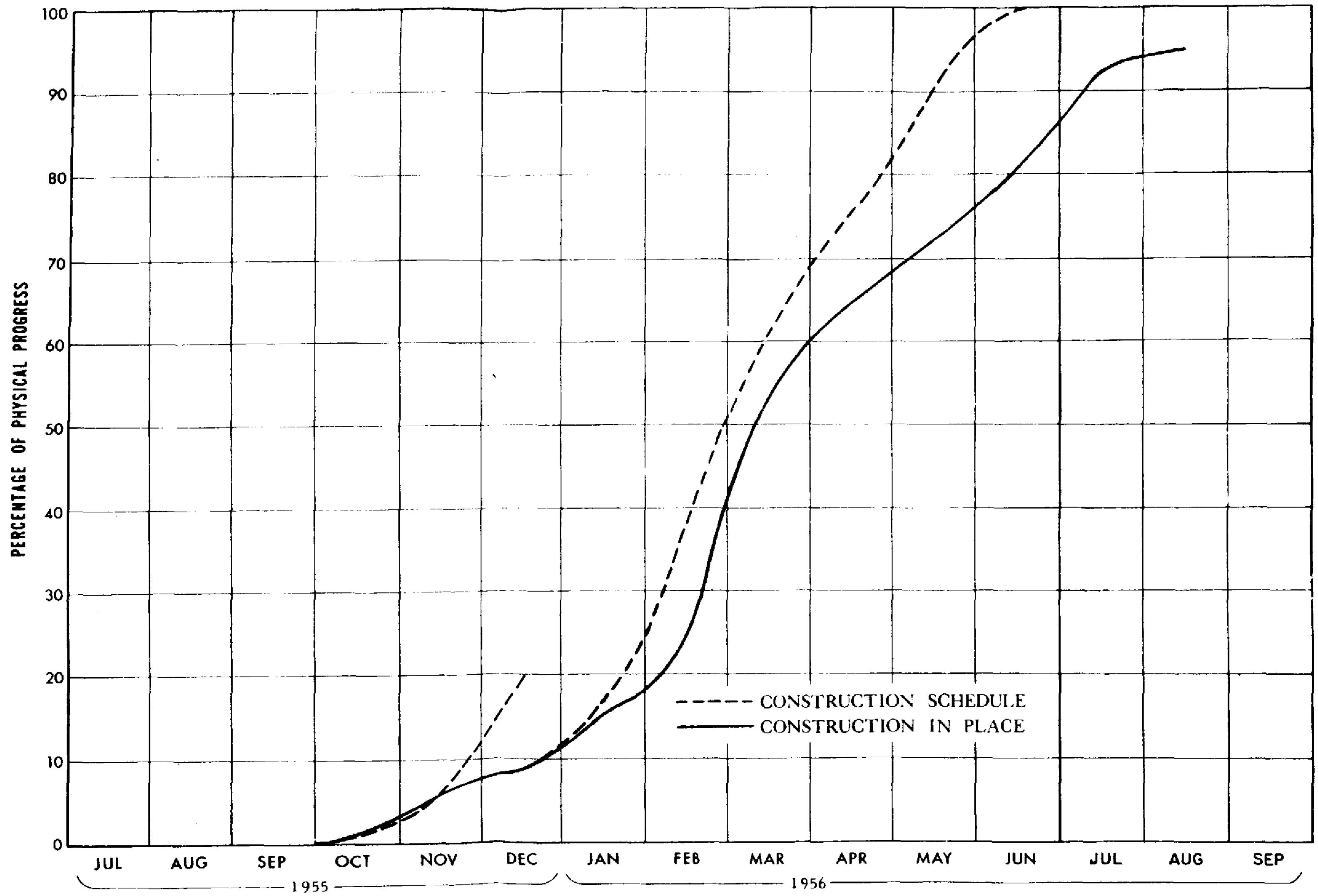


Chart 2-6. Total Budgeted Construction Program - Plant & Equipment Funds FY 1956 Project 6001

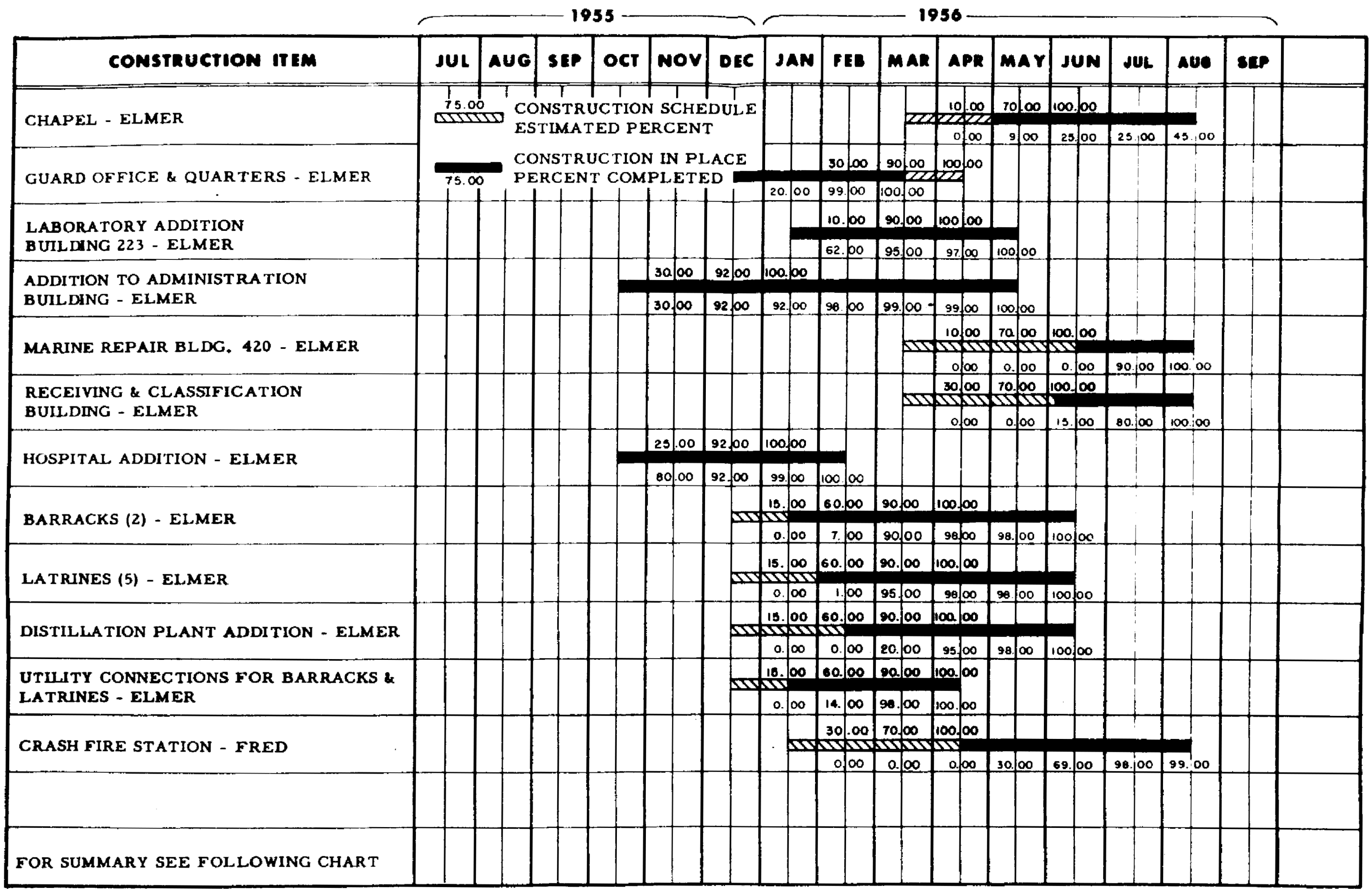


Chart 2-7. Construction Progress of Project 6001 Plant & Equipment Funds FY 1956 - Sheet 1 of 2

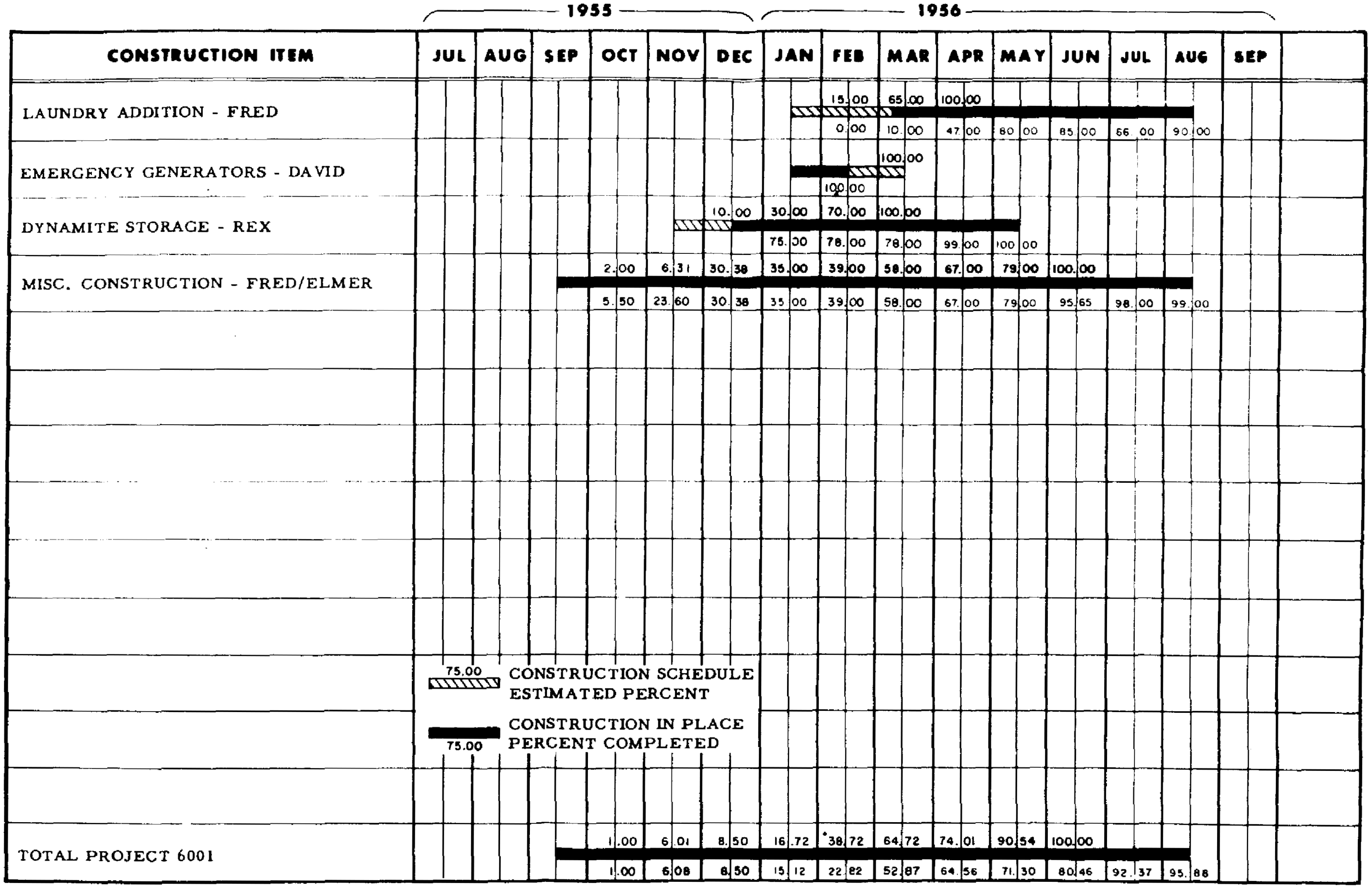


Chart 2-7. Construction Progress of Project 6001 Plant & Equipment Funds FY 1956 - Sheet 2 of 2

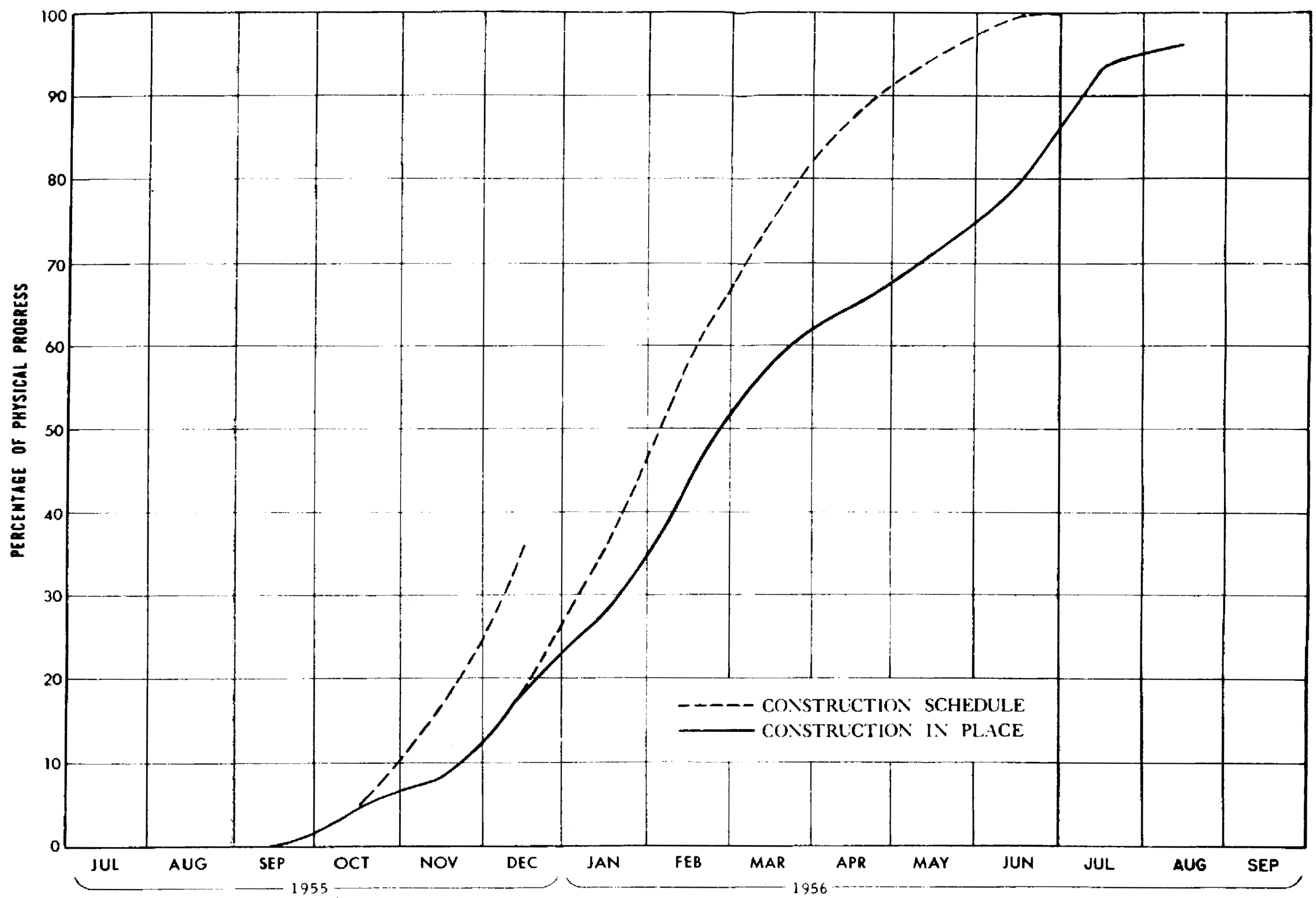


Chart 2-8. Total Budgeted Construction Program - Plant & Equipment Funds FY 1956 Project 6011

CONSTRUCTION ITEM		1955 JUL	AUG	SEP	OCT	NOV	DEC	1956 JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
CABINET SHOP & CONSTRUCTION MAINT. OFFICE - BLDG. 427 - ELMER	Schedule										25.00	75.00	100.00			
	In place										0.00	0.00	0.00	20.00	40.00	
PAINT SHOP - BLDG. 424 - ELMER	Schedule										25.00	75.00	100.00			
	In place										0.00	0.00	5.00	40.00	75.00	
PAINT STORAGE - BLDG. 425 - ELMER	Schedule										25.00	75.00	100.00			
	In place										0.00	0.00	0.00	20.00	70.00	
POL FACILITIES IMPROVEMENT - ELMER	Schedule								15.00	40.00	70.00	90.00	100.00			
	In place								0.00	0.00	1.00	9.00	44.00	88.00	98.00	
OPERATIONS & ADMINISTRATION BLDG. 679 - FRED	Schedule				6.00	40.00	47.00	80.00	95.00	100.00						
	In place				6.00	13.50	47.00	85.00	93.00	99.00	99.00	99.00	100.00			
CHAPEL - BLDG. 678 - FRED	Schedule				1.00	35.00	1.00	10.00	35.00	75.00	100.00					
	In place				1.00	1.00	1.00	1.00	1.00	10.00	12.00	40.00	78.00	97.00	100.00	
CONSOLIDATED FIELD MAINTENANCE SHOP - BLDG. 682 - FRED	Schedule								25.00	75.00	100.00					
	In place								85.00	95.00	99.00	100.00				
CONSOLIDATED FIELD MAINTENANCE SHOPS - BLDGS. 683 & 684 - FRED	Schedule							15.00	55.00	85.00	100.00					
	In place							0.00	20.00	28.00	39.00	65.00	84.00	100.00		
ELECTRONICS & COMMUNICATIONS BLDG. 681 - FRED	Schedule						1.00	10.00	60.00	90.00	100.00					
	In place						1.00	6.00	12.00	15.00	68.00	98.00	100.00			
ORDNANCE WAREHOUSE BLDG. 642 - FRED	Schedule								25.00	45.00	65.00	80.00	100.00			
	In place								55.00	94.00	98.00	98.00	100.00			
QM EXPENDABLE WAREHOUSE BLDG. 643 - FRED	Schedule							15.00	45.00	60.00	80.00	100.00				
	In place							0.00	2.00	2.00	2.00	20.00	65.00	98.00	100.00	
QM SALES WAREHOUSE BLDG. 644 - FRED	Schedule							15.00	45.00	80.00	80.00	100.00				
	In place							0.00	0.00	0.00	0.00	15.00	23.00	78.00	100.00	

FOR SUMMARY SEE FOLLOWING CHART

75.00 CONSTRUCTION SCHEDULE ESTIMATED PERCENT

75.00 CONSTRUCTION IN PLACE PERCENT COMPLETED

Chart 2-9. Construction Progress of Project 6011 - Plant & Equipment Funds FY 1956 - Sheet 2 of 2

	1955						1956								
CONSTRUCTION ITEM	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**
QM NON-EXPENDABLE WAREHOUSE BLDG. 641 - FRED				17.00	60.00	96.00	100.00								
				17.00	57.00	96.00	99.00	100.00							
AIR FORCE SUPPLY WAREHOUSE BLDG. 648 - FRED				36.00	60.00	96.00	100.00								
				36.00	88.00	96.00	97.00	98.00	98.00	98.00	99.00	100.00			
AIR FORCE SUPPLY WAREHOUSE BLDG. 649 - FRED						22.00	80.00	100.00							
					1.00	22.00	76.00	98.00	98.00	98.00	99.00	100.00			
AIR FORCE SUPPLY WAREHOUSE BLDG. 650 - FRED							40.00	80.00	100.00						
							41.00	97.00	98.00	98.00	99.00	100.00			
AIRCRAFT ENGINE BUILD-UP & STORAGE - BLDG. 646 - FRED						6.00	60.00	80.00	100.00						
						6.00	23.00	45.00	90.00	94.00	98.00	100.00			
NAVY EQUIPMENT & STORAGE BLDG. 651 - FRED							38.00	60.00	85.00	100.00					
							1.00	9.00	42.00	46.00	85.00	85.00	100.00		
POL FACILITIES - FRED						2.00	30.00	70.00	90.00	100.00					
						2.00	13.00	41.00	70.00	95.00	96.00	97.00	100.00		
DEMOLITION & REMOVAL EXISTING STRUCTURES FOR NEW BUILDINGS - FRED								24.00	47.00	100.00					
								90.00	90.00	100.00					
SUMMARY OF PROJECT 6011				3.00	21.00	17.11	35.32	57.96	75.35	87.61	93.57	100.00			
				3.34	8.25	17.11	27.82	43.87	58.52	64.30	70.68	79.75	92.24	96.65	

75.00 CONSTRUCTION SCHEDULE ESTIMATED PERCENT

75.00 CONSTRUCTION IN PLACE PERCENT COMPLETED

Chart 2-9. Construction Progress of Project 6011 - Plant & Equipment Funds FY 1956 - Sheet 1 of 2

SECTION 3
SCIENTIFIC STATIONS

INDEX OF EVENTS

ZERO STATIONS	EVENTS
1	Kickapoo
2	Yuma
3	Mohawk
4	Inca
6	Erie
7	Blackfoot
10	Huron
11	Navajo
12	Apache
13	Flathead
14	Dakota
15	Tewa
18	Cherokee
19	Osage
22	Zuni
23	Seminole
24	LaCrosse

The above list shows the zero stations in numerical sequence with the applicable event names as used in Operation REDWING. In the text that follows, the participation of each station in various events is shown by listing the appropriate zero Station. The stations are described in numerical order, including information as to purpose, location, User and starting and completion dates of construction.

STATIONS:	1, 2, 3, 4, 5, 6, 7
PURPOSE:	Zero Towers
SITES:	1 and 2, Sally; 3, Ruby; 4, Pearl; 5, Janet; 6 and 7, Yvonne
USERS:	LASL and UCRL
CONSTRUCTION:	Station 1, 8-29-56/5-2-56; Station 2, 10-26-56/5-23-56; Station 3, 11-14-55/6-4-56; Station 4, 11-3-55/6-4-56; Station 5, 1-9-56/(Work stopped 4-17-56 at Station 6, 48% progress); 10-11-55/5-26-56; Station 7, 1-16-56/6-8-56.

Stations 1, 3, and 6 were 300-foot steel towers, and Stations 2, 4, and 7 were 200-foot steel towers; each had a 100-ton capacity cab. In order to maintain flexibility in use, the towers were designed in 100-foot increments, which permitted increasing their heights from 100 feet to as much as 300 feet, requiring only adjustments to the footings and guys. Tower components were fabricated in 25-foot modules for ease of erection.

All tower shafts were free from lateral bracing, which enabled the User to place pipes for data collection within the shaft without structural interference.

The towers were designed for uniform pressure effects with the exception of Station 7, which required additional guying to withstand an earlier test event. Weights of the constituent materials utilized in each 100-foot section of the tower were established and furnished to the User.

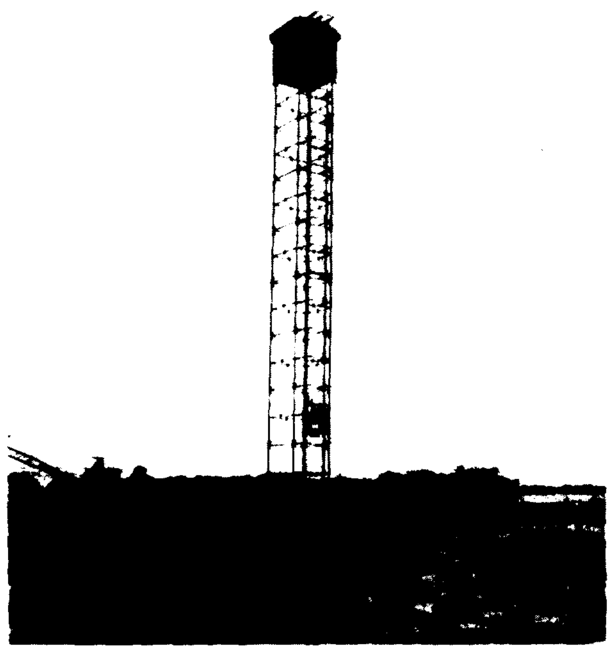


Figure 2-26. Station 4 Complete Except for Final Tensioning of Guy Wires

Each tower had an elevator with a 9-foot x 7-foot platform and a lifting capacity of 6,000 pounds of freight or a passenger conveyance of 2,000 pounds. Lifting power for the elevators was provided by seven hoists which had been previously used at the Nevada Test Site. Hoisting speeds were maintained at 75 to 100 feet per minute. The hoists were removed prior to each event, and in the case of Station 7, the hoist was made portable, thus enabling rapid recovery between experiments.

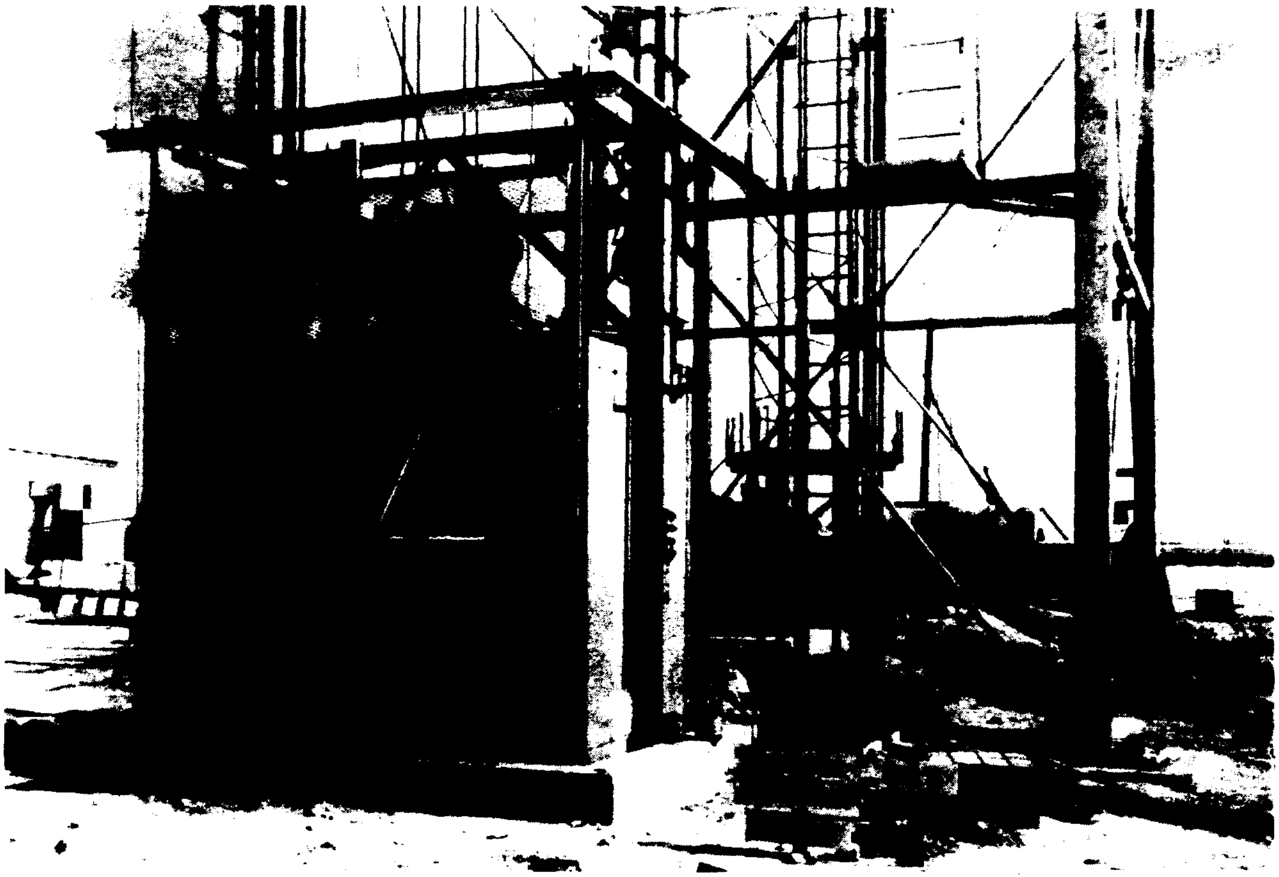


Figure 2-27. Base of Station 3

Tower cabs were equipped with roll-up shutter doors on three sides, which permitted operation by remote control and closing by means of a timing signal. Siding was removable on the elevator side of the cab, and a personnel door led to the towers' vertical ladders. The LASL stations had a hand-operated bridge crane with a 6-ton chain hoist; the UCRL stations were equipped with bridge cranes using electrically-driven hoists of two-ton capacity.

Shielding for Stations 6 and 7 consisted of concrete and paraffin which was supported by structural steel members; lead was used for Station 3; none was required for Stations 1, 2 and 4.

As designed and built, the strength of the towers was controlled by the capacity of the web system. Further increases in strength could therefore be obtained by reinforcing the web system and enlarging guy footings to match the tower leg strength. It was assumed in the design that when the tower was subjected to blast overpressure, all cab doors would be rolled up and the removable siding taken off. In addition to having its doors and cab siding rolled up the Station 7 tower was reinforced for heavy overpressure on one side by removing all elevator and ladder appendages and by leaving the erection guys at the 100-foot level in place.

A pile foundation was mandatory for all anchor blocks located on ocean reefs. To ensure a stable footing, four 12-inch H-piles were driven to a depth of 25 feet into the reef or coral base locations. Forms were then built around the piling and concrete placed.

During the process of tower erection, temporary guy lines were used at the 100 and 200-foot elevations. In order to keep the tower plumb during erection of each 25-foot section, a tensioning devise was fabricated with which the tower guys were jacked to final position using hydraulic jacks. The pressure in the jacks was indicated by a calibrated pressure gage. Permanent guy lines were tensioned to 10.4 tons.

Sites of tower erection varied from the usual coral base and ocean reef locations to a man-made island connected by a causeway for Station 1, Sally. To construct the man-made island, a total of 21,860 pounds of rail piles was driven into the reef to an average depth of 15 feet and a cutoff elevation of plus 10 feet.

Figure 2-28. Pre-Assembly of Tower Components

A total of 3,735 lineal feet of 3x12-inch planks and 3,200 cubic yards of fill were utilized in the construction of this island, and 256 cubic yards of concrete were placed for guy anchor blocks. The causeway was approximately 150 feet long by 70 feet wide and led to the man-made island, which was 110x170 feet in size. A special base was provided for Tower 1, which was a concrete structure 24'x24'x11' deep in which were incorporated tower footings, elevator pit, and the embedded steel recording shelter of Station 3011.

Prior to the erection of the Station 4 tower and other scientific structures at Pearl, one-half of the island was cleared of tropical overgrowth. This clearing covered an area 3,000 feet long and 475 feet wide on the lagoon side of the island. In addition, a channel was blasted in the reef and a ramp was made in order to accomodate LCM, LCU and DUKW craft used for transporting equipment, material, and personnel involved

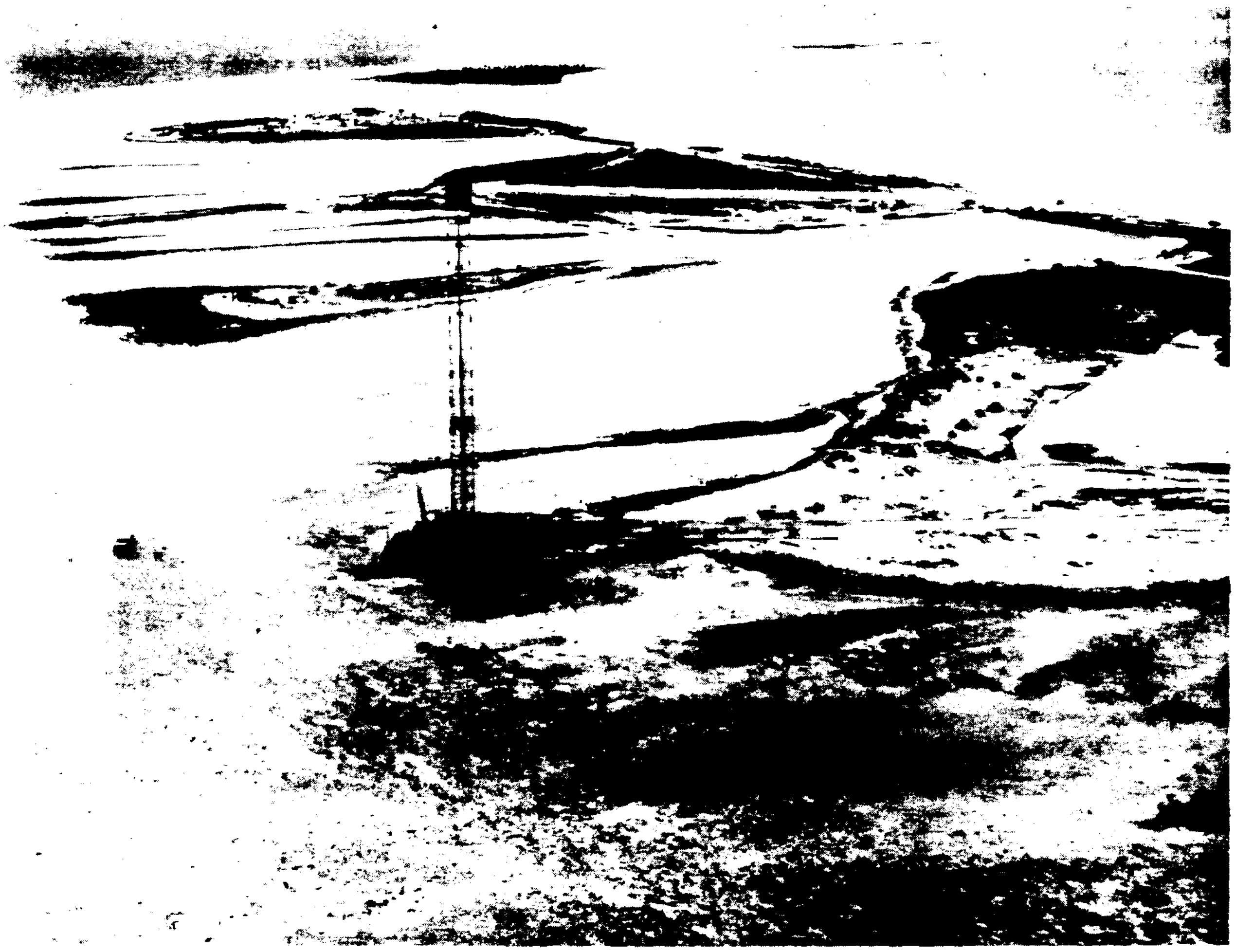


Figure 2-29. Station 1 - Note Guy Anchor Blocks on Reef

with station construction. The sub-base of the tower footings and the guy anchor blocks for Station 4 was below high tide level; construction work was therefore performed at low tides. During concrete placement, at least one foot of water was encountered even at low tide. A pump was used to keep the water at as low a level as possible.

Power to these towers was supplied by two power centers. Each power center consisted of a primary disconnecting switch, a transformer, and a secondary circuit breaker distribution panel. Primary power was supplied by the island distribution system. Power center No. 1 had a capacity of 112.5 KVA with secondary distribution at 120/208 volt, 3-phase, 4-wire, and was used to supply the scientific requirements as well as general utilities; the total connected load was 106 KW. Power center No. 2 had a capacity of 150 KVA with the secondary distribution at 480 volt, 3-phase, 3-wire, and was used to supply the 50 HP elevator motor. The connected load consisted of the 50 HP motor only. The load divided between the two power centers provided the best voltage regulation for the scientific load, as the surge of the starting elevator motor was confined to the one circuit and had no effect on the scientific circuit. The use of the two power centers provided a second advantage in that the different voltages and number of wires could be adapted to the most economical use.

Timing signals were installed for scientific purposes and for door and floodlight control. Signals were arranged to open or close the three electrically-operated doors in the cab and to shut off the tower floodlights. Signal cabinets, telephones, and extensions were provided at the base and in the cab. Coaxial cables were installed to the tower cabs and special supports for the cable runs were mounted at 12′-6″ intervals on Stations 1, 3, 4, 6 and 7; for Station 2, a special messenger cable was used to run the cables to the cab.

Station 5 was designed similar to other 300-foot towers and was built to the 75-foot level; completion was held in abeyance until the execution of the LaCrosse test (in accordance with User instructions). After the LaCrosse event, this station was deleted from the scientific program and was subsequently dismantled and returned to Elmer for storage.

All of the zero stations were located within second order survey (1:10,000) and tied into the primary triangulation network of Eniwetok Atoll.

Concrete placed at each of the tower bases and at the four guy anchor blocks varied from 256 to 369 cubic yards.

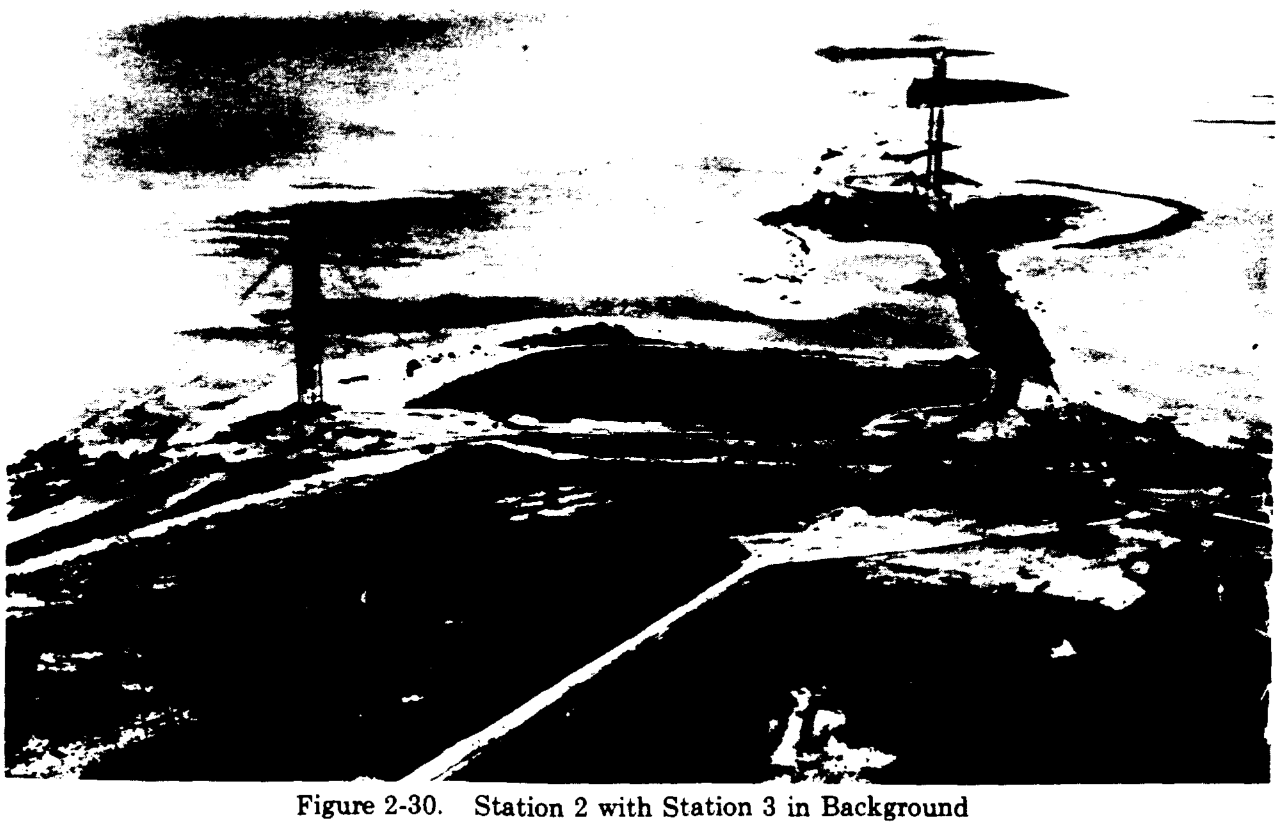


Figure 2-30. Station 2 with Station 3 in Background

Figure 2-31. Barges at Outfitting Ship

STATIONS:	10, 11, 12, 13, 14, and 15
PURPOSE:	Barge Zero Stations
SITES:	Stations 11, 13, 14, 15 Moored Off Fox; Stations 10, 12 Moored off Gene
USERS:	LASL and UCRL
CONSTRUCTION:	Barge No. 10, 8-30-55/6-16-56; Barge No. 11, 12-2-55/6-2-56; Barge No.12, 9-7-55/7-2-56; Barge No. 13, 9-12-56/6-2-56; Barge No. 14, 11-22-55/6-13-56; Barge No. 15, 5-4-56/7-2-56

These Stations were U. S. Army type 231-A barges 120' long and 33' wide, with a capacity of 585 tons. The stations were readied in the Barge Slip at Elmer. Station 12 was located at the Mike crater off Gene; the other five were moved via LSD to Bikini Atoll and moored off Fox. Station 10 was later relocated in the Mike crater and Station 15 was relocated between Charlie and Dog.

A steel frame superstructure, with columns extending to the side plates of the barges, was erected for carrying large loads. A large, wooden room for scientific equipment was constructed with sufficient height to accommodate a 17' sliding door on the starboard side. A removable 1-1/2 ton capacity monorail was provided with a clear hook height of 15'-10" over the working point of Station 15; hook height was 14'-10" for the other five stations. A 1-1/2 ton jib crane with a 14' clearance was installed at the rail for loading and unloading. An 8' x 10' hatch in the roof of the large room was provided to facilitate loading scientific equipment during the outfitting period. Two smaller rooms for living quarters and mess, a small shack for a military sentry, and fresh water and fuel storage were provided. When all weights were aboard, ballast was installed to maintain an even keel.

Installed in the device housing on Barges 13 and 14 were 1'-3" x 1'-10" x 2'-3-½" collimating shields filled with concrete; each had a 1/2" diameter lifting ring welded to the bottom plate and extending up through the concrete. On Barge 15, a collimating wall constructed of 2x4's and plywood, and containing three 24" diameter openings equally spaced, was built across the roof of the living quarters and tied into the wall of the device housing. Two User-furnished vacuum pipes were installed, and the collimating wall on the starboard side was painted.

The limitation in movement of the moored barge required that its working point be within a 2-foot radius circle, and that it remain on the line of sight from Station 1320 and within the field of Station 1528. To accomplish this requirement, mooring winches of approximately 30,000 pounds pull each were located at the corners of each barge, necessitating reinforcements below deck to properly transfer the loads.

Power for each barge was supplied by two 15 KW, 120/208 volt, 3-phase, 4-wire, 60-cycle diesel driven generators. During the outfitting and pre-shot period, one generator supplied power for scientific purposes with a connected load of 12.5 KW, while the other generator provided an estimated load of 14 KW for utilities. With the generators operating separately, it was possible to maintain good voltage regulation on the scientific load. However, when personnel disembarked prior to the actual test, the generators were paralleled. Since no utility power was then required, good voltage regulation was possible. A stand-by generator was thus available since either unit was capable of carrying the scientific load separately.

A signal-controlled magnetic contactor was connected to the lighting panel of each station so that all lights could be turned off by signal. This apparatus also controlled a target light array consisting of floodlamps (pointing vertically) which were mounted on top of Stations 10, 11, 12 and 13. Timing signals and telephone service were provided through plastic armored submarine cables running from the island timing station to the barge stations. These cables terminated on the barges in a cast iron junction box and were supported at the box by a specially-designed frame. From the terminal box, the cable led through conduit to the zero timing signal cabinets located in the scientific enclosure of the stations. One of the signal cabinets also contained telephone lines.

Prior to each mooring, the location of each anchor point and the barge working point were established by surveyors. Marker buoys were set over these points. Anchors connected to mooring buoys were dropped by a specially-fitted LCU which was maneuvered on a course to the working point marker buoy. The barge was later attached to the mooring buoys with wire from the mooring winches. With surveyors on shore and on the barge directing movement, the barge was worked into position with the winches. In setting the barge anchors, the survey points used in Eniwetok Atoll were the west end of Gene, and Boru located 650 feet northwest of Gene. In Bikini Atoll they consisted of Station 1528, George, and a leaden tack, called Tony, located in the reef 15,000 feet northwest of George.

After the initial experiment in Eniwetok Atoll, Barge 12 was modified for use as living quarters off Ursula due to the island radioactivity. Three lavatories, two enclosed showers, a hot water heater, a Navy cube, and an 8′ x 23′ canvas cover on the stern of the barge were installed. After this temporary use, the modifications were removed and the barge was returned to Elmer.

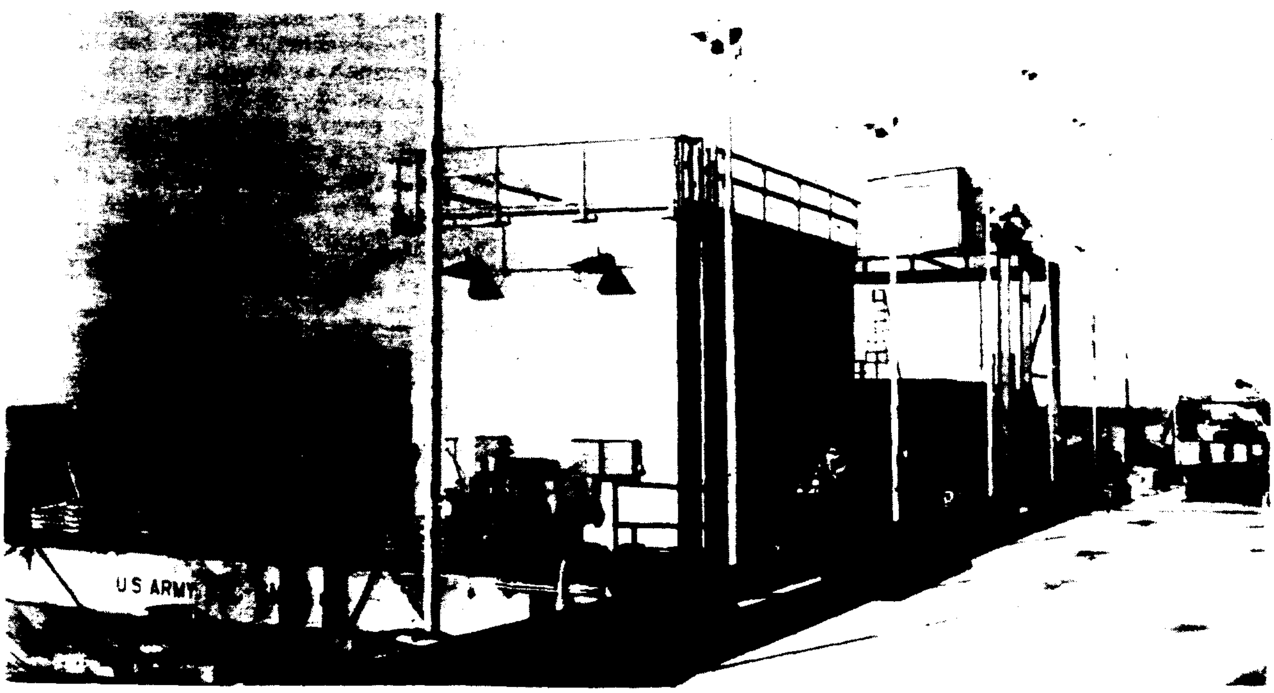


Figure 2-32. Station 12 - 76% Complete

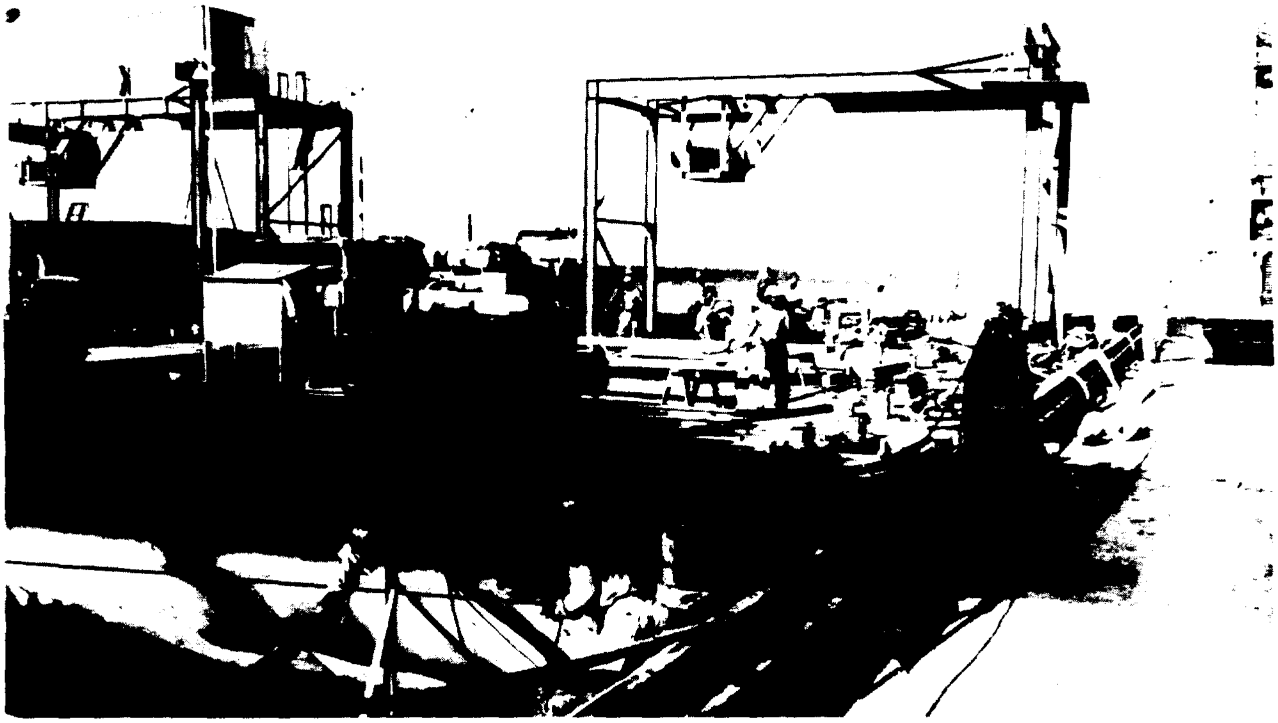


Figure 2-33. Station 14 - 26% Complete

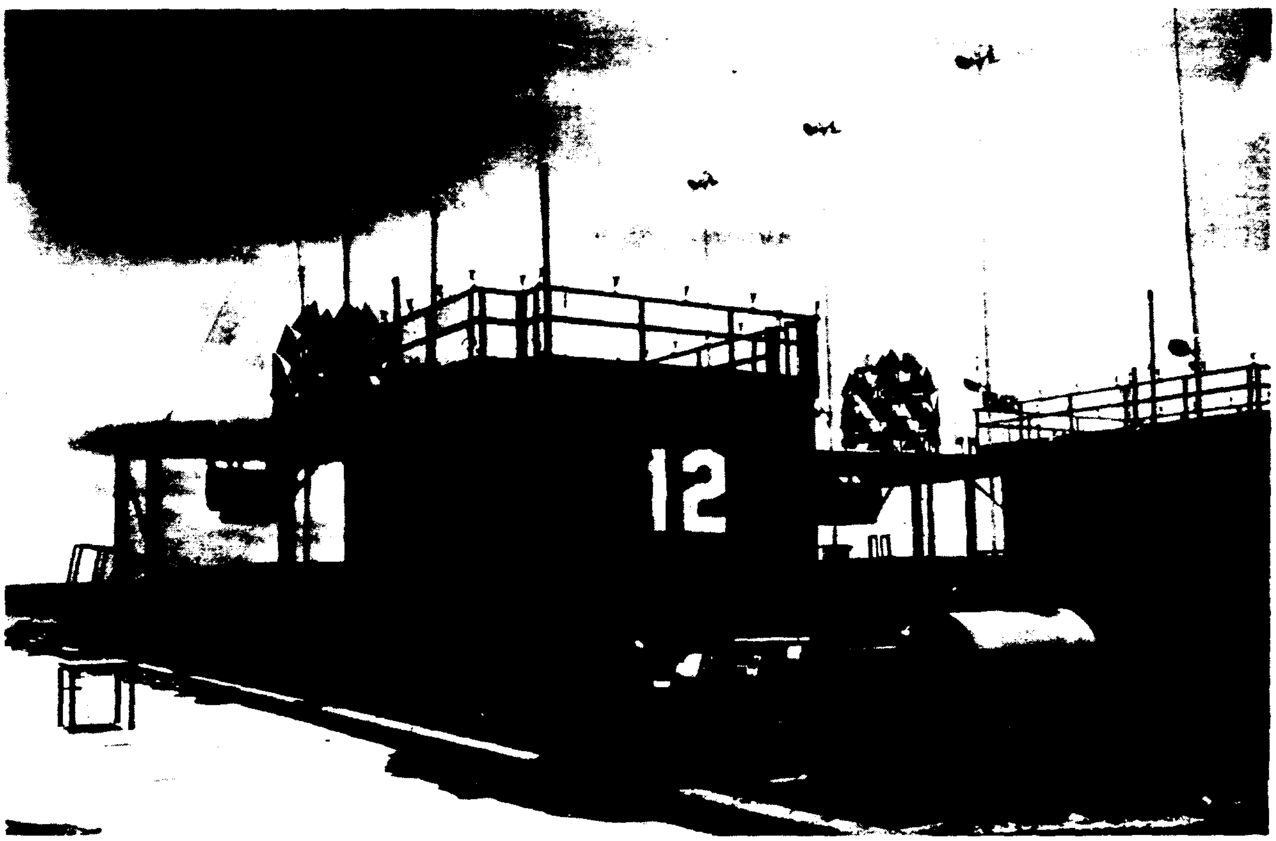


Figure 2-34. Station 12 - 98% Complete

Figure 2-35. Station 18

STATIONS:	18 and 19
PURPOSE:	Ground Zero (Airdrop target)
SITES:	18 Charlie, 19 Yvonne
USER:	LASL
CONSTRUCTION:	Station 18, 2-23-56/4-25-56; Station 19, 6-10-56/6-15-56

At the site of Station 18, the ground was leveled, white sand was spread, and concentric black rings were provided by spraying with an asphaltic emulsion. The rings were 20′ wide, with the exception of the inner ring, which was 30′ wide. The outside diameter of the largest ring was 440′ and the inner rings had outside diameters of 340′, 240′, and 100′ respectively.

Station 19 requirements were similar to Station 18, except that the diameters of the concentric rings were smaller; the outside ring was 310′, the two inner rings were 210′ and 100′, respectively. It was necessary to extend the rings over buildings that were located within the marked area in order to provide a continuous ring.

Located at the center of each target was a 50 foot creosoted wooden pole set in a 4′x4′x6′ high concrete footing. A 500-watt clear lens beacon with flasher and a fused disconnect switch were mounted on top of each pole. Power for Station 18 was provided from Station 7412; Station 19 was supplied from Station 7413.

STATION:	22
PURPOSE:	Ground Zero
SITE:	Tare
USER:	UCRL
CONSTRUCTION:	10-25-56/5-23-56
OCCUPANCY:	4-10-56

This station was a steel frame building 40′ x 27′ x 31′ high built on a concrete slab foundation. Three walls and the roof were covered with corrugated aluminum. The 27′ long 36′ high east wall was of reinforced concrete 3 feet thick. This wall contained blockouts through which the 90′ and 300′ pipe arrays of Station 2310 were grouted. Two reinforced concrete wing walls 21′ long, 32′ high, and 3 feet thick extended from the sides of the front wall at angles of 120 degrees. The front and wing walls were designed for pressures of previous events. Within the building was a 5-ton bridge crane, with a 20-foot span and a clear hook height of 25 feet. Two equipment foundations, each 6 feet square and capable of supporting a 20-ton distributed load, were required in the reinforced concrete floor. The steel columns of the building were suported on spread footings 4 feet below grade. However, at each of the two proposed equipment locations, the settlement limitation was 1/4 inch. Subsequent to a soil investigation, it was decided to isolate the two equipment foundations by means of a premolded joint filler, and to support them by means of a 3-foot thick pile cap and four 12″ bearing piles with a 30 foot penetration. The anticipated maximum settlement was then 0.2 inch.

Anchor bolts were embedded in the equipment foundations and various locations in the floor. The floor also contained two trenches 8″ wide, 8″ deep, 28′ and 23′-4″ long, respectively. Five 4-inch diameter conduits were placed, starting at the floor of the east end wall and terminating beyond a concrete collimating wall, Station 2250. A 3′ x 7′ door was provided in the south wall. Ventilation of the building was accomplished with three 24″ roof vents of the gravity type and a framed opening in which six 20″x20″ air filters were installed.

Power was suplied to this station by one 25KW and one 50KW diesel engine generator at 120/208 volt, 3-phase, 60-cycle. The 25 KW machine carried the utility load and the 50 KW machine the scientific load. Separate machines were used to obtain good voltage regulation for the scientific load. However, provision was made for parallel operation when the station was abandoned, at which time there would be no utility load. Signal-controlled outside security lighting was installed around the perimeter of the station. Outside flood lighting was placed at the generator pad. One 16-pair submarine cable terminating in a 16-pair timing terminal cabinet provided for timing signals; a special 16-pair terminal cabinet was also connected by a 6-pair cable to Station 2200; and a 16-pair direct burial telephone cable terminating in a 16-pair telephone cabinet serviced the telephone lines to the station.

The corrugated aluminum siding was removed from this station for the Cherokee event and replaced immediately thereafter.

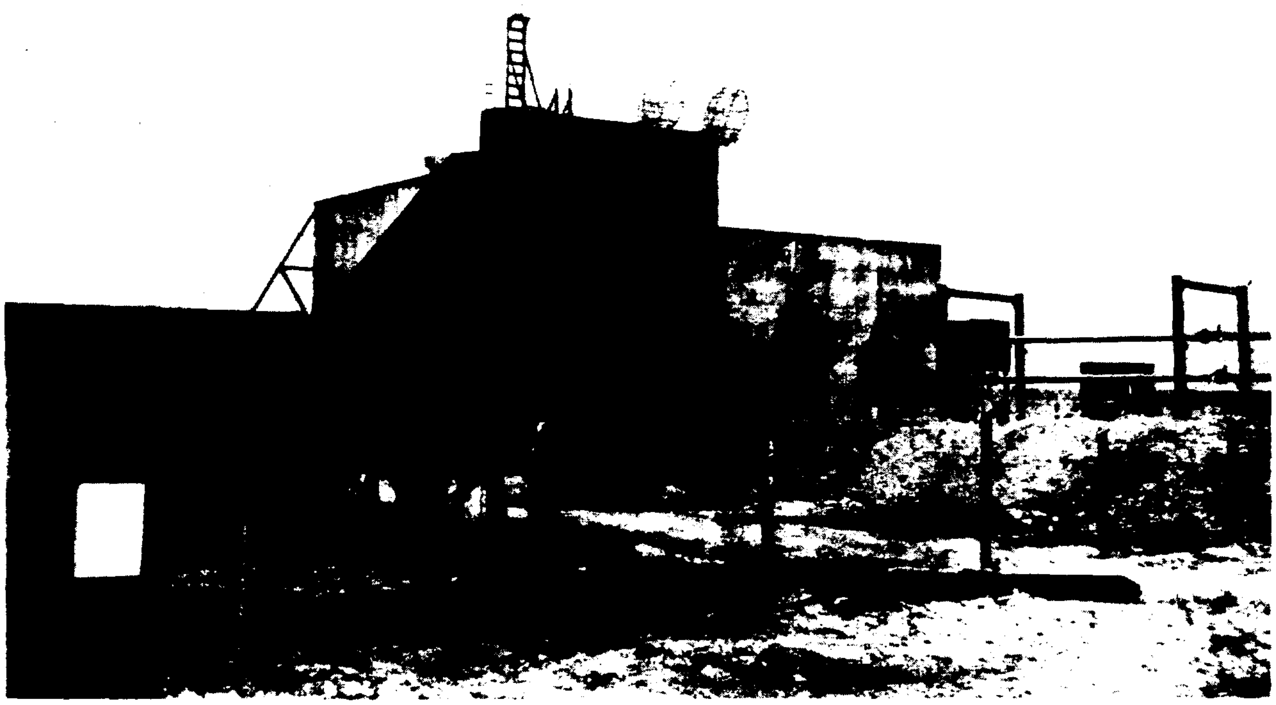


Figure 2-36. Stations 22 and 2250

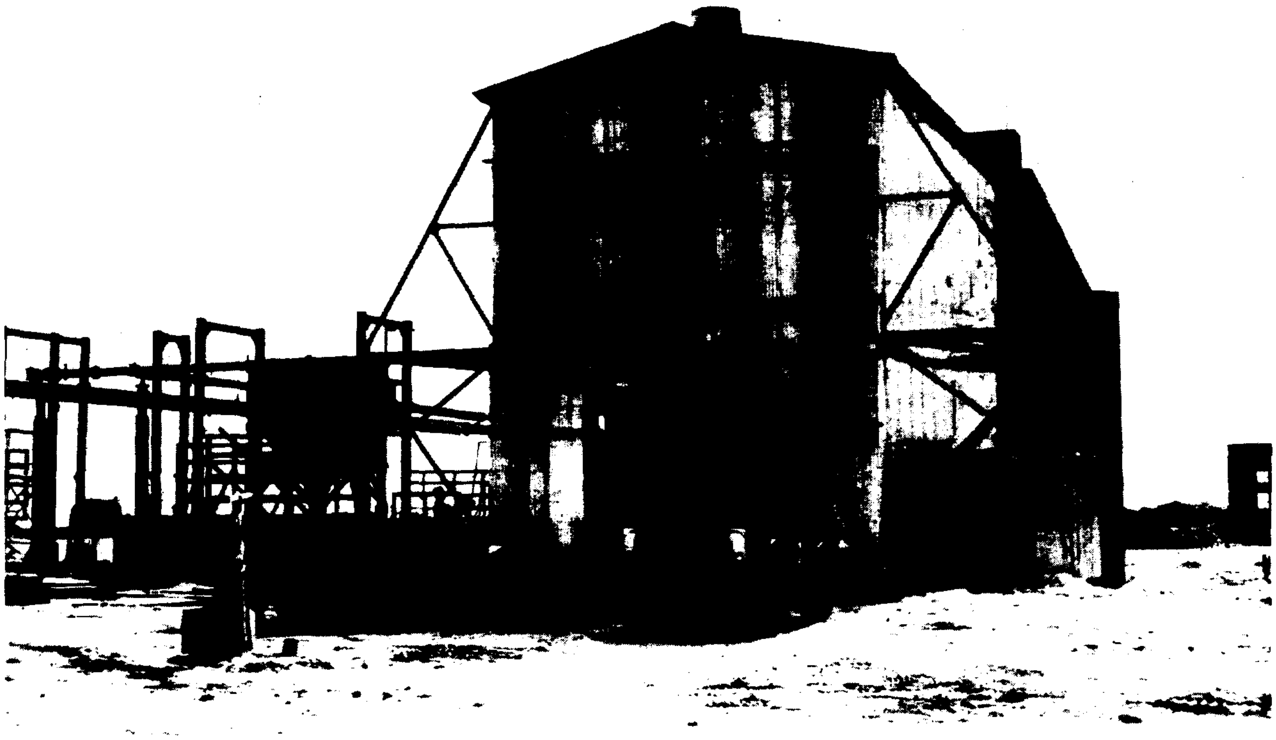


Figure 2-37. Station 22 - 83% Complete

STATION: 23
PURPOSE: Ground Zero
SITE: Irene
USER: LASL
CONSTRUCTION: 12-17-55/4-26-56

This station consisted of two steel tanks, one inside the other. The inner tank, made of 5/16" boiler plate, was 15' in diameter, approximately 15' high and was watertight. The outer tank was 50' in diameter and approximately 30' high so as to maintain 10' of water over the inner tank. The outer tank required a 1/4" thick welded steel plate floor. A heavy structural steel tunnel equipped with watertight doors connected the inner and outer tanks. The floor of the tunnel was capable of carrying a movable two-ton load. Means were provided for flooding the outer tank with sea water within six hours.

The inner tank was equipped with a revolving bridge crane with a hook height of 12 feet above the floor and a hoist capacity of 2 tons. An air intake was run under the large tank foundation to the smaller tank. To exhaust this air, a vent pipe was extended above the waterline of the outer tank and turned down 180 degrees to within eight inches of the water level.

A foundation capable of supporting 100 tons was required for a lead shield located within the outer tank. Six three-inch I. D. pipes used as collimators in connection with Station 1612 and a tapered rectangular pipe used in connection with collimation of Program 12 detectors were connected between the inner and outer tanks. Three runs of project-furnished Amphenol RE 57 U cable and eleven runs of coaxial cable terminated in Station 1611. A 14' x 14' tent and 6' x 8' wooden building for housing vacuum pump equipment and instruments were erected outside of the outer tank.

Settlement of the station was critical. A special soil investigation led to the decision that the Station should be supported on a concrete mat and that the outer tank and access tunnel should be filled with water to ensure settlement taking place prior to the installation of equipment. With the mat founded on compacted soil and the tank empty, a bench mark elevation was established 150 feet away, and initial elevations at the quadrants of the mat were determined. Settlement readings were taken every 12 hours while filling the tank and continued thereafter until the settlement was 1/1000 of a foot in that period of time. Thereafter, the readings were taken every 24 hours until settlement was constant, at which time the tank was emptied. Readings were taken while the tank was being emptied and tank rise had ceased. A line of sight was established from the readings. Most of the settlement took place while initially filling the tank. Upon further refilling, settlement was limited to a maximum of ⅛".

Power to this station was provided through a 30 KVA 2400/120-208 volt, 3-phase, 4-wire, 60 cycle transformer. Primary power to the transformer was supplied through an oil fuse cutout from the island distribution system of 2400 volt, 3-phase, 3-wire, 60 cycle. The transformer and secondary distribution panel were mounted inside a waterproof wooden enclosure 22 feet from the outer tank. The circuit breaker distribution panel provided power to Station 23 and the adjacent tent within which a 12-circuit lighting panel was mounted that supplied power to 12 special receptacles. Power for Station 23 ran through a 12-circuit lighting panel with a 60-amp special receptacle for scientific needs. This panel also furnished power for Station 1336.04. The total connected power load for the station was 21 KW.

Timing signals were provided by one 37-conductor cable and a 9-conductor cable, and telephone lines by one-pair conductor cables, all terminating in a 26-pair terminal cabinet within the station. Three 2-conductor cables extending from the terminal cabinet provided timing signals for Station 1336.04. Eleven 7/8-inch aluminum coaxial cables were run between Stations 1611 and 23 and the enclosure on the north edge of the large tank. A twenty foot cable for final hook-up was left at each end.

Two portable 500 gpm gasoline-driven water pumps with 6-inch hose connections were used for filling the tanks. Ventilation of the inner tank was accomplished with a 700 cfm blower forcing air through steel pipes.

A total of 311 cubic yards of concrete was poured.

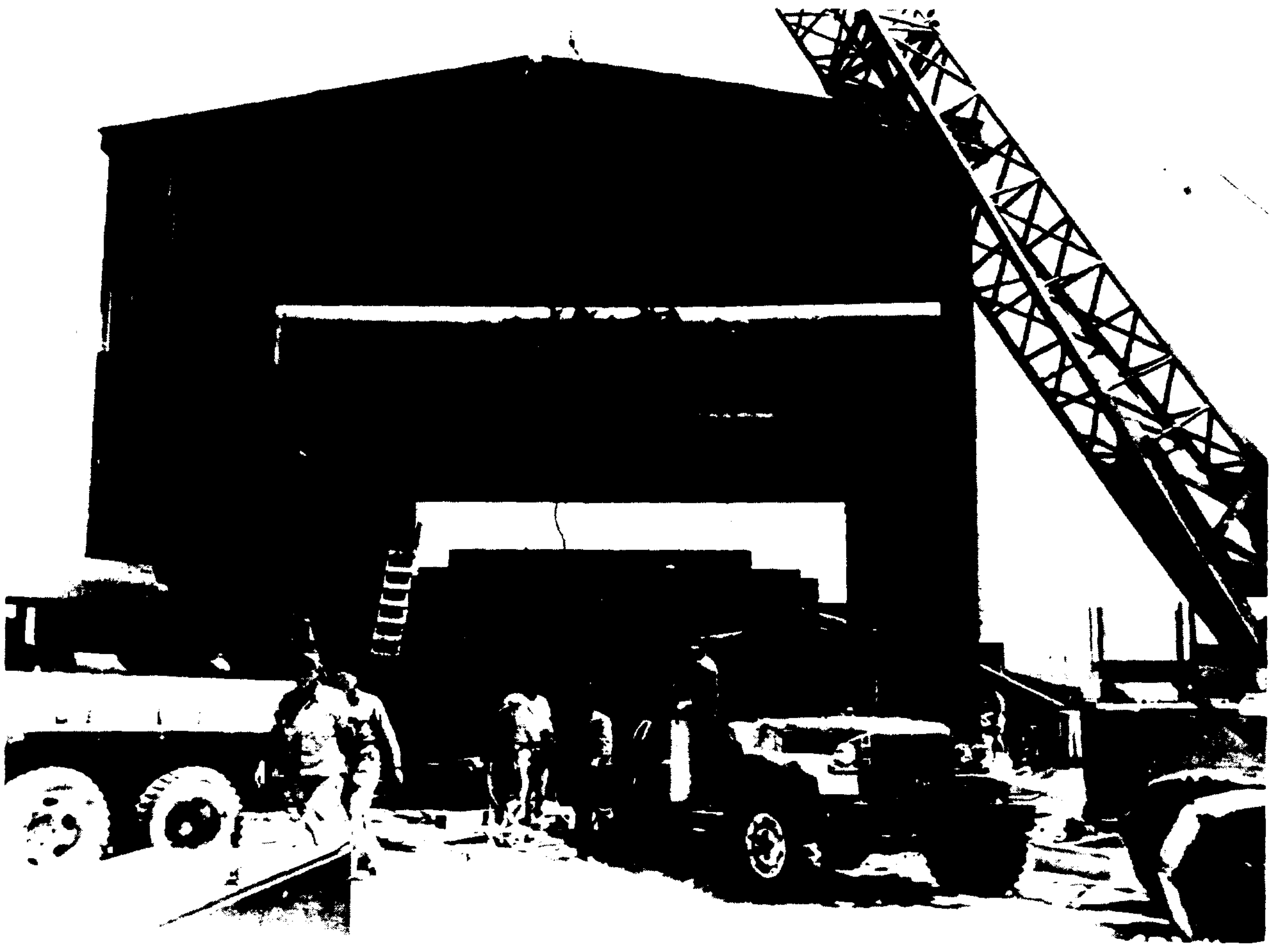


Figure 2-38. Station 24 - 55% Complete

STATION:	24
PURPOSE:	Ground Zero
SITE:	Yvonne
USER:	LASL
CONSTRUCTION:	1-11-56/4-24-56

This station was a 30′ x 34′ structural steel building with metal siding; it was high enough to accommodate a 5-ton bridge crane with a hook height of 21 feet. The roof and sides were covered with bituminus-coated corrugated aluminum. An opening in the east wall contained a steel plate baffle for supporting 38 steel pipes used in connection with Program 15 tests. One large roll-up door on the west side permitted entry of heavy equipment. The finished floor elevation was plus 9 feet. Under the scientific working point and embedded in the concrete floor were two rails for guiding a movable dolly used in handling equipment. The south and west walls were free of bracing in order to permit the installation of pipes. Steel ladders provided access to the roof for antenna maintenance.

The station was located approximately 500 feet offshore from Yvonne. To provide the proper location, a man-made island approximately 100′ x 125′ was constructed and then connected to the shore by a causeway having a minimum width of 24 feet. The bulkheads were of standard design.

To minimize settlement of the station, the frame columns were supported on concrete piers which extended down to coral. To ensure a relatively fixed position of the dolly tracks, they were supported on a continuous concrete wall foundation extending down to coral. The ends of the walls were supported on 12-inch H-piles driven to a depth of 31 feet.

A major problem was that of providing terminal supports for the Project 18 and Program 15 vacuum pipes (38 pipes) and supplying a pipe loop around the station for maintaining vacuum during the period of scientific equipment installation. The vacuum pipe system was designed to permit accurate supports with fixed clamps, which prevented movement

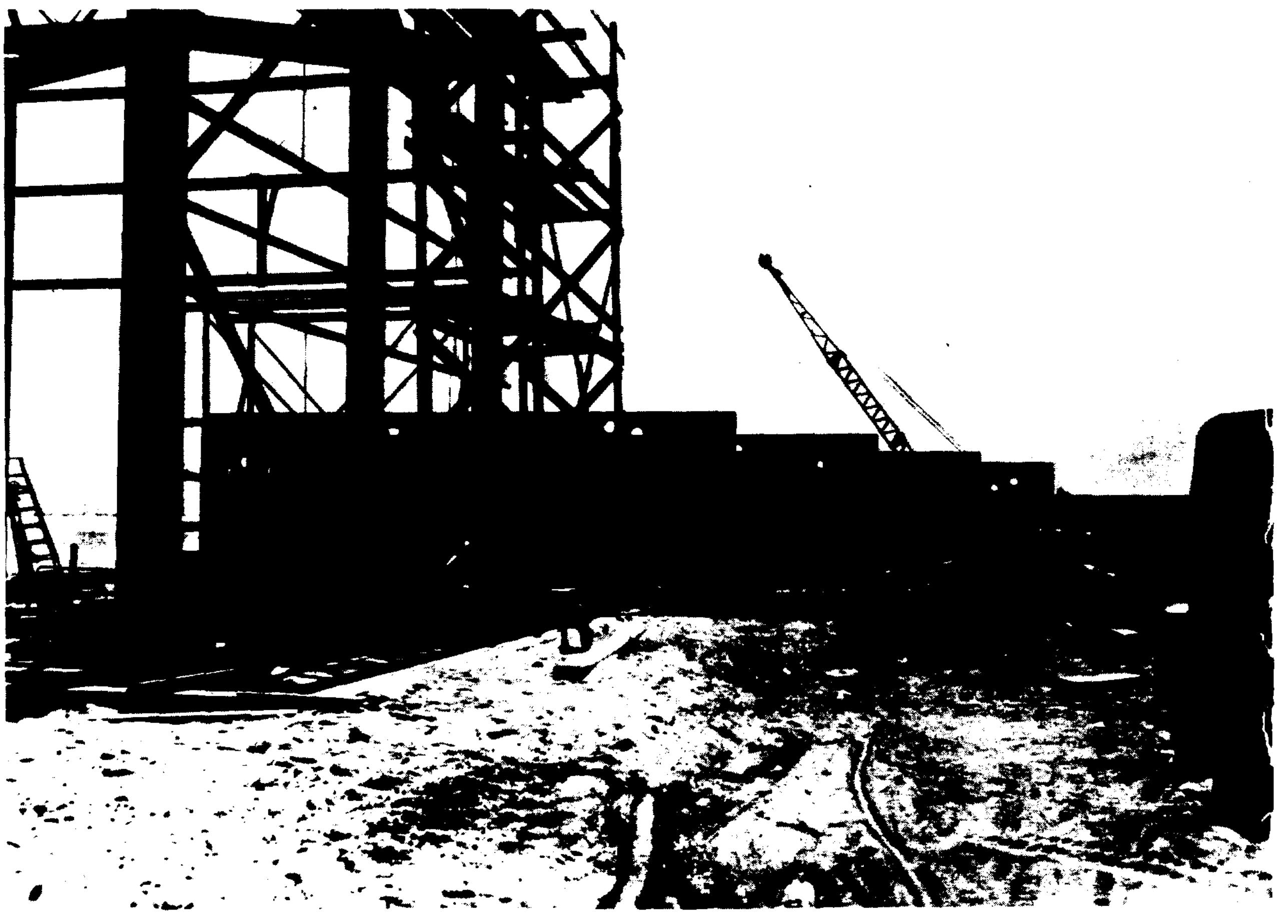


Figure 2-39. Station 24, and Terminal Supports for Station 1524 Pipes

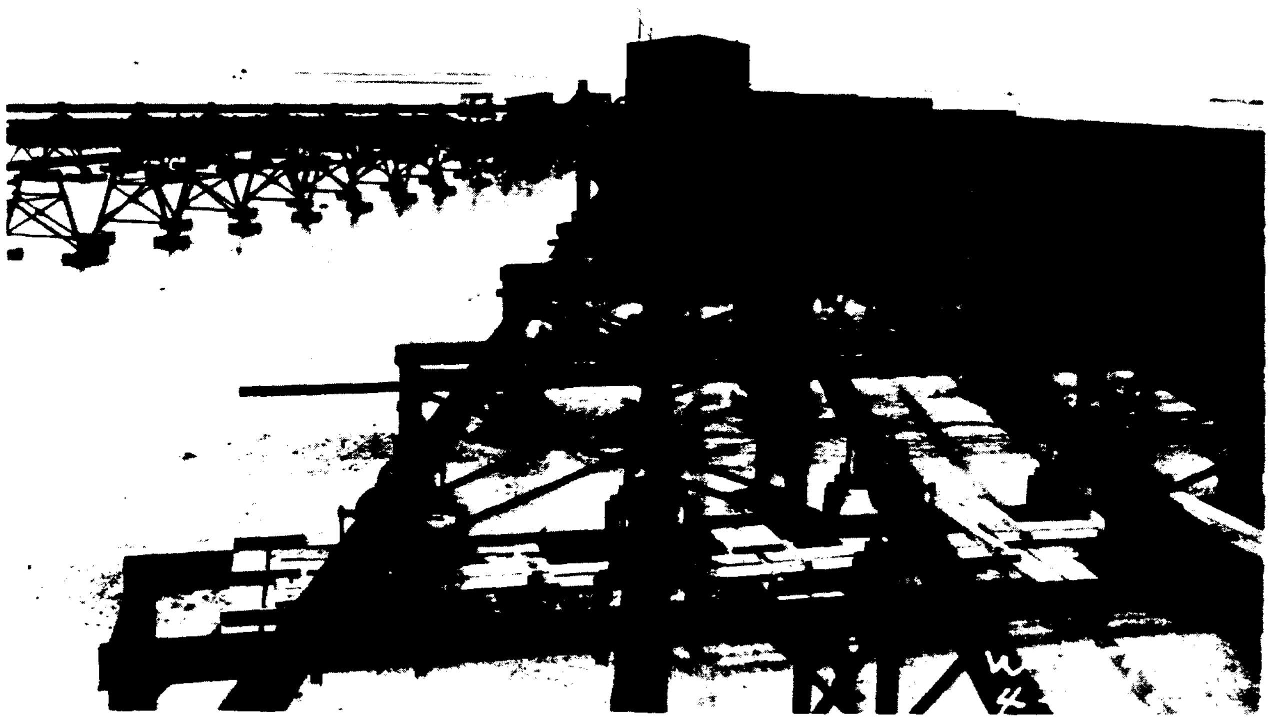


Figure 2-40. Pipe Arrays Leading to Station 24

due to temperature changes or any vibrations from being transmitted to the scientific equipment. Roller supports and expansion joints in front of the fixed supports maintained accurate pipe alignment and provided for the longitudinal movement of the pipes.

Power from the island primary distribution system led to a load center consisting of a disconnect switch, a 112.5 KVA transformer, and a circuit breaker secondary distribution panel of 120/208 volt, 3-phase, 4 wire, 60 cycle. This load center also provided the power to two trailer receptacles and Stations 1817.02, 1816 and 1312.01. The connected load was 80 KW. Power distribution for utility and scientific purposes within Station 24 was made through an 18-circuit lighting panel. The scientific power was supplied through a special steel cabinet equipped with 20 duplex receptacles. Power to the receptacles ran through a "variac" voltage control device which permitted adjustment from zero to 17 per cent above line voltage.

Timing signals were supplied through a 37-conductor cable terminating in a watertight 52-pair terminal cabinet. Telephone lines were provided through one 6-pair and four 1-pair cables terminating in a 52-pair terminal cabinet.

In the process of station construction, difficulty in pouring concrete was encountered due to the base of the foundation being underwater. This situation was overcome by placing the forms and back filling around them, thus forming a makeshift cassion. Prior to concrete placement, the water was pumped to as low a level as possible to eliminate dropping the concrete through the water. A total of 230 cubic yards of concrete was used in this station. The concrete cylinders taken averaged 4,421 psi when broken at 28 days. This average was high because a richer mix was used for the portion of the structure that was located in the water.

STATION: 62
PURPOSE: Electronics Repair Shop
SITE: Ruby
USER: Various Groups.
CONSTRUCTION: 1-24-56/4-13-56

Station 62, used in CASTLE, was rehabilitated for this Operation and identified as Building 62. The rehabilitation consisted of new plywood siding and a new roof, rewiring of the electrical system, and the installation of two new dehumidification units on the exterior of the building.

STATION: 70 (Room 18)
PURPOSE: Recording Shelter
SITE: Nan
USER: DOD-13
PARTICIPATION: 10, 11, 12, 13, 18 and 22
CONSTRUCTION: 2-29-56/5-12-56

The use of room 18 in existing Station 70 was a requirement for this Operation. A wave guide and two 7/8-inch coaxial cables were run into the room from 10-foot dish-type antennas. A breaker panel was connected to an existing 100-ampere breaker, and four timing signals and a telephone were installed. Power consisting of 15 KW, 3-phase, 120/208 volt was furnished by the main station source. Additional work included adding an unroofed equipment room to the existing radio station, drilling a salt water well, placing various equipment, and constructing an earth enbankment around the station. Total concrete poured was 102 cubic yards with an average 28-day strength of 4,400 psi.

STATIONS: 70, 71, 72.02, 73.04, 73.07, 74, 75.01, 75.02, 76 and 77
PURPOSE: Timing Stations
USER: EG&G
PARTICIPATION: All

Functionally, timing stations provided additional power for distributing timing impulses locally. Terminals within station enclosures permitted participation of several stations on each of the available signals. Thus, only one each of the signal pairs was brought to the timing station via the trunk submarine cable lines while many connections to the trunk were made locally. The Contractor was required to provide the enclosures and essential utilities including generators for battery charging. EG&G generally provided and installed all the equipment and batteries required for use within the station.

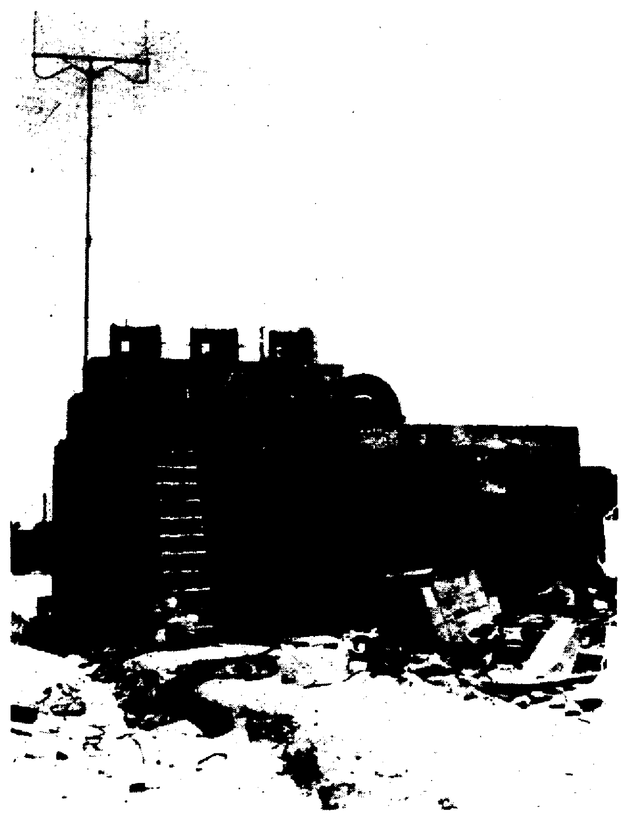


Figure 2-42. Station 77

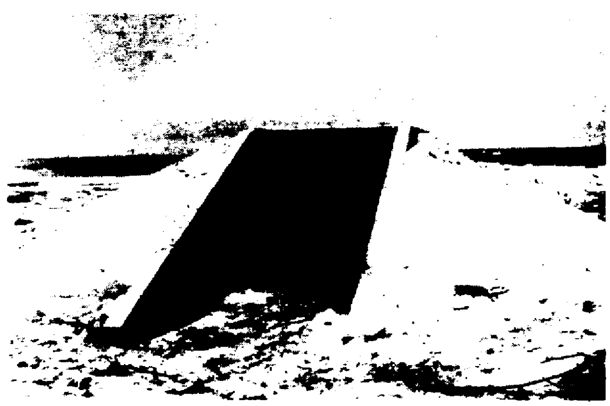


Figure 2-41. Station 73.07

A survey was made of the condition of the existing stations which determined Operation REDWING work requirements. As a result, the following stations were modified and rehabilitated: 70 site Nan; 71 site Elmer; 72.02 site Ursula; 7304 site Irene; 73.06 site Tare; 74 site Oboe; 75.02 site How; and 76 site George. The rehabilitation of these stations consisted of replacing conduits and providing additional circuits and outlets. Radio loads were critical at Station 70. Therefore, a 20 KW generator was installed for auxiliary power. An automatic transfer switch provided for changeover to this auxiliary power in case of low voltages in the main island system.

Figure 2-43. Station 75.01 (Right) - 65% Complete - Old Station (Left)

New stations required for this Operation were Station 73.07, Uncle, Station 75.01, Dog, and Station 77, Yvonne. Station 73.07 was a reinforced concrete building 9′-4″x9′-4″x8′-2″ high with 8″ thick walls located on a concrete slab 8″ thick. From the ends of the wall away from zero, two concrete wing walls 8″ thick tapered from the top of the building to 15 feet from the wall face. The wall facing zero was protected by a compacted coral fill 8′-8″ thick which was encased by 6″-thick concrete. A 3 KW generator was located adjacent to the station for battery charging and interior lighting. Conduits, wiring, and outlets were provided as needed for timing circuits.

A structure similar to that of Station 73.07 was constructed orginally for Station 75.01, Dog. However, the design criteria were changed after completion and a new structure had to be provided. The second building was of reinforced concrete 19′ wide, 12′-8″ long, and 15′-6″ high with 4′-thick walls located on a concrete slab. On the wall facing zero there was constructed a solid concrete buttress 15′-4″ long and 19′ wide, tapering with a batter 3 to 4′ from the top of the building. Electrical installation was similar to that provided for 73.07.

Station 77, Yvonne, was a one-story reinforced concrete structure, 27′ x 25′ x 10′ high, with walls of 1′-6″ concrete and located on a slab 1′-6″ which extended 1′-6″ beyond the walls. This building was divided into two rooms by a concrete wall. Vent fans were located in two ports of one wall which could be covered for blast protection. Power was supplied from the nearby island powerhouse.

STATION: 72.01
PURPOSE: Telephone and Signal Terminal
SITE: Janet
USER: EG&G
PARTICIPATION: 4 and 23
CONSTRUCTION: 1-9-56/6-6-56

Existing GREENHOUSE Station 69 was rehabilitated and known as Station 72.01 during this Operation. This rehabilitation primarilly consisted of electrical work. A safety switch was relocated, and conduit and a new main panel with 50-amp IP breakers were installed. Power was supplied from two 5 KW gasoline engine generators located outside of the station.

STATIONS: 78.01 and 78.02
PURPOSE: Release Tone System Antennas
SITES: Elmer-Nan
USER: TU-4, Sandia Corporation
PARTICIPATION: 18 and 19
CONSTRUCTION: 4-4-56/4-7-56

These stations were a pair of User-furnished antennas. Antennas for 78.01, Elmer, were mounted at the 50′ and 30′ level of Station 79.01 and antennas for Station 78.02 were mounted at the same levels on a pole located near Station 70, Nan. An RG 8/U cable extended from the antennas to Station 70, Nan, and Station 71, Elmer. No power for the signal cable was required.

STATIONS: 79.01 and 79.02
PURPOSE: Receiving Antennas
SITES: Elmer-Nan
USER: TU-10 (LASL)
PARTICIPATION: 5, 6, 7, 10, 11, 13, 23, and 25
CONSTRUCTION: 4-4-56/4-7-56

These stations consisted of User-furnished antennas. Station 79.01 was mounted at the top of a 75-foot pole, and Station 79.02 was mounted at the 125-foot level of the leg of the Station 70 tower. RG 8/U cable was run from the antennas to Station 71, Elmer, and Station 70, Nan.

STATIONS: 110 and 111
PURPOSE: Diffraction Measurements (P.V.S.T. Gages)
SITE: Uncle
USER: DOD
PARTICIPATION: 22
CONSTRUCTION: 3-7-56/5-5-56
OCCUPANCY: 3-28-56

CASTLE Stations 300 and 310 were rehabilitated and identified as Stations 110 and 111 for REDWING. The replacement of fill, metal corrosion preventive measures, and power were required. Power was supplied by a 5 KW, 110 V, 60-cycle, single-phase generator Timing signals and blue boxes were provided.

STATION: 112.01
PURPOSE: Pressure Versus Time, on Ground
SITE: Charlie
USER: DOD-1
PARTICIPATION: 18

This station was a self-recording gage in a ground baffle and was used for measuring pressure versus time. All equipment was User-furnished and installed. The Contractor furnished and set one survey reference stake at a location within the target area of Station 18.

STATIONS: 113.01 thru 113.11
PURPOSE: Pressure versus Time and Velocity versus Time at 3′0″
SITES: Charlie-Dog Reef, Dog, Able and Man-Made Islands.
USER: DOD-1
PARTICIPATION 18
CONSTRUCTION: 2-27-56/4-23-56
OCCUPANCY: 4-21-56

These stations consisted of pipe columns bolted to anchor bolts embedded in heavy con-

Figure 2-44. Station 113.06 - 45% Complete

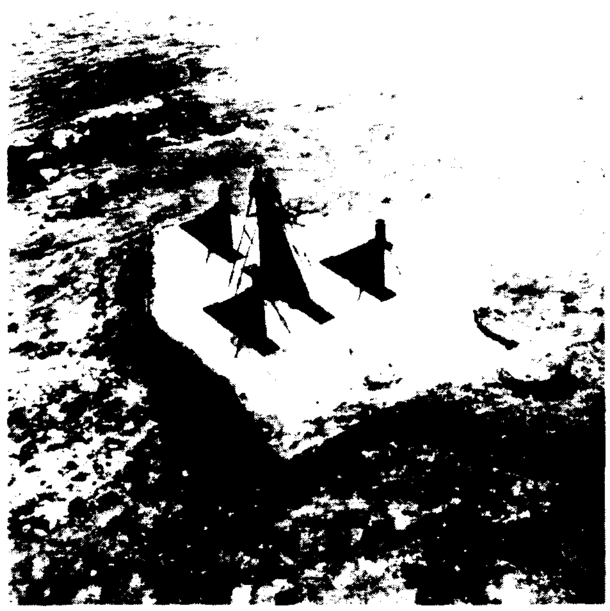


Figure 2-45. Station 113.02

crete bases keyed into the coral. The pipes were used to mount User-furnished and installed gages. Locations varied from the ocean reef to each of the three man-made islands. Heavy foundations were required due to the stations being nonexpendable with the Cherokee event in which they participated. The reef elevation at Stations 113.01 and .03 was approximately 0-0. Foundation forms were prefabricated with rebars and embedded items in place; concrete pours were accomplished at low tide.

Figure 2-46. Station 113.04

STATIONS:	114.01 thru .11, 114.15 thru .19, 114.22 thru .31, 114.39 thru .40
PURPOSE:	Pressure versus Time on Surface
SITES:	Sally, Sugar, Roger, Peter, Oboe, Uncle, Yvonne and Man-Made Island
USER:	DOD-1
PARTICIPATION:	2, 22, 24 and 18

These User-furnished and installed stations were identical to Station 112.01. The Contractor provided survey reference stakes.

STATIONS:	115.01 thru 115.27
PURPOSE:	Pressure versus Time and Velocity versus Time at 3′-0″
SITES:	Sally, Sugar, Roger, Peter, Uncle, Pearl and Yvonne
USER:	DOD-1
PARTICIPATION:	2, 22, 4 and 24

These stations were pipe columns placed 3″ above the ground for supporting gages utilized in recording pressure and velocity versus time. All equipment was User-furnished and installed. The Contractor set a survey reference stake at each station.

STATIONS:	115.28 thru 115.30
PURPOSE:	Velocity versus Time at 10′0″
SITE:	Man-Made Island
USER:	DOD-1
PARTICIPATION:	18

These stations were pipe columns extending 10′ above the ground level for supporting gages used in recording velocity versus time. All equipment was User-furnished and installed. The Contractor set a survey reference stake at each station.

STATIONS:	116.02 thru 116.05
PURPOSE:	Pressure versus Time on Surface
SITE:	Pearl
USER:	DOD-1
PARTICIPATION:	4
CONSTRUCTION:	2-13-56/4-12-56

These stations required 18″ x 18″ x 24″ deep concrete foundations buried flush with the ground. The pressure gage was connected to an insert sleeve and signal cable was installed in each gage mount and run back to recording Station 118.01. A 12′-diameter area was stabilized around each station. Less than .25 cubic yards of concrete were placed in each of the four stations.

STATIONS:	117.01 thru 117.04
PURPOSE:	Pressure versus Time and Velocity versus Time at 3′0″
SITE:	Pearl
USER:	DOD-1
PARTICIPATION:	4
CONSTRUCTION:	2-16-56/4-13-56

These stations consisted of two pipe columns back-to-back embedded in a 4′ x 8′ x 4′-thick concrete footing. A pressure gage was installed at the 3′ level of the pipe column facing ground zero, and a second gage was mounted at 90 degrees to ground zero. A signal cable was connected to the gages and run back to recording Station 118.01. A total of 19 cubic yards of concrete was placed.

STATION:	118.01
PURPOSE:	Recording Station for Stations 116.02 thru .05 and 117.01 thru .04
SITE:	Pearl
USER:	DOD-1
PARTICIPATION:	4
CONSTRUCTION:	2-13-56/4-23-56

This station was a concrete pit 12′ x 4′ x 4′ deep. The roof was of planking and covered with earth. The recording equipment in this station was used for instrumenting the 116 and 117 series stations. A 16′ x 16′ tent provided weather protection over the pit when it was open prior to D-Day. Timing signals and a blue box were installed. A total of 6 cubic yards of concrete was poured.

STATIONS:	120.01 thru 120.04
PURPOSE:	Pressure versus Time and Velocity versus Time at 3′0″
SITE:	Yvonne
USER:	DOD-1
PARTICIPATION:	24
CONSTRUCTION:	4-12-56/4-17-56

These stations were identical to those of the 117 series on Pearl with the exception that the gage mount at 90 degrees to ground zero was not required and the signal cable was run back to Station 3020. A total of two cubic yards of concrete was used on these stations.

STATIONS:	121.01 and .02
PURPOSE:	Pressure versus Time on Surface
SITE:	Yvonne
USER:	DOD-1
PARTICIPATION:	24
CONSTRUCTION:	4-12-56/5-4-56

These stations were identical to those of the 116 series on Pearl with the exception that the signal cable was run back to Station 3020.

STATIONS:	130.01 and 131.04
PURPOSE:	Smoke Rocket Launching
SITES:	130.01 Reef NW of Able, 131.04 NW of Yvonne
USER:	DOD-1
PARTICIPATION:	18 and 24
CONSTRUCTION:	1-16-56/4-26-56

The Stations consisted of stable wooden platforms size 18′x24′ on a steel frame supported on four 12″ H-piles. Required elevation was plus 12 feet, which placed the platforms about 9′ above the coral surface of the reef. The piling for Station 130.01 was driven into the coral to refusal at an average penetration of 13.5 feet, and for Station 131.04, the piling was driven to a depth of 25 feet. Station 130.01 was located within a tolerance of plus 1000 feet to minus 500 feet and Station 131.04 was located to a tolerance of plus or minus 200 feet.

The stations were fitted with a fender system on one side and mooring cleats which facilitated boarding the platform from marine craft. One side of the platform had a "lift out" type railing, while the other three sides had removable bolted railing. Eyebolts were installed around the platform as tie points for rocket launchers.

Scientific power requirements were established at 1-1/2 KW for each station. Two 2 KW, 120-volt, single-phase, 60-cycle gasoline engine generators were installed. The generators were connected together through an automatic transfer switch; normal operation called for one of the units to carry the load while the other was on stand-by. Duplex receptacles for two radio signals were provided by the Contractor and a radio was furnished by EG&G.

For Station 130.01, a standard 14′ x 14′ tent was erected complete with work bench, receptacles, and lighting.

Progress on these Stations was slow due to the fact that the work had to be scheduled in accordance with tidal and weather conditions. During the construction of Station 130.01, a DUKW carrying a welding machine was damaged and sank while approaching the construction site. Operations were suspended until the equipment was recovered.

STATIONS:	131.01 and 131.02
PURPOSE:	Rocket Trail Photography
SITES:	Able and Uncle

Figure 2-47. Stations 121.01, 160.01 and 115.01 (Right to Left)

USER: DOD-1
PARTICIPATION: 18 and 22
CONSTRUCTION: 3-7-56/4-23-56

These stations consisted of a 40′ x 80′ cleared area for rocket launchers, a 2 KW gasoline engine generator, and a 14′ x 14′ tent with work bench. All obstructions over 25 feet high and within 100 feet of each station were removed. Minus 15 seconds and minus 5 seconds timing signals were provided.

STATION: 150.01
PURPOSE: Raydist Relay Station
SITE: Able
USER: DOD-1
PARTICIPATION: 18
CONSTRUCTION: 4-4-56/4-14-56
OCCUPANCY: 4-9-56

This station served as 150.01 for the Cherokee event only. For succeeding events it became the concrete shelter for Station 560.01. Refer to Station 560.01 for further details.

STATIONS: 151.01 and 151.02
PURPOSE: Drag Response Stations
SITES: Able and Dog
USER: DOD-1
PARTICIPATION: 18
CONSTRUCTION: 2-28-56/4-18-56
OCCUPANCY: 4-14-56

These stations consisted of User-furnished spheres mounted on top of 6″ pipe columns, 3′ high. Two 3″ spheres and one 10″ sphere were mounted at each station. The pipe columns were embedded in a concrete foundation which was 4′ x 11′ x 3′ deep. Each pipe column was connected to a junction box by conduit. Cable was drawn through this junction box and thence to a recording station. Because the depth of sand above the coral at these locations was approximately 5.5 feet, it was necessary to drive 12-inch H-piles to support the concrete foundations of the stations. These piles were driven to a total penetration varying from 15.5 to 17.0 feet; average penetration into the coral was 10 to 12 feet. Concrete poured for each station was 5 cubic yards at an average 28-day strength of 3,900 psi.

Figure 2-48. Station 130.01

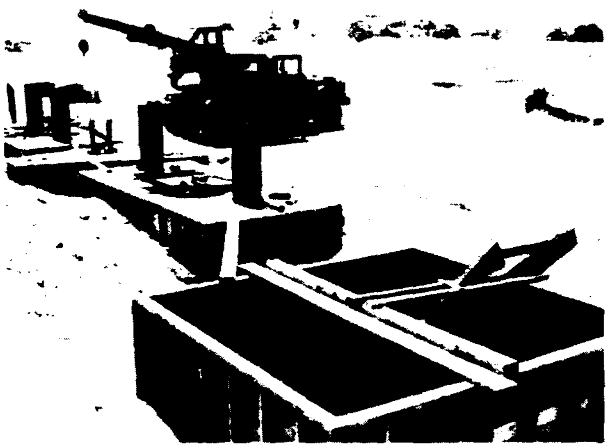


Figure 2-49. Stations 151.02 and 152.04 - 65% Complete

STATIONS:	152.01 thru 152.04 and 153.01 thru 153.04
PURPOSE:	Drag Response Stations
SITES:	Man-Made Island, Able and Dog
USER:	DOD-1
PARTICIPATION:	18
CONSTRUCTION:	2-18-56/4-20-56
OCCUPANCY:	4-20-56

These stations were two 12-inch flanged columns 3′-6″ high with steel plate members, used for supporting User-furnished I-beam and L-iron members. The 152 station series were for I-beams, and the 153 series were for L-irons. The steel columns were embedded in a pile-supported concrete foundation which was 6′ x 14′ x 2′ for the 152 station series, and 6′ x 10′ x 2′ for the 153 series. Cable was run back to a recording station for instrumenting the beams and angles. The average concrete poured was approximately 9 cubic yards for each of the series 152 stations, and 8½ cubic yards for the 153 series.

STATIONS:	154.01 thru 154.12
PURPOSE:	Drag Response Stations
SITES:	Yvonne, Sally, Peter and Roger
USER:	DOD-1
PARTICIPATION:	22, 2 and 24

These stations were two User-furnished ¼-ton jeeps at each location. One jeep faced, and the other was side-on, to ground zero.

STATIONS:	155.01, 156.01 and 156.02
PURPOSE:	Pressure versus Time and Velocity versus Time
SITE:	Uncle
USER:	DOD-1
PARTICIPATION:	22
CONSTRUCTION:	4-2-56/4-24-56
OCCUPANCY:	4-18-56

These stations were rehabilitated CASTLE Stations 311.02, 312.02 and 312.05. Gage mounts were furnished and installed by the User.

STATIONS:	160.01 and 161.01
PURPOSE:	Drag Response Station
SITE:	Yvonne
USER:	DOD-1
PARTICIPATION:	24
CONSTRUCTION:	1-25-56/4-21-56

Each station consisted of five different models for supporting User-furnished specimens of various shapes and weights. Eight-inch steel pipes of lengths varying from 3′-6″ to 5′ were embedded in 3′ x 3′ x 20′ concrete foundations to support the specimens approximately 3′ above grade. It was necessary to weld the pipes to the reinforcing steel in order to maintain good alignment and elevation while pouring the concrete (57 cubic yards).

STATION:	162.01
PURPOSE:	Instrument Shelter
SITE:	Yvonne
USER:	DOD
PARTICIPATION:	24
CONSTRUCTION:	1-16-56/4-16-56

This station was a one-room 8′ x 18′ x 8′ high reinforced concrete structure which had 1′-6″ thick walls and was used for housing the recording instruments of Stations 160.01 and 161.01. The south wall had a 4′-6″ x 9′ watertight blast-resistant door for access. A wooden partitioned room within the station was utilized for battery storage.

Because the structure was exposed to blast pressure from several directions, the foundation slab was extended beyond the walls so as to pick up the pressures acting downward, which would tend to resist overturning the building from side loads. Since the station was located near the lagoon shoreline, it was also necessary to build a riprap retaining wall for the floor slab.

Power to the station was supplied from the island distribution system through a primary oil switch to a 45 KVA transformer and then to a 12-circuit breaker power panel at 120/208 volt, 3-phase, 4 wire, 60 cycle. The circuit breaker panel was located in the interior of the station. A 14′ x 14′ tent and a trailer receptacle located outside the station were fed from this panel. User-furnished and installed batteries provided signal power at H minus one minute. A vapor-proof light fixture was installed in the battery room and a receptacle was provided for the battery charger. Receptacles for User-furnished equipment were installed along the main walls of the station.

A 16-pair timing signal and telephone cabinet were provided for six timing signals and two-pair telephone lines. The station was equipped with one portable dehumidifier and an exhaust fan.

A total of 62 cubic yards of concrete was used. The average psi was 3,745 for 28 days.

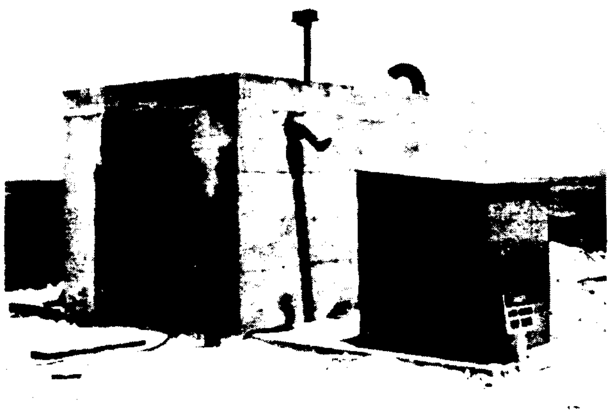


Figure 2-50. Station 162.01

STATION:	190.01
PURPOSE:	Transducer Measurement and Wave Study
SITE:	Nan
USER:	DOD-1
PARTICIPATION:	All Bikini Events Except Station 18
CONSTRUCTION:	4-10-56/5-3-56
OCCUPANCY:	4-14-56

This station was a wooden platform built at the 25′ level of an existing wooden tower known as Station 1580.01 in CASTLE. A 3′ x 4′ x 6′ high steel cab was placed on this platform to house camera equipment. The camera equipment was designated as Station 911. Magnesium flares were mounted on five wooden poles located on the beach. Project-furnished and installed cable extended from the cab to a water depth of approximately 70′ in the lagoon where it was attached to a buoy for marking the terminal point. A 3 KW gasoline engine generator supplied 120 volt, single-phase, 60-cycle power. A minus one minute timing signal was required.

STATION:	191.01
PURPOSE:	Transducer Measurement and Wave Study
SITE:	Oboe
USER:	DOD-1
PARTICIPATION:	All Bikini Events Except Station 18
CONSTRUCTION:	4-6-56/4-27-56
OCCUPANCY:	4-10-56

This station consisted of User-furnished equipment installed in existing CASTLE Station 102. A transducer cable was run from this station to a water depth of from 50′ to 70′ in the lagoon. Emergency power consisted of a 3½ KW gasoline engine generator and switch gear which were located on the station roof, except for the Zuni event when they were secured inside the shelter.

STATIONS:	192.01 and 193.01
PURPOSE:	Transducer Measurement and Wave Study
SITES:	William and How
USER:	DOD-1
PARTICIPATION:	All Bikini Events Except Station 18
CONSTRUCTION:	3-20-56/5-4-56
OCCUPANCY:	4-18-56

These stations were User-furnished equipment located in Stations 560.05 and 75.02. A transducer cable was run from the station to a water depth of from 50′ to 70′ in the lagoon. Power from Stations 560.05 and 75.02 and a minus one minute timing signal were provided.

STATION:	194.01
PURPOSE:	Long Period Pressure Measurement
SITE:	Elmer
USER:	DOD-1
PARTICIPATION:	Continuous Operation for All Events
CONSTRUCTION:	4-11-56/8-10-56

This station, which consisted of User-furnished equipment located in Barrack 107, was identical to CASTLE Station 165.01. Cable was run from the barrack to the low tide line on the reef. Normal power was supplied by the barracks system.

STATION:	195.01
PURPOSE:	Continuous Pressure Measurement
SITE:	Elmer (Personnel Pier)
USER:	DOD-1
PARTICIPATION:	Continuous Operation for All Events
CONSTRUCTION:	5-1-56/6-9-56

This station was a 3′ x 4′ x 6′ high wooden frame structure in which User-furnished and installed equipment was located. Cable was run from this station to a water depth of 30′ in the lagoon. Normal power was required, which was available on the pier.

STATIONS:	196.01 and 196.02
PURPOSE:	Wave Study
SITE:	Bikini Lagoon
USER:	DOD-1
PARTICIPATION:	All Bikini Events Except Station 18

These stations were 16′ skiffs moored in the lagoon. No construction was involved. All equipment was User-furnished and installed.

STATIONS:	197.01 thru 197.10
PURPOSE:	Wave Study
SITE:	Bikini Lagoon
USER:	DOD-1
PARTICIPATION:	10, 11, 12, 13 and 22

These stations were User-furnished and installed. They consisted of self-contained recording units located on the lagoon floor and marked with a buoy.

STATIONS:	210.22 thru 210.41
PURPOSE:	Gamma Total Dose
SITES:	Oboe, Peter, Roger, Uncle, William, Yoke, Zebra, Alfa and Bravo
USER:	DOD-2
PARTICIPATION:	All Bikini Events

Stations 210.22 thru .41 were User- furnished film badges placed on existing 2″ aluminum rods driven 4′ into the ground and extending 2′ above grade. These stations were originally constructed for CASTLE and were known by the same station numbers during REDWING.

STATIONS:	211.01 thru 211.04
PURPOSE:	Gamma versus Time
SITES:	Dog, Dog-Easy Causeway, Easy-Fox Causeway and Fox-George Causeway
USER:	DOD-2
PARTICIPATION:	All Bikini Events
CONSTRUCTION:	3-2-56/4-20-56

This station series consisted of providing a hole 6′ deep by 8″ in diameter in which a pipe 8′ long by 8″ in diameter was inserted. Film badges were placed in the pipe.

STATIONS:	212.01 thru 212.06
PURPOSE:	Gamma versus Time
SITES:	Able, Charlie, Dog, Easy, Fox and George
USER:	DOD-2
PARTICIPATION:	All Bikini Events
CONSTRUCTION:	2-27-56/4-12-56
OCCUPANCY:	4-14-56

These stations were User-furnished 8-1/2″ O. D. by 6′-6″ long pipes embedded in 7′ x 7′ x 6′-deep concrete foundations, which were also used for stations in the 221 series. Film badges were placed inside the pipes. Approximately 10 cubic yards of concrete were poured for each station, which had an average 28-day strength of 3,000 psi.

STATIONS:	220.08, 220.09 and 220.14
PURPOSE:	Gamma Dose versus Time
SITES:	Oboe, Roger and Peter
USER:	DOD-2
PARTICIPATION:	All Bikini Events

These stations existed from CASTLE and bore identical station numbers for REDWING. No work was performed by the Contractor. The stations were concrete with embedded pipes and similar to the 221 series constructed for this Operation. Timing signals of minus one minute and one second were required for participation in the Zuni event.

STATIONS:	221.01 thru 221.06
PURPOSE:	Gamma Dose versus Time
SITES:	Able, Charlie, Dog, Easy, Fox and George
USER:	DOD-2
PARTICIPATION:	All Bikini Events
CONSTRUCTION:	2-27-56/4-12-56
OCCUPANCY:	4-10-56

These stations consisted of concrete foundations 7′ x 7′ x 6′ deep set flush with the ground. Four User-furnished 16-7/8″ diameter x 4′ long pipes were embedded in the foundations with a 3″ high projection above the top. Stations in the 212 series were located with these stations. A 100′-radius area was cleared around the structures and a 50′ wide area was daylighted toward each zero station. Timing signals of minus one minute and minus one second were provided for Stations 221.03 thru 221.06 and signals of minus 15 minutes and minus 15 seconds were supplied for Stations 221.01 and 221.02. The approximate amount of concrete poured for each station was 10 cubic yards with an average 28-day strength of 3,000 psi.

STATIONS:	222.01 and 222.02
PURPOSE:	Gamma Dose versus Time
SITES:	Dog and George
USER:	DOD-2
PARTICIPATION:	All Bikini Events

Requirements for these stations consisted of providing space in existing CASTLE Station 101, George, and in Station 1320, Dog. No construction was involved. Minus one minute and minus one second timing signals were supplied.

STATIONS:	250.01 thru 250.03 and 251.01
PURPOSE:	Neutron Flux Detectors
SITES:	Charlie and Charlie-Dog Reef
USER:	DOD-2
PARTICIPATION:	18
CONSTRUCTION:	3-23-56/4-4-56
OCCUPANCY:	4-6-56

These stations were concrete foundations set flush with the ground except for 251.01, which was on the reef and set 12 inches above high tide. Each station was 6′ x 12′ x 3′ deep except for Station 251.01, which was 6′ x 21′ x 6′. A detector was mounted on a steel plate that slanted at an angle normal to the Station 18 height of burst. A total of 8 cubic yards of concrete, with an average 28-day strength of 4,450 psi was poured for Stations 250.01 thru .03, 18 cubic yards for Station 251.01.

STATIONS:	252.01 thru 252.11
PURPOSE:	Threshold Detectors
SITE:	Yvonne
USER:	DOD-2
PARTICIPATION:	7

These stations were User-furnished detectors clipped to the crossarms of Stations 1211.01 through 1211.11. (See description on 1211 station series.)

STATIONS:	253.01 thru 253.06, 253.08 thru 253.13, 253.15 thru 253.29, 253.32 thru 253.40 and 253.42 thru 253.51
PURPOSE:	Threshold Detectors
SITES:	Tilda and Sally
USER:	DOD-2
PARTICIPATION:	1 and 2
CONSTRUCTION:	2-16-56/6-9-56

These stations consisted of various types of detectors. Type one was a 3″-diameter 4′-high standard pipe buried in an 8″-diameter concrete footing to a minimum depth of 4′. Type two was a 3″ diameter, approximately 4′ high, standard pipe buried in a 2′-square by 4′-deep reinforced concrete block. Type three was a 3″ diameter, approximately 4′ long, standard pipe buried in an 8″ concrete footing 4′ deep. A 3/8″ wire rope with 1″ minimum slack was bolted at each end to retain the pipe after the blast sheared it at the base. Types four and five consisted of 1″ plow cables laid on top of sandbags and sawhorses, respectively, both with User-furnished instruments attached.

One-inch steel cable was used to assist in recovering the detectors, which were spaced at approximate 300-foot centers along the cable. Three runs of cable were utilized in conjunction with Station 1, and three runs with Station 2. Sandbags kept the cable in place. The detectors were raised 4′ above the ground by using wooden horses beginning at a point 900 feet from each zero station. Stations 253.42 through 253.51 consisted of detectors clipped to the crossarm of a pipe column set in the reef. The height of the crossarm was 6 feet above high tide. (For description of these stakes, see station series 1211.)

A total of four cubic yards of concrete was poured.

STATION:	255.01
PURPOSE:	Neutron Effects
SITE:	Yvonne
USER:	DOD-2
PARTICIPATION:	7
CONSTRUCTION:	5-14-56/6-7-56

This station consisted of six boxes, each 3′ x 3′ x 3′ high with 6″-thick reinforced concrete top and side walls. The bottom was open and set in the ground to a depth of 6 inches. The top was made removable by the use of bolts. All boxes were spaced 3′ apart in an array approximately 750′ from Station 7. Box 1 was plain reinforced concrete; Box 2 concrete was User-furnished; Box 3 concrete contained 20 pounds of borax; Box 4 concrete contained 40 pounds of borax; Box 5 concrete contained 60 pounds of dry sulphur and Box 6 concrete contained 15 pounds of dry sulphur. All the boxes were made in the testing laboratory at Elmer to ensure proper mixing and curing. A total of 16 cubic yards of concrete was poured.

STATION:	257.01 thru 257.03
PURPOSE:	Neutron Studies
SITE:	Charlie
USER:	DOD-2
PARTICIPATION:	18

These stations consisted of soil samples placed in a depressed section of concrete within Stations 250.01, .02 and .03.

STATION:	261.01
PURPOSE:	Rocket Launching
SITE:	How
USER:	DOD
PARTICIPATION:	11, 18 and 22

CONSTRUCTION: 2-6-56/5-4-56
OCCUPANCY: 4-9-56

Station 261.01 was composed of two reinforced concrete launching pads, each 100′x 12′ x 1′ thick, with surfaces finished smooth and located with the axis of each slab normal to a line through Station 18. Three bench marks were located in each slab. The orientation was accurate to plus or minus 5 degrees and had to be known to 30 minutes. No obstruction was allowed 15 degrees above the horizontal from the launcher site toward Stations 11, 18 and 22. The launcher site was located within a User-approved area which required a minimum of ground clearing

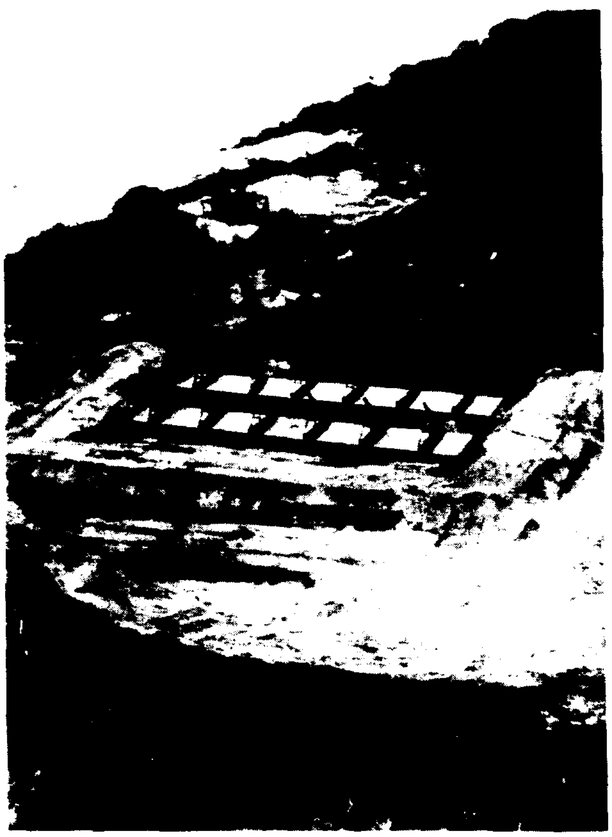


Figure 2-51. Station 261.01

For protection against inundation, an embankment was constructed immediately in front of the concrete slabs with the toe of the slope approximately 8.5 feet from the first slab and with a height of 5′, which provided protection on the front and sides of the launching area. A reinforced concrete building for use as a timing relay station was constructed which was 8′ x 10′ x 8′ high, with 12″-thick walls and slabs, and equipped with a blast door 2′ - 10″ x 6′ for resisting anticipated pressures. The blast door was watertight for protection against inundation. A work bench was installed along the walls. The criteria for power at the relay station called for 110 volt, single-phase, with a peak demand of 30 amps. Power was required through zero time to approximately H plus 30 minutes. Two 5 KW portable generators supplied the power thru an automatic transfer switch.

Timing for Stations 11 and 12 was minus one minute and minus one second; for Station 18, minus five minutes and minus 2.5 seconds, plus a User-installed photocell-operated timing signal.

A temporary facility for 15 rockets was erected consisting of a squad-type tent with a concrete floor; a portion of the tent was used for office space. The tent was removed prior to and reinstalled after the Cherokee, Navajo, and Apache events. Four portable-type duplex receptacles of 120 volt and 20 amps plus lights and two large CO^2 fire extinguishers were installed.

Because of post-zero power requirements, special consideration was given to the engine generator sets. A 3′ x 6″ high steel-frame shelter was constructed for each of the two 5 KW gasoline engine-driven sets. The sides and top of the shelter were covered with removable steel plate but the ends were left open for ventilation. To protect the open ends from expected pressures, baffled, removable panels were used. Each baffle consisted of two panels back-to-back with 8-inch steel horizontal channels alternating in vertical positions. It was anticipated that the baffles would eliminate reflected pressures within the housing and still permit ventilation. The generators were mounted on the roof of the station as a protection against inundation. The connected load was 4.8 KW. A six-circuit panel mounted in the station distributed the power within its interior and also to the adjacent tent. A special engine shutdown timer permitted the generators to run through zero and be automatically stopped at zero plus 90 minutes. The timer was operated by the minus one minute timing signal, which started a time clock set to stop the generators at any pre-set time. Running time of 24 hours after zero was available on the clock.

A 16-pair terminal cabinet with 4-pair signal and 2-pair telephone lines was installed in the station.

A total of 63 cubic yards of concrete was poured, with an average strength of 3,400 psi. Bronze marker plates were set in the concrete to give elevations and orientation.

STATION: 262.01
PURPOSE: Cloud Sampling with Rockets

SITE: Nan
USER: DOD-2
PARTICIPATION: 11, 18 and 22

This station consisted of space in an existing magazine and was used as a receiving and recording station for the rocket launcher Station 261.01, How. Four racks of User-furnished electronic equipment, requiring 5 KW, 110-volt, single-phase power, were installed. Power was furnished by the normal island supply and back-up power was supplied by a 20 KW emergency generator. Antennas mounted on poles picked up signals from Station 261.01, How. Two pair of wire for monitoring were run from Station 261.01. Minus-one-minute, 2-1/2-seconds, and one-second timing signals were required.

STATIONS: 263.01 thru 263.18
PURPOSE: Fall-out Distribution
SITE: In Ocean (Bikini)
USER: DOD-2
PARTICIPATION: 11, 13, 18 and 22

These stations were User-furnished and installed and consisted of skiffs moored in deep water. A 10,000 square foot area was provided at Nan to support project work on the skiffs.

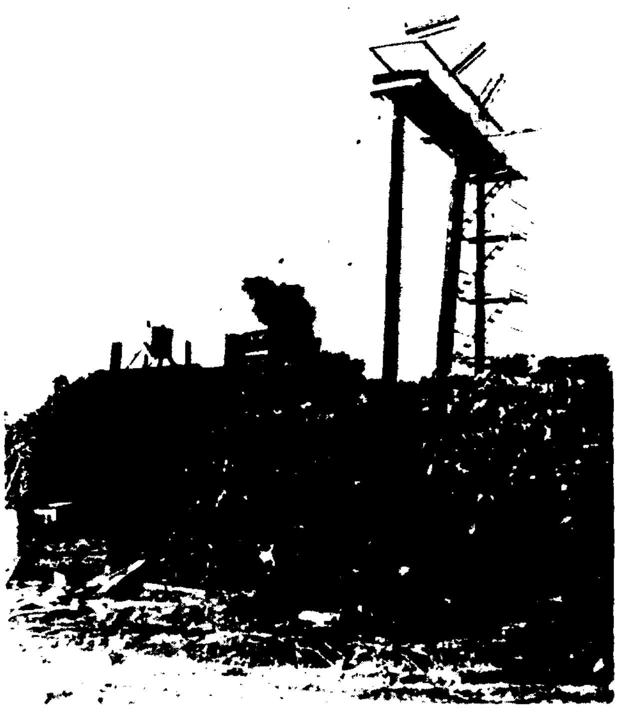


Figure 2-52. Station 262.01

STATIONS: 265.01 thru 265.02
PURPOSE: Fall-out Distribution
SITE: Bikini Lagoon
USER: DOD-2
PARTICIPATION: Stations 11, 13, 18 and 22

Stations 265.01 and .02 were User-furnished, and consisted of moored YFNB barges equipped with two blue box and radio timing signals of minus one second. Power was supplied thru barge generator equipment.

STATIONS: 266.02 and 266.03
PURPOSE: Fall-out Distribution
SITES: How and Love
USER: DOD-2
PARTICIPATION: 11, 13, 18 and 22

These structures were existing CASTLE Stations 251.02 and 251.03 and consisted of concrete boxes 6′ x 6′ x 3′ deep. It was necessary to place backfill and level the stations to meet original conditions. Minus 2-1/2-seconds and one-second timing signals were provided.

STATIONS: 267.01 thru 267.03
PURPOSE: Fall-out Distribution
SITE: Bikini Lagoon
USER: DOD-2
PARTICIPATION: 11, 13, 18 and 22

These User-furnished stations were moored pontoon rafts containing fall-out sampling equipment.

STATIONS: 268.01 thru .22
PURPOSE: Fall-out Distribution
SITES: Able, Charlie, Dog, Fox, George, How, Love, Nan, Oboe, Uncle, Victor, Yoke and Bravo
USER: DOD-2
PARTICIPATION: 11, 13, 18 and 22
CONSTRUCTION: 1-5-56/5-24-56

These stations were the existing 252 series of CASTLE, which were leveled for Operation REDWING by placing them inside of a new concrete foundation. The stations were concrete, 6′-10″ x 2′-6″ at one end, 4′-8″ at the opposite side and with a depth of 1′-8½″. A battery pit was in one end of the station and a fall-out collector in the other. The stations were located in a 100′ square clearing. Requirements included a battery for supplying power and two blue boxes. Each station contained 2 cubic yards of concrete with an average strength of 4,700 psi. Stations 268.01 thru .12 were precast at Nan and 268.13 thru .22 were precast at Tare. All of the stations were transported to their sites via LCM and placed with a forklift.

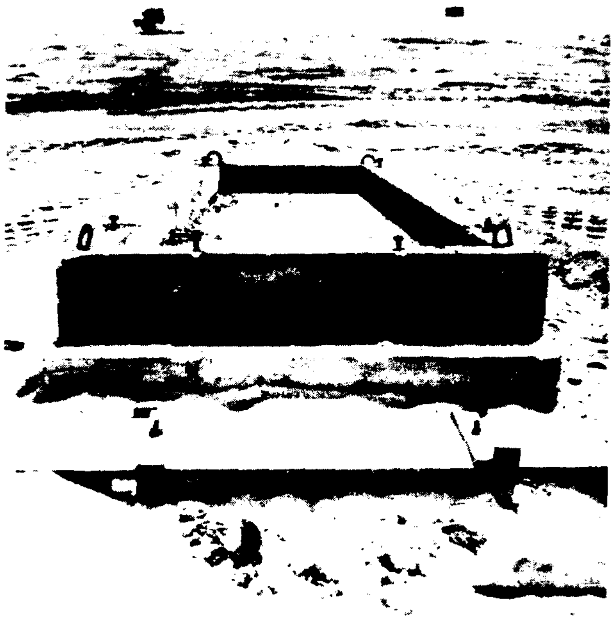


Figure 2-53. Station 268.22 - 95% Complete

STATIONS:	269.01 thru 269.04
PURPOSE:	Base Surge Measurements
SITES:	Fox, George, Oboe and Uncle
USER:	DOD-2
PARTICIPATION:	11, 13, 18 and 22
CONSTRUCTION:	3-3-56/4-12-56
OCCUPANCY:	4-12-56

These stations were two 4′ x 4′ x 2′ deep concrete foundations in each of which one 4″ diameter 3′ high pipe column was embedded. A 3′ x 3′ x 2′ deep plate steel box was on the same center line as the two concrete pipe foundations. Conduit embedded in the concrete connected this box to each pipe column. User-furnished equipment was placed in the steel box and on top of the pipe columns. A minus-1-minute timing signal was required. Each station contained 2-1/2 cubic yards of concrete.

STATIONS:	270.05 thru 270.08
PURPOSE:	Fall-out Collectors and Cessation Monitors
SITES:	Wilma, Bruce, LeRoy and Mack
USER:	DOD-2
PARTICIPATION:	13, 18 and 22

These stations were User-located, furnished, and installed measuring devices.

STATION:	271
PURPOSE:	Fall-out Collector
SITE:	How
USER:	DOD-2
PARTICIPATION:	13, 18 and 22
CONSTRUCTION:	3-28-56/4-18-56
OCCUPANCY:	4-13-56

Station 271 was a User-furnished steel fall-out collector tower set on concrete piers. The tower was delivered to Nan by YFNAB barge, upon which the tower had been completely assembled. The tower was later placed on an LCU and transported to How.

STATIONS:	310.01, .02 and .03, 311.01, .02 and .03
PURPOSE:	Loading and response of Structures
SITES:	Man-Made Islands, Charlie-Dog Reef: Except 311.03 on Dog
USER:	DOD
PARTICIPATION:	18
CONSTRUCTION:	12-12-55/4-27-56

Three 40′ x 40′ and three 40′ x 80′ steel structures were built. The User furnished drawings, steel schedules, and special provisions covering these structures, which were of the identical type used for Operation Teapot in Nevada. All materials and equipment, other than the structural steel and the test apparatus, were furnished by the Contractor. The siding and roofing were the same type and had the arrangement and attachment as in the buildings utilized during Teapot. The locations were the following distances from Station 18 to the working point of the building: 310.01 (40′ x 40′) 20,500 feet; 310.02 (40′ x 40′) 24,000 feet; 310.03 (40′ x 40′) 29,000 feet; 311.01 (40′ x 80′) 24,000 feet; and 311.02 (40′ x 80′) 29,000 feet; and 311.03 (40′ x 80′) 35,600 feet. The area in front of Station 311.03 was cleared of debris and any rock more than 1-1/2 inches in diameter.

The man-made islands had an elevation of plus 9.5 feet which was sufficient in height for protection against normal wave action. The leading edges of the man-made islands were rounded on a radius of approximately 2′ from high tide level to the normal elevation.

The steel columns of each station within this series rested on concrete piers which extended through the island fill and 6″ into the coral. The piers were interconnected by means of foundation walls extending down to coral. During construction, it was found impractical to keep the foundation walls keyed continuously into the coral because of its hardness.

A decision was reached that adequate reaction would be obtained by keying only the pier footings into the coral and then driving

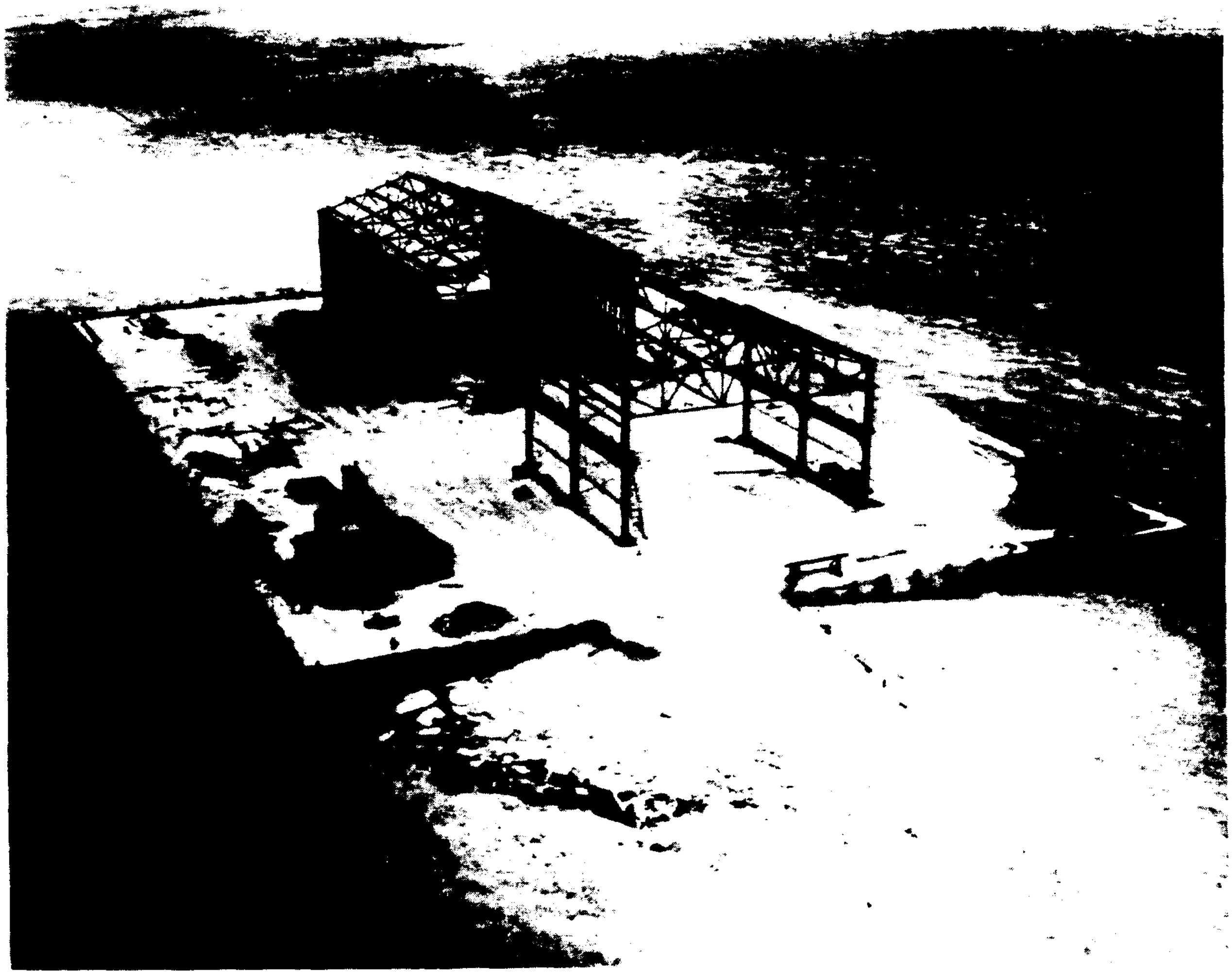


Figure 2-54. Stations 311.02, 310.03 and 312.03 Under Construction - Man-Made Island No. 3

two 60-pound rails 4′ into the coral at each end of the foundation wall.

Soil conditions were more favorable for Station 311.03, Dog. The foundation scheme was similar to the other stations but footings were extended 2′ below natural grade and no attempt was made to connect to coral. These footings had additional cover in that the final grade required several feet of fill on top of the natural grade.

Stations 310.01, .02 and .03 were steel trussed with roof and siding of corrugated asbestos. The ends of the buildings were left open. The asbestos material was frangible and therefore could be shattered, exposing the steel framework in case the roof and sides were subjected to blast pressures; this factor became the basis for the foundation design and influenced developing the strength of the exposed steel framework.

Figure 2-55. Stations 311.01 and 310.02 50% Complete - Man-Made Island No. 2

Stations 311.01, and .02 and .03 were also steel trussed with corrugated asbestos roofs, but the siding was 8-inch thick reinforced concrete with a 7′ high continuous opening 7′ off the ground. The ends of the buildings were left open.

On 18 December 1955, a combination of high tides and a storm caused inundation in the vicinity of Station 311.03, Dog. All of the work accomplished on the station to date, even to the stakeouts, was lost.

The criteria covering the size of the man-made islands and the location of the stations were furnished by the User. A description of the islands and problems involved in their construction are found in this report under the sub-heading of Man-Made Islands.

A total of 55 cubic yards of concrete at an average 28-day strength of 5,300 psi was poured for Station 310.01, 55 cubic yards at 3,800 psi for 310.02, 62½ cubic yards at 5,000 psi for 310.03, 180 cubic yards at 4,600 psi for 311.01, 204 cubic yards at 3,200 psi for 311.02 and 167½ cubic yards at 4,025 psi for 311.03.

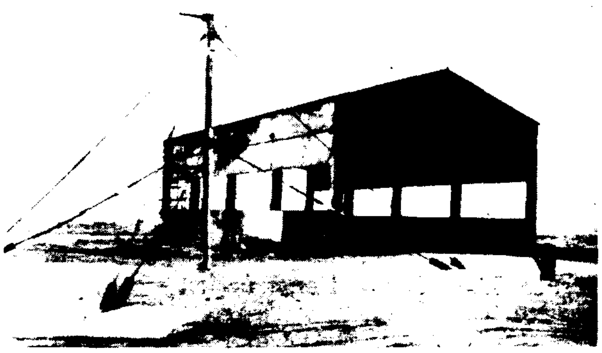


Figure 2-56. Stations 311.03 with 313.06 in Foreground

STATIONS:	312.01 thru 312.04
PURPOSE:	Instrument Shelters
SITES:	Man-Made Islands (Charlie-Dog Reef) (312.01-312.03) Dog 312.04
USER:	DOD Program 3 Project 3.1
PARTICIPATION:	18
CONSTRUCTION:	2-13-56/4-20-56
OCCUPANCY:	4-11-56

These stations were reinforced concrete buildings 10′ x 15′ x 10′ high with walls and a floor slab 10″ thick designed to withstand expected overpressures. The tops of the structures were 2′ above finished or natural grade. Proper

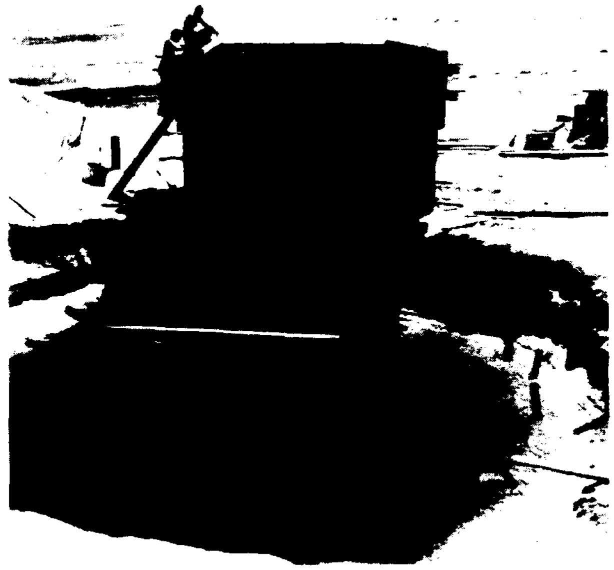


Figure 2-57. Station 312.04 - Form for Precasting

measures were required to prevent leakage. Since the finished grade on the man-made islands was only two feet above the high water line, a portion of the structure was constantly submerged in saturated soil. This posed two problems: first, the buildings might necessitate cassion shafts of sufficient size to accommodate construction and heavy enough to remain submerged when set in place; secondly, was the need for sealing the porous concrete from the water that would seep in the sides and bottoms of the building. The best solution appeared to be precasting each building and then setting it in place. The structures were therefore designed to be as light as possible and yet strong enough to withstand expected pressures. The bottoms and about four feet of the sides were encased in ⅛″ steel jackets with watertight seams. The jacket served in part as the outside form for the concrete pour. The entire form was erected adjacent to the excavations. At Dog, an attempt was made to lower the form with only the floor precast. It floated and had to be raised; walls were added, which provided the weight necessary to help the structure set in place. Precasting of the floor slabs for the stations on the man-made islands was also necessary.

Three 8-inch pipe vents extended through the roof and at each end of the battery room, and one was installed opposite the shelter entrance. Blank flanges on each vent covered the openings prior to the experiment. The entrance was a 2′-6″ square hatch with a blast resistant, watertight, steel cover.

Power to each station was supplied by a portable 25 KW diesel-driven generator which was removed before each test. The connected load was 8 KW. Distribution was through a 16-circuit 120/208 volt, 3-phase, 4-wire lighting circuit breaker panel. Two 20-amp, 120-volt and one 130-amp, 120-volt receptacles provided outlets for scientific power; two 20-amp, 120-volt receptacles provided the power required for ventilation and dehumidification; and one 20-amp, 120-volt receptacle provided the power for a battery charger.

Seven timing signals were provided by an EG&G furnished radio. Contractor furnished equipment included a small portable type room humidifier, a 280-gallon steel oil storage tank and a 7-inch exhaust fan which was installed in the 8" pipe vent in the battery room.

Station 312.01 had 23 cubic yards of concrete poured at an average 28-day strength of 4,950 psi, 312.02 had 23 cubic yards at 4,250 psi, 312.03 had 23 cubic yards at 4,400 psi and 312.04 had 22 cubic yards at 4,070 psi.

STATIONS:	313.01 thru .06
PURPOSE:	Pressure versus Time and Velocity versus Time at 25 Feet
SITE:	Charlie-Dog Reef
USER:	DOD-3
PARTICIPATION:	18
CONSTRUCTION:	2-29-56/4-25-56
OCCUPANCY:	4-29-56

These stations were 8" diameter 25'-4" high masts which were guyed at the 13' and 23' levels. Each station required a concrete mast footing and three concrete guy anchor blocks. User-furnished and installed gages were located at the 10' and 25' levels of the stations and were oriented toward ground zero. Cable was run from the gages to the 312 series recording shelters. Forms and guy rods were fabricated at Nan. The design of the anchor block layout had to be changed to meet field conditions, which in turn necessitated changing the guy rods. This was met by welding sections of #12 rebar to the fabricated guy rods. The following amounts of concrete were poured for each station: Station 313.01, 52½ cubic yards at an average 28-day strength of 3,675 psi; 313.02, 52½ cubic yards at 2,700 psi; 313.03, 52½ cubic yards at 2,700 psi; 313.04 and .05, 52½ cubic yards at 3,850 psi and 313.06, 53 cubic yards at 3,850 psi.

STATION:	410.01
PURPOSE:	Flash Blindness and Blink Measurements
SITE:	David
USER:	DOD-4
PARTICIPATION:	3, 6, 19 and 24
CONSTRUCTION:	4-9-56/4-26-56

This station was a tent and shed structure with a wooden floor set on dirt, located at the north end of the island. It was used as a shelter for a User-furnished and installed rack containing timed shutters over holes for the purpose of checking flash blindness to monkeys. A clear line of sight was required to Stations 3, 6, 19 and 24. An animal exercise cage, Building 149, was used in support of this project. Two 5 KW generators with automatic switch-over gear provided for service and stand-by power. Timing signals of minus 15 minutes, 2½ seconds, and one second, and two blue boxes were required.

STATION:	411.01
PURPOSE:	Flash Blindness and Blink Measurements
SITE:	Nan
USER:	DOD-4
PARTICIPATION:	13, 18 and 22
CONSTRUCTION:	2-25-56/5-4-56
OCCUPANCY:	5-7-56

Station 411.01 was an earth embankment 50' x 10' at the top with a concrete slab covering the entire area and set at elevation plus 15'. Two 21' x 10' concrete ramps extended down the sides of the embankment. Tie-down anchors in the slab were provided to secure two 2½ ton flat-bed trailers on which racks were placed. The racks were the same as described for Station 410.01. Power in the amount of 5 KW was supplied by island distribution with emergency back-up from an engine generator. Timing signals of minus 15 minutes, 5 seconds, 2½ seconds, and 1 second, and two blue boxes were required. A total of 21 cubic yards of concrete with a 28-day strength of 3,450 psi was poured.

STATION:	411.02
PURPOSE:	Flash Blindness and Blink Measurements
SITE:	How
USER:	DOD-4
PARTICIPATION:	13, 18 and 22
CONSTRUCTION:	6-7-56/6-30-56

This station was an earth embankment with tie downs for securing animal cages. The installation also included a generator and power cable. No concrete was poured.

STATION:	550.01
PURPOSE:	Aircraft Positioning
SITE:	Fred
USER:	DOD-5
PARTICIPATION:	1, 3, 4, 5, 6, 23 and 24
CONSTRUCTION:	2-20-56/2-22-56

Twelve trailers and 8 generators furnished and installed by the Users were known as Station 550.01. The trailers were grouped in three, at four locations within a 50′ x 320′ cleared and stabilized area. A 16′ x 16′ storage tent and forty-eight 6″ x 6″ x 6″ high blocks for generator supports were provided. Main and spare count-down outlets were furnished. Timing signals for minus 15 minutes and minus 1 minute and a blue box were required. A total of 4 cubic yards of concrete was poured.

STATION:	560.01, .03, .04 and .05
PURPOSE:	Aircraft Positioning, Raydist Relay Stations
SITES:	Able, How, Nan and William
USER:	DOD-5
PARTICIPATION:	10, 11, 12, 13, 18 and 23
CONSTRUCTION:	1-11-56/5-5-56
OCCUPANCY:	4-9-56

Each station consisted of a reinforced concrete building and either a four or eight-antenna tower array. The building for Station 560.01 was 18′ x 33′ x 13′ high with 4-foot thick walls and slabs. To allow for reflected pressures hitting the side of the building, the foundation slab was extended 5′ out from either side to prevent overturning. Station 560.01 served as Station 150.01 for the Cherokee event. The buildings for Station 560.03, .04 and .05 were 18′ x 33′ x 13′ high with 1 foot-thick walls and slabs. Each structure had three blast resistant doors designed to be watertight. One was a 2′-10″ x 6′ steel framed door and the other two were 20″-square steel doors for ventilation. These smaller doors were hinged at the top and triggered to close by means of an assembly containing an explosive link. A 7′ x 9′-high earth berm around each station prevented inundation of the tower footings and buildings. In the case of Station 560.01, the outer face of the entire berm was covered with sandbags containing a sand-cement mixture. After being set in place, the bags were wetted down to form a mat. At Station 560.05, the side of the berm facing the shore was covered with riprap. It was thought that riprap provided the more stable facing, but since it was not readily available at the Station 560.01 site, sandbags were substituted. At Stations 560.03 and 560.04, the nature of the anticipated wave was such that it did not warrant reinforcing the face of the berms.

To protect the engine generators from pressures, the two units at each station were equipped with a steel-framed shelter utilizing rigid 5′ high frames. The sides and top were covered with removable steel plate. The ends, however, were left open to allow for exhaust and clean air. This presented the problem of keeping the ends protected from pressures. It was decided to use removable baffled-end panels. Each baffle consisted of two removable panels back-to-back with 8″ steel horizontal channels alternating in vertical positions. It was anticipated that the baffles would eliminate any possibility of reflected pressure within the housing and still allow the air to circulate. As an added precaution against inundation, the generator sets were mounted on the roofs of the concrete buildings.

Power to these stations was supplied by two 20 KW, 120/208 volt, 3-phase, 4-wire, 60-cycle diesel engine generators. To ensure uninterrupted power, the generators were run in parallel when the stations were abandoned. Each control panel had a reverse power relay which automatically cut one generator out in the event of operational difficulties.

Two 12-circuit breaker distribution panels were installed in the stations, one for utilities and the other for scientific loads. Each panel was connected to one 20 KW generator so that when the machines operated separately, each unit furnished power to one panel. With this setup, all surges caused by utilities were limited to one generator, while the other unit supplied power to the scientific load free of voltage disturbances. The generators were run separately while the stations were set up and tested.

Eighteen 30-amp, 120-volt receptacles were installed for scientific instruments. The connected loads for scientific and utility purposes, respectively, were 18 KW and 5.6 KW.

Since power was required for scientific instruments through zero to at least plus 60 minutes, an automatic signal-actuated timer was designed to shut down the generators at 90 minutes past zero. The timer was actuated by a minus-one-minute timing signal.

A No. 8 AWG solid copper ground bus was installed above the work benches. The bus was connected to two ground rods, two generator neutrals, and the electrical conduit system.

Inasmuch as the stations were equipped with blast doors, automatic shutdown was provided for the ventilation equipment. Conduit and wiring were installed for two blast doors.

No signals were required except for utilities. Four pair of signal lines were provided, three for the three signals required and one spare. A 16-pair terminal cabinet for signal and telephone and one telephone were installed.

Ventilation was accomplished by installing a 3,200 CFM blower. Aluminum ducts were installed around the work bench bases for exhausting battery fumes. Three 20″ filters were

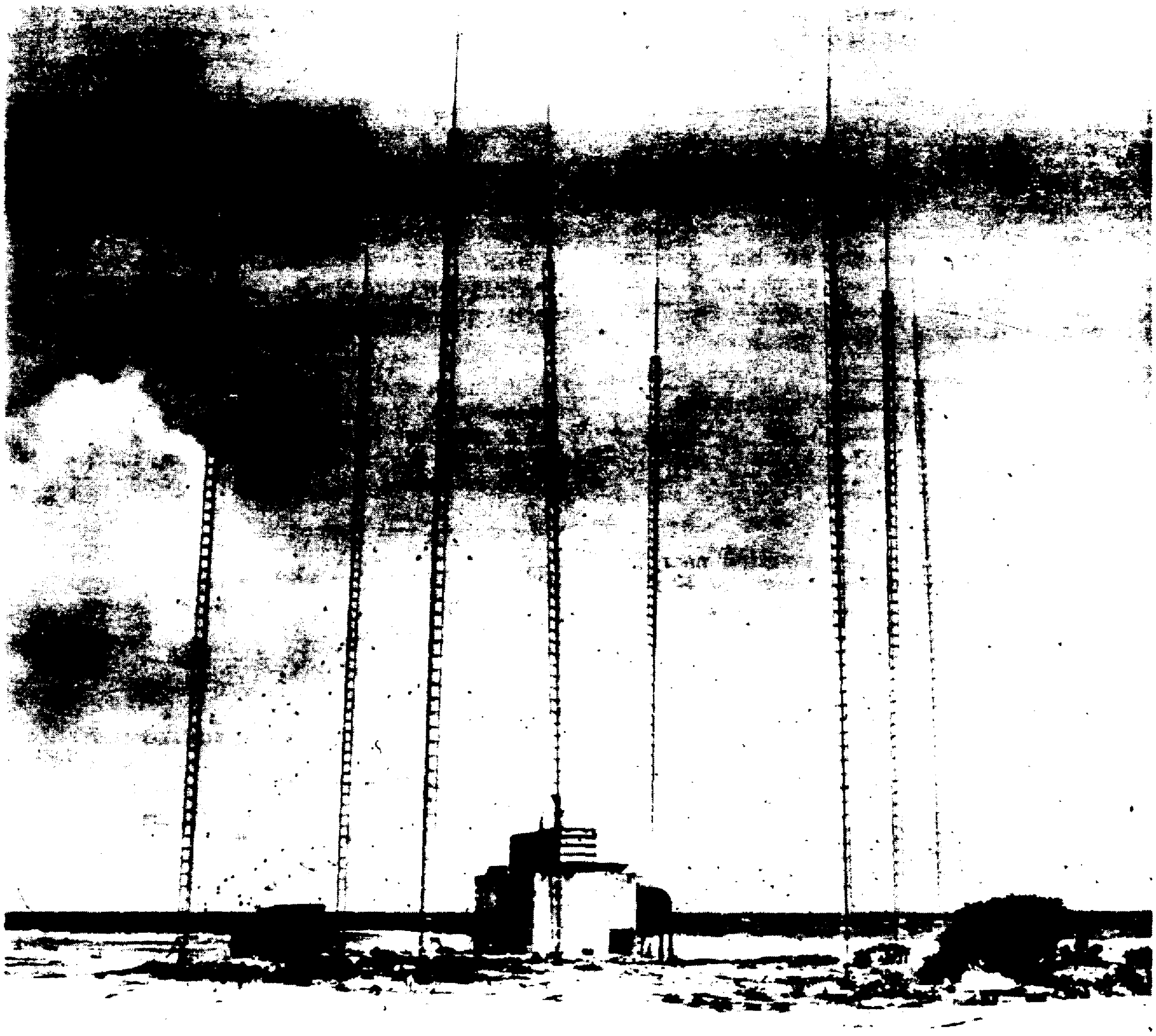


Figure 2-58. Station 560.04

installed in the aluminum sheet plenum at the blower air inlet.

A 550-gallon, steel, all-welded tank used for supplying fuel to the generators was anchored to the station.

STATIONS:	562.01 and .02 and 563.01
PURPOSE:	Aircraft Positioning, Raydist Receiver, Transmitter and Reference Stations
SITES:	Wotho and Rongerik
USER:	DOD-5
PARTICIPATION:	All Events

Stations 562.01 and 562.02 were raydist receiving and transmitting stations consisting of two antenna farms, each with four 60′-high poles erected in cleared ground approximately 3,200 feet apart. Three concrete guy anchor blocks were provided for each pole. Station 563.01 on Rongerik required eight antenna poles. A 16′ x 32′ tent was erected at each station. Power to Station 562.01 and 563.01 was supplied by two 25 KW, 120-volt, single-phase generators and power for Station 562.02 was furnished by two 30 KW, 120-volt, three-phase generators.

STATIONS:	580.01, .03, .04 and .05
PURPOSE:	Aircraft Positioning
SITE:	Able, How, Nan and William
USER:	DOD-5
PARTICIPATION:	10, 11, 12, 13, 18 and 22
CONSTRUCTION:	1-20-56/4-9-56
OCCUPANCY:	4-9-56

This structure was one 60′ high antenna tower as part of the raydist array for Stations 560.01, .03, .04 and .05. No power or timing signals were required.

STATION:	590.01
PURPOSE:	Missile Vulnerability
SITE:	Yvonne
USER:	DOD-5
PARTICIPATION:	6
CONSTRUCTION:	4-12-56/5-26-56

A 4″ x 4″ steel bracket mounted near the top of tower Station 6 was known as Station 590.01. Specimens of varied shapes were suspended from the bracket. No power or timing installations were required.

STATIONS:	591.01, 592.01, 593.01, 594.01, 595.01 and 596.01
PURPOSE:	TV Specimen Towers
SITE:	Yvonne
USER:	DOD
PARTICIPATION:	6
CONSTRUCTION:	4-12-56/5-27-56

These stations consisted of 11 television-type steel towers triangular in cross section, 18″ on a side, and ranging from 86′ to 266′ in height. The towers were mounted on 5′ x 5′ x 3′-thick concrete footings and were guyed to 6′ x 6′ x 6′ concrete anchor blocks. One tower was required for Station 596.01 and two towers each for the other stations. Criteria as to location specified that the tower guys were not to interfere with the line of site from Station 1311.01, would not hinder the construction of the zero stations and accessories and should not create a safety hazard along the airstrip.

Each station was fitted with a one-inch triangular-shaped steel plate to match the top of the tower. The Contractor was required to suspend a two-ton User-furnished specimen between these plates. The rigging broke while mounting the specimen for Station 591.01; the specimen fell striking guys and a tower causing the collapse of both towers. Due to the limited time available, a new method of hanging the specimen was designed in the field. This method consisted of two 6″ pipes, 30 feet long, mounted V-shaped, and welded on a bracket to one of the Station 6 tower legs. Each pipe end of the V was guyed from the top of the tower with ½″ cable. Brackets were placed on each end of the pipe between which the specimen was suspended.

A total of 281 cubic yards of concrete was poured.

STATIONS:	598.01 thru 598.04
PURPOSE:	Reference Markers
SITE:	Yvonne
USER:	DOD-5
PARTICIPATION:	6
CONSTRUCTION:	4-22-56/4-28-56

These stations were concrete cylinders, 1′ in diameter and 4′ long, embedded in the ground to within 10 inches of the top. They were located at a range of 260 feet from the working point of Station 6 and used as reference markers for Stations 591.01 thru 596.01. No power or timing signals were required. A total of 2 cubic yards of concrete was poured.

STATION:	599.01
PURPOSE:	TV Specimen Tower
SITE:	Ruby
USER:	Dayton University
CONSTRUCTION:	6-1-56/6-28-56

Station 599.01 was a triangular tower 1′-6″ on a side and 150′ high. The tower was mounted on a 5′ x 5′ x 3′-thick reinforced concrete footing and was guyed with cables tied to 6′ x 6′ x 6′-high concrete anchor blocks. User-furnished specimens were mounted at the top of the tower. A total of 19 cubic yards of concrete was used.

STATIONS:	810.01 thru 810.03
PURPOSE:	Thermal Radiation Measurements
SITES:	Dog, William and Oboe
USER:	DOD-8
PARTICIPATION:	18 and 22
CONSTRUCTION:	2-17-56/5-5-56
OCCUPANCY:	4-12-56

These stations consisted of User-furnished and Contractor-installed steel instrument shelters. They were approximately 9′ x 6′ x 6′ high and contained a vertical hatchway. Each shelter was buried under about 10 feet of earth. A 10′-high pipe mast used to support reflectors was installed at each of Stations 810.01 and 810.03. The mast was eliminated at Station 810.02; this station was used with a mirror known as Station 812.01 which was mounted at the 37½-foot level of Station 1515. Power was supplied by User-furnished batteries. Timing signals of minus 15 seconds, minus 5 seconds, and minus 2½ seconds were required at Station 810.01, and minus 15 seconds, minus 5 seconds, and minus 1 second were provided at Stations 810.02 and 810.03.

STATIONS: 811.01 and 811.02
PURPOSE: Thermal Radiation Measurements
SITES: George and How
USER: DOD-8
PARTICIPATION: 18
CONSTRUCTION: 2-27-56/5-3-56
OCCUPANCY: 4-11-56

These stations were User-furnished trailers 35′ x 8′ x 12′ high and weighing 25,000 pounds. The space around the base of the trailers was sandbagged to prevent inundation. Steel cables were used to guy each trailer to four concrete anchor blocks. Power was furnished by two 75 KW generators. Timing signals of minus 45 minutes, minus 15 minutes, minus 1 minute, minus 15 seconds, minus 5 seconds, and minus 2½ seconds, plus a special radio drop signal, were provided. The concrete poured for Stations 811.01 and .02 totaled 18 and 18½ cubic yards, respectively. All the pours had an average 28-day strength of 2,500 psi.

STATIONS: 812.01 and 812.02
PURPOSE: Thermal Radiation Measurements
SITES: William (812.01) and Wilma (812.02)
USER: DOD-8
PARTICIPATION: 22 and 24
CONSTRUCTION: 4-9-56/4-28-56

These stations consisted of 25′ square working platforms and brackets for supporting mirrors at the 37½-foot levels of photo tower Stations 1513 and 1514. In addition, a steel instrument shelter located at the base of tower Station 1513, identical to Station 810.01 without the 10-foot mast, was required for Station 812.02. The shelter was covered with earth to within 1 foot of the entrance hatchway and sandbags were placed over the hatch cover. Power and timing for each station were furnished from steel instrument shelters. (See description of Stations 810.01 thru 810.03).

STATION: 813.01
PURPOSE: Thermal Radiation Measurements
SITE: Nan
USER: DOD-8
PARTICIPATION: 18
CONSTRUCTION: 2-27-56/5-24-56
OCCUPANCY: 5-15-56

This station consisted of two User-furnished trailers identical to those described for Stations 811.01 and 811.02. They were located on an earth mound and guyed to four concrete anchor blocks adjacent to Station 70. This station also included a 3-inch pipe and working platform located at the 150-foot level of Station 1517, which was used for the installation of two User-furnished mirrors. Island power was supplied to each trailer. Timing signals of minus 45 minutes, minus 15 minutes, minus 1 minute, minus 15 seconds and minus 1 second were provided. A total of 25 cubic yards of concrete was poured.

Figure 2-59. Station 815.01

STATION: 815.01
PURPOSE: Thermal Radiation Measurements
SITE: Yvonne
USER: DOD-8
PARTICIPATION: 24
CONSTRUCTION: 4-7-56/4-23-56

This station was originally to be identical to Station 810.02 (instrument shelter) with a 30-foot-high mast. It was later decided to use the powerhouse as a shelter and mount the instrument on its roof. The instrument mount consisted of a 6-inch-diameter pipe bolted on the existing slab and guyed three ways. Timing signals of minus 15 seconds and minus 1 second were required.

STATIONS: 820.01 and 820.02
PURPOSE: Thermal Radiation Effects
SITES: Dog and George
USER: DOD-8
PARTICIPATION: 18
CONSTRUCTION: 4-11-56/4-14-56
OCCUPANCY: 4-17-56

These stations were User-furnished and installed A-frames made of tubing on which samples of cellulose paper and wood were installed. Clearing and trenching were accomplished. Timing signals of minus 5 seconds with one relay extended to Station 820.01 from Station 810.01, and minus 5 seconds with three relays were provided to Station 820.02 from Station 840.02. No power was required.

STATIONS: 830.01 thru 830.10
PURPOSE: Thermal Radiation Measurements
SITES: Dog, George, How and Yvonne
USER: DOD-8
PARTICIPATION: 7 and 18
CONSTRUCTION: 3-14-56/4-14-56
OCCUPANCY: 4-11-56

These stations were 3-inch-diameter steel pipes each embedded in a 2'x2'x4' deep concrete footing. The pipes extended 10 feet above the ground. User-furnished calorimeters were installed at the top of each pipe. Each of the stations utilized approximately 1 cubic yard of concrete with an average 28-day strength of 2,500 psi.

STATIONS: 840.01 and .02
PURPOSE: Thermal Radiation Effects
SITES: George and How
USER: DOD-8
PARTICIPATION: 18
CONSTRUCTION: 4-12-56/4-14-56
OCCUPANCY: 4-12-56

These stations were of metal framework 16' long x 10' high on which sandwich-type aircraft panels were attached. All material was User-furnished. A steel instrument shelter identical to Station 810.02 was located in the immediate vicinity of Station 840.01. Timing signals were minus 15 minutes, minus 15 seconds, and minus 5 seconds. Power was not required.

STATIONS: 850 thru 854
PURPOSE: Thermal Measurement
SITES: Sally, Yvonne and Peter
USER: DOD-8
PARTICIPATION: 1, 10, 13, 22 and 24

These stations were User-furnished light sources having an intensity of 10 to the 8th lumens located at Stations 1, 10, 13, 2300 and 3020. Five KVA, 220-volt, 60-cycle power was supplied from the same source as used by the station on which located. Automatic timers turned off the lights at minus 45 minutes.

STATION: 910
PURPOSE: Photography of Fireball, Canister Drop and Steel Structure
SITE: Man-Made Island No. 1
USER: DOD-9
PARTICIPATION: 18
CONSTRUCTION: 4-3-56/4-20-56
OCCUPANCY: 4-23-56

This station was a concrete structure 21' x 7' x 4' high with two compartments. Cameras were mounted in tandem inside the structure and directed at two different angles. Each compartment contained two ports set with 3"-thick glass and was covered with plexiglass shields. A 10' x 10' wooden frame building located behind the camera station housed two generators and provided support for a television-transmitting antenna. The two generators each furnished 5 KW power and were connected by a transfer switch. Timing signals of minus 15 minutes, minus 15 seconds, and minus 5 seconds were required. A total of 19 cubic yards of concrete was poured, with an average 28-day strength of 3,000 psi.

STATION: 911
PURPOSE: Photography of Wave Motion
SITE: Nan
USER: DOD-9
PARTICIPATION: 18
CONSTRUCTION: 4-16-56/4-25-56
OCCUPANCY: 4-27-56

This station provided shelter for a User-furnished camera within Station 190.01, which was located at the 24.5 foot level of existing Castle wooden tower Station 1580.01. A 2 KW generator and minus 15 minutes, minus 15 seconds, and minus 5 seconds timing signals were required.

STATION: 912
PURPOSE: Photography of Rocket Launching
SITE: How
USER: DOD-9
PARTICIPATION: 11, 18 and 22
CONSTRUCTION: 3-15-56/5-2-56
OCCUPANCY: 5-4-56

This station was a 4' x 2' x 3'-high wooden bench set on a concrete pad on which four cameras were mounted. A 2-cubic-foot metal box containing camera controls was buried in the ground 5 feet behind the bench. The cameras were used to photograph rocket launchings at Station 261.01 and were located 200 feet from the working point of this station. Timing signals consisted of minus 15 minutes, minus 15 seconds, and minus 5 seconds. One cubic yard of concrete with an average 28-day strength of 2,750 psi was used.

STATION:	913
PURPOSE:	Fireball Photography
SITE:	George
USER:	DOD-9
PARTICIPATION:	18
CONSTRUCTION:	3-22-56/4-11-56

This station was a 15′ x 11′-6″ x 6′-10″ high frame-type plywood shelter set on a concrete slab and having a tarpaulin roof. A pipe beam supported by end columns was located along an open side of the station. Four vertical posts which supported cameras were furnished and attached to the beam by the User. Power was furnished by a 10 KW, 110-volt, single-phase, 60-cycle generator which was protected with sandbags. Minus 15 minutes, minus 15 seconds, and minus 5 seconds timing signals were provided. A total of 5 cubic yards of concrete was poured, with an average 28-day strength of 3,600 psi.

STATIONS:	1210.01 thru 1212.12
PURPOSE:	Threshold Detectors
SITES:	Yvonne and Janet
USER:	DOD-12
PARTICIPATION:	5, 6, 7 and 24
CONSTRUCTION:	4-7-56/5-17-56

These stations were 3-inch pipes about 8′ high set in concrete, with double and single ¾″ round top crossarms attached. Stations 1212.02 through .04 had cable in the centers for holding the pipes in case of shearing from blast effects. The bottom crossarms were set at an elevation of plus 7 feet. The User attached detectors to the crossarms with cable clips. Several of these stations participated in various events, requiring their location at varying distances from the zero stations, which in turn necessitated that some be constructed on the reef and others on land. Stations 1211.01 through .11 were used conjointly with Stations 252.01 through .11. No timing signals or power were required. A total of 4 cubic yards of concrete was used. Due to the blast effects of previous events, it was necessary to replace five of the pipes for later shots. This replacement was accomplished by prefabricating 4′ x 4′ x 3′-high concrete blocks with embedded pipes and then transporting them to the site of installation. After the blocks were set, the pipes were lined by transit and grouted in place.

STATIONS:	1214.01 thru 1215.12
PURPOSE:	Threshold Detectors
SITES:	Helen to Irene Causeway and Janet
USER:	DOD-12
PARTICIPATION:	5 and 23

Design criteria called for User-furnished detectors clipped to 1-inch steel cables, each approximately 4,000 feet long located at Stations 5 and 23. Construction of these stations was not started per User request.

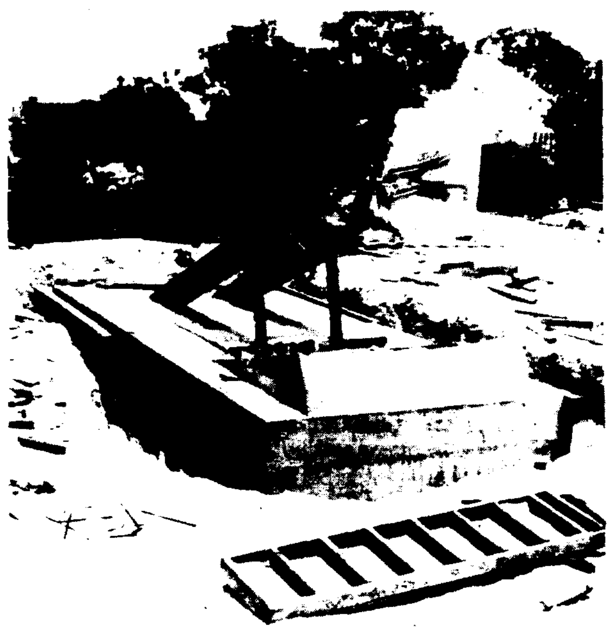


Figure 2-60. Station 1220.01

STATIONS:	1220.01 thru 1220.07
PURPOSE:	Alpha Detectors
SITE:	Yvonne
USER:	DOD-12
PARTICIPATION:	6 and 7
CONSTRUCTION:	4-2-56/4-19-56

These stations required 26′ x 10′ x 4′-thick reinforced concrete foundations with partially embedded structural steel frames, which were used for mounting 30-ton concrete blocks containing a collimator and detectors. New foundations and steel bracing were required in order to orient the stations on the working point of Stations 6 and 7. It was necessary to pour the foundations in two pours with a construction joint in the center of the block to enable setting the steel frame on a solid base rather than suspending it during the concrete pour.

Figure 2-61. Station 1220.07

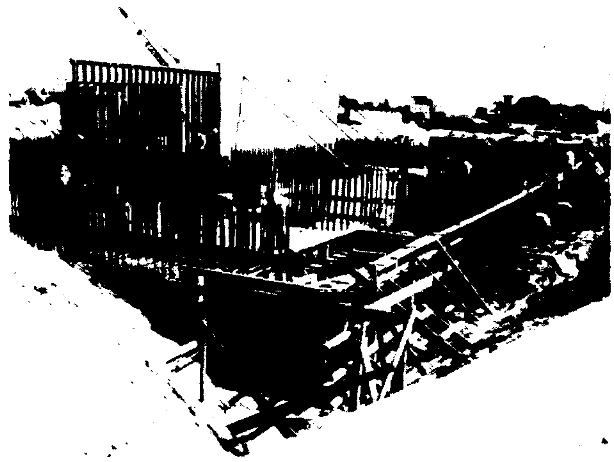


Figure 2-62. Station 1310 - 15% Complete

STATION:	1310
PURPOSE:	Alpha Recording Station
SITE:	Yvonne
USER:	LASL
PARTICIPATION:	6, 7 and 24
CONSTRUCTION:	12-2-55/4-28-56
OCCUPANCY:	3-4-56

This station was a non-expendable 56′ x 70′ x 16′-high reinforced concrete building, with 5′-6″-thick walls; it was divided into three scientific equipment rooms and one utility room with connecting corridors for ingress and egress. The entrance corridor had two 90-degree offsets for reducing the possibility of a radiation hazard. An entrance tunnel maze extended from one corner of the building and a separate vestibule provided emergency access in case blast pressures rendered the main entrance unusable. Surrounding the tunnel and on three sides of the building was a 24-foot high retaining wall which held back a 12-foot earth cover over the station. The leading edge of the fill was sandbagged. The exterior walls and slabs of the station were 5′-6″ thick with most of the reinforcing placed in two layers to provide reasonable bar spacing for the concrete pour. A large quantity of stirrup reinforcing was used in order to obtain a flexible structure and allow for high shear loads. The interior walls were 3′-6″ and/or 4′ thick in order to carry the roof and base slab reactions. Numerous openings in the roof coupled with a relatively thin roof slab required special design considerations with respect to blast loadings. Embedded 24-inch I-beams spaced between the sleeves and conduits took the shear loads and acted as the tension reinforcing the slab. The lower flanges of the I-beams were set flush with the ceiling and used as supports for sliding steel-framed lead doors which covered the lower end of the 12-inch pipe sleeves. Steel blast doors were installed at the ends of the tunnel maze, the entrance to the forward room, and the emergency access vestibule. Two ventilation pipe doors located in one retaining wall permitted extending 12-inch piping through the fill into the station. A 1-ton capacity crane with removable rail was provided over the main entrance corridor door for lifting heavy equipment off trucks.

Power was supplied from the island distribution system to two dry-type 150 KVA, 3-phase transformers in the utility room, with secondaries at 120/208 volt, 4-wire. One transformer supplied scientific and the other utility power. The utility system consisted of air conditioning units, de-humidifiers, room heaters, trailer receptacles, and vacuum pumps for Station 1841. The scientific system comprised special instruments, detectors, normal lighting, and a postshot recovery panel. The postshot panel provided for emergency lighting to the corridor, utility room (A), instrument rooms (B and C), and the general purpose room (D). During preshot operations, the emergency panel was supplied by the scientific system, but for post-shot recovery, a User-furnished portable generator was provided.

Room B was divided into three parts: an isolated screened section, large instrument section, and light channel section. The isolated screened section was built of wood with a copper screen between two layers of plywood. All copper-screened connections were lapped and soldered for maximum continuity and insulated from one layer of the plywood by a sheath of polystrene plastic. All electrical circuits leading into the screened room passed through a User-furnished filter panel. The outlet boxes and wire coverings within the room were nonmetalic. The station was used as a distribution point for

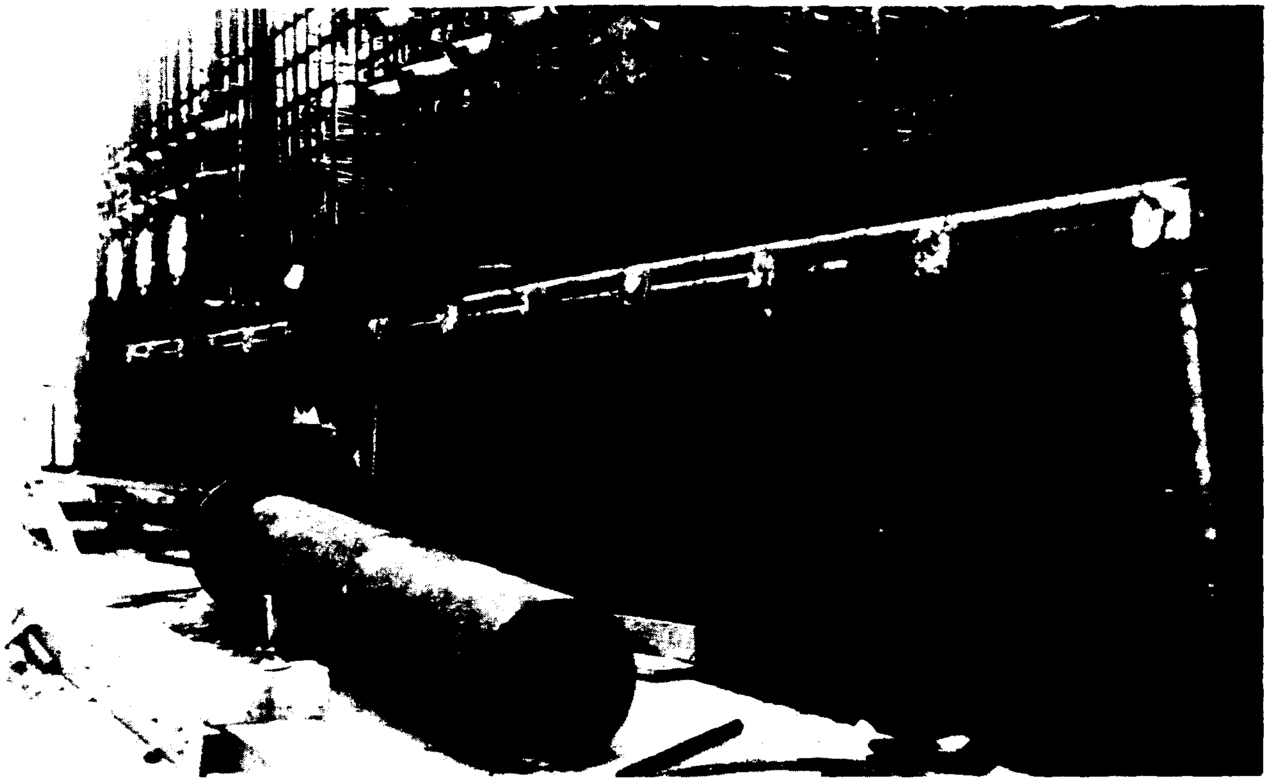


Figure 2-63. Station 1310 - Showing 14" Pipe and Conduit Installation

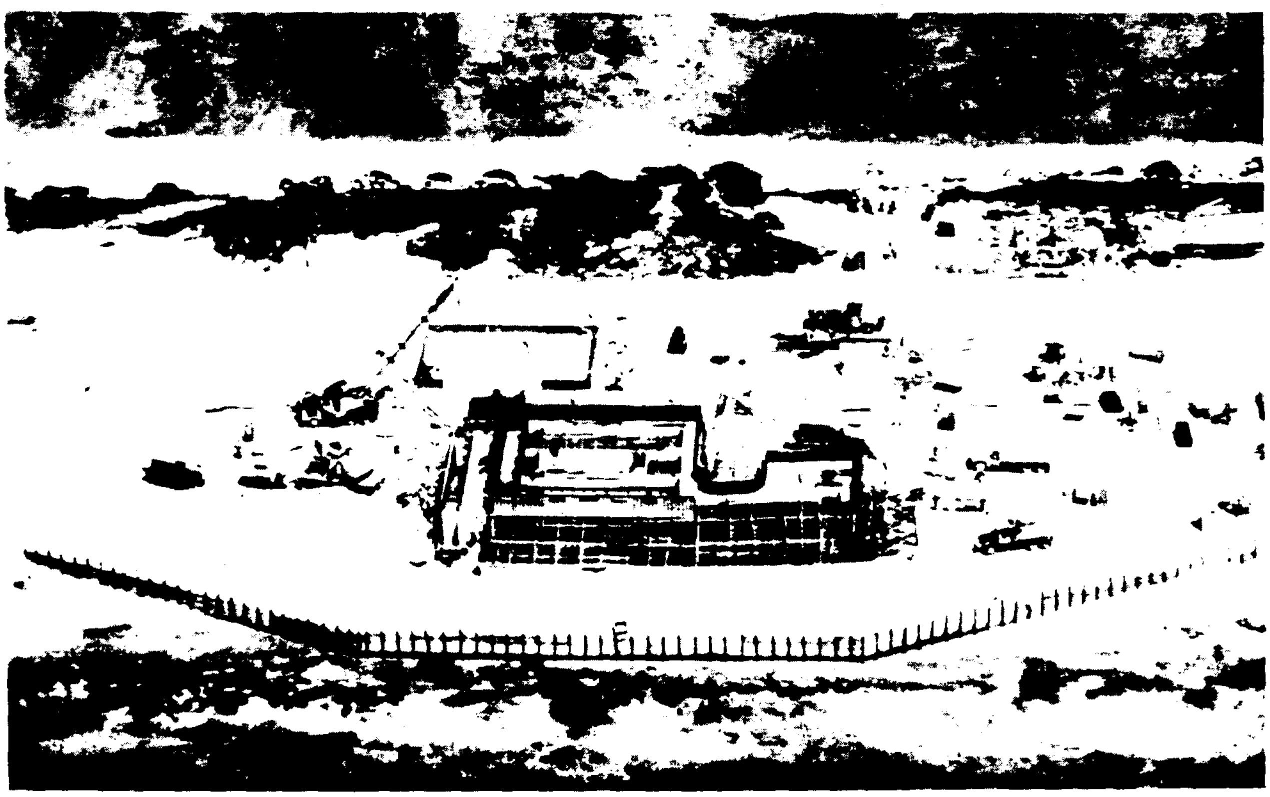


Figure 2-64. Station 1310 - 45% Complete

Figure 2-65. Station 1310 - 85% Complete

Figure 2-66. Station 1310 - 98% Complete

telephone and signal systems. The main signals terminated at a panel from which distribution was effected to the surrounding stations. Communications with the Atoll system were established through four telephones connected to the panel. Three local telephones were utilized for communication with the zero station, a mirror house, and a vacuum pump station.

The dehumidification system comprised two 103,000 btu/hr refrigerant compressors with two 27-gpm water-cooled condensers mounted above one of them. Five ceiling-mounted dehumidifiers were provided; one in Room B, two in Room C and two in Room D. A primary air coil of 64,000 btu/hr at 300 fpm face velocity was installed in the primary air inlet. Two vertical-type, centrifugal, self-priming, 54-gpm pumps located outside of the station were utilized in circulating salt water for cooling to the condenser units.

The ventilation system consisted of a 12-inch round air inlet duct leading to a primary air fan of 600 cfm, which discharged into a system of ducts leading to the various rooms. A 20-inch square air filter was fitted in the air inlet; a 600-cfm exhaust fan was installed in the utility room.

Electric room heaters were provided as follows: Room B, one 10 KW unit; Room C, four 7.5 KW units; and Room D, two 3 KW units. A coax dryer assembly was installed in Room D.

A total of 4,058 cubic yards of concrete was poured with a 28-day average strength of 3,936 psi. Difficulties were encountered with pouring concrete for this station due to the depths of the forms and the closely tied reinforcing steel, both of which caused a large amount of separation. This situation was overcome by pouring a 3-to-6-inch layer of grout first, in order to absorb separated aggregate and

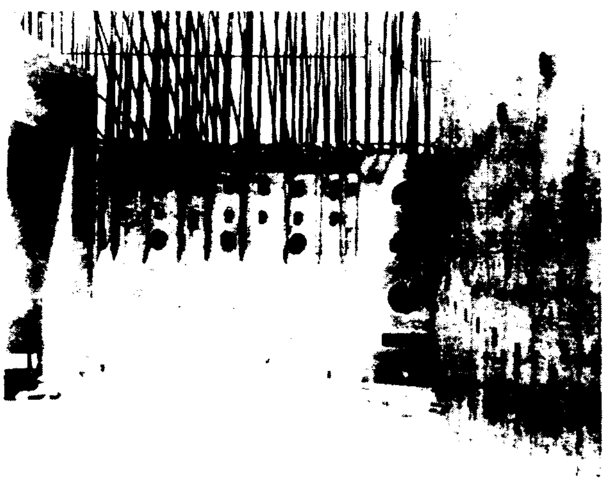


Figure 2-67. Station 1310 - Room B - During Construction

to ensure a firm bond between the coarse and fine aggregate. Also, whenever possible, inspection windows were used to reduce the free fall of concrete, thus reducing separation. The 34 E ransome paver was used on large pours in conjunction with the mixer trucks, thus ensuring a continuously uniform flow of concrete. Difficulty with closing the blast-proof doors was also encountered as they were too heavy for the hinges. It was necessary to shim under the hinges to bring the doors up level and to bevel the blocks for locking to ensure securing them.

Figure 2-68. Station 1311.04 - 20% Complete

STATIONS:	1311.01, .03, .04 and .05
PURPOSE:	Alpha Detector Stations
SITE:	Yvonne
USER:	LASL
PARTICIPATION:	6
CONSTRUCTION:	1-4-56/5-25-56

Each station was a reinforced concrete L-shaped building 25′-4″ x 21′ x 19′-6″ high with walls and slabs 5 feet thick and a 5′ x 3′ entrance corridor. For the most part, double layers of reinforcing steel and inclined stirrups were used. A 2′-6″-square blast door in the end wall provided access. The stations were precisely located along the lines of coaxial cable covered with fill to a depth of 15′. Upon approaching the station, the fill was increased so that no less than 5′ of cover was maintained over the building. The fill extended to a point approximately 30′ beyond the station. Each station had three detector heads mounted on a concrete pad that was approximately 20 feet above the coaxial cable and rested on top of the fill. The detector mounts were within 1 inch of their specified locations in relation to the zero stations with which they participated. All detectors from the stations were connected to main runs of coaxial cable which eventually terminated in

Station 1310. Instrument power was received from Station 1310 through lines in a 4-inch conduit; other conduits were run for utility, telephone, and signal circuits.

Figure 2-69. Station 1311.04 - 80% Complete

In order to retain cover over Station 1311.04 during high tides, a 15-foot retaining wall was built on the ocean side of the building by driving rail piles in the reef and covering them with planking. A total of 1,032 cubic yards of concrete was used for these stations with an average 28-day cylinder break of 3,733 psi.

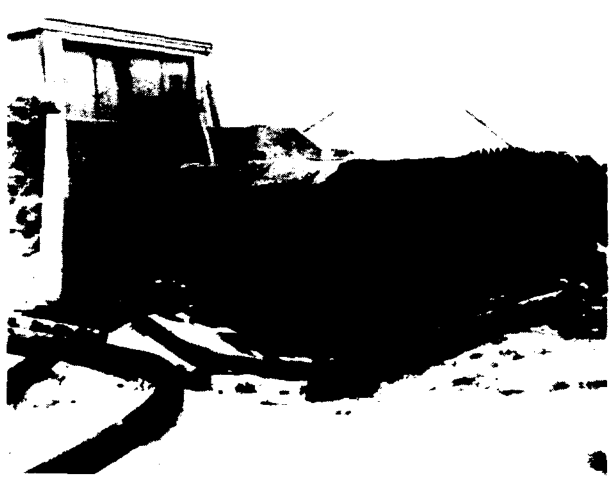


Figure 2-70. Station 1311.01 - Reinforcing Cage Cut and Moved Out of Line of Stations 1524 and 1520

After the base of Station 1311.01 was poured, difficulties were encountered when it was discovered that the building was in the line of sight between Stations 1524 and 1520. As this station was to be utilized for the second and not the first shot, it was decided to set all wall and ceiling reinforcing steel and weld rather than tie it; the cage of the reinforcing steel was then cut one foot from the floor and moved out of the line of sight. After the first experiment, the cage was set back in place and two splices were welded on to tie the cage to the steel protruding out of the base. The station was then formed and poured monolithically. This procedure proved to be very satisfactory due to the critical time element.

STATION:	1312.01
PURPOSE:	Alpha Detector
SITE:	Yvonne
USER:	DOD-13
PARTICIPATION:	24
CONSTRUCTION:	3-15-56/4-24-56

This station was a wooden frame platform 8′-7½″x6′-5½″x7′ high and set at an elevation of plus 16 feet. The platform was located on an existing slab next to Station 24. A User-furnished detector was mounted on the station at an elevation of plus 17 feet. Five pair of signal wire were run from Stations 1312.01 to 1311.04. No power was required.

STATIONS:	1313.01, 1313.03, 1313.05 and 1313.07
PURPOSE:	Alpha Detectors
SITE:	Yvonne
USER:	DOD-13
PARTICIPATION:	6 and 7

These stations were two User-furnished and installed detectors located at the 187½-foot level and in the cab on Station 7, and at the 287½-foot level and in the cab of Station 6. Power consisted of 3 KW, 120-volt, single-phase. Five pair of signal wire and one phone jack were provided at each location.

STATIONS:	1314 and 1315
PURPOSE:	Coaxial Cable Junction Pits
SITE:	Yvonne
USER:	DOD-13
PARTICIPATION:	6, 7 and 24
CONSTRUCTION:	11-25-55/4-28-56

These stations were heavily reinforced concrete underground pits in which User-furnished coaxial cable was spliced and branched off to various detector stations. Station 1314 was 12′-4″ x 11′-8″ x 11′-6″ high with 2′-6 inch walls and an entrance tunnel 7′ x 7′ and 18′ long with 2-foot-thick walls. Station 1315 was 12′ x 16′ x 14′ high with 3-foot-thick walls and an entrance tunnel 6′-6″ x 6′-6″ and 5′ long with 2-foot-thick walls. Station 1315 was connected to Station 1310 by 14 6-inch conduit and to Station 1316 by 14 1-inch conduit. Both stations were covered with approximately 8 feet of earth fill for shielding. Entrance to each station was by means of a heavy steel blast-resistant door at the end of the access tunnel. Power requirements consisted of 0.3 KW, 120-volt, single-phase. Two phone jacks were required and 7 pair of signal wires were extended to Station 1315.

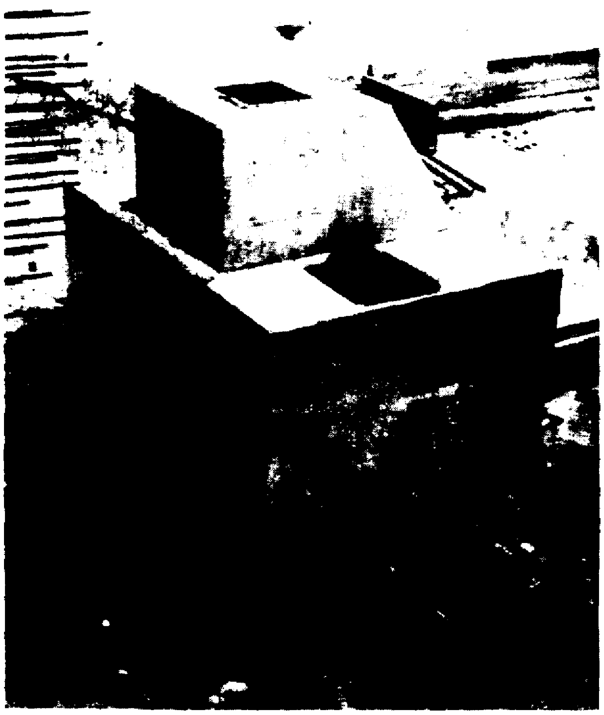


Figure 2-71. Station 1315 - 85% Complete

A total of 86 cubic yards of concrete, with an average 28-day cylinder break of 4,201 psi, was poured for Station 1314, and 80 cubic yards was poured for Station 1315.

On pouring concrete for Station 1314, it was noted that the conduits were spaced too close together to allow the large aggregate to pass between them, so it was decided to use grout up to the level of the top of the conduit and place concrete the remainder of the way. This procedure proved satisfactory and assured a good tight bond around the conduit.

STATION:	1316
PURPOSE:	Detector and Collimator Station
SITE:	Yvonne
USER:	LASL
PARTICIPATION:	6, 7 and 24
CONSTRUCTION:	12-6-55/4-21-56

This station was a 27′ x 7′ x 4′-6″-high reinforced concrete shelter divided into five cubicles by walls 1 foot thick. The cubicles were 3′ x 3′ x 3′-6″ high except for the end cubicles, which were 3′ x 4′ x 3′-6″ high. The foundation slab was 3 feet thick. The exterior of the walls was 2 feet thick and contained stirrups as well as other reinforcing. A detector head was mounted in each cubicle at an elevation of plus 17 feet. Each cubicle had a removable cover of reinforced concrete 12 inches thick, with eyebolts installed to facilitate handling. An open slot in the front and rear walls of each cubicle permitted detector heads to have an unobstructed line of sight to Stations 6, 7 and 24. Located on each side of the detector cubicles and 4 feet from the exterior walls were two 36′-7″ x 13′ concrete bins with heights varying from 8′ to 9′-6″ for one bin and from 9′-6″ to 10′-2″ on the other. One bin contained ten 12″-diameter steel pipes with the bottom row of 5 pipes oriented on the working point of Station 24 and the top 5 pipes oriented on the working point of Station 7. In the other bin were five 12-inch pipes oriented on the working point of Station 6. The reference point from which all pipes were oriented was the detector head within each cubicle. The bins were filled with coral sand. A 4½″-diameter 4″-thick lead stopper was supported in the outside end of each pipe by a styrofoam plug, cut to fit the 12″ pipe.

Three cubicles had two 4″-diameter conduits and the two end ones had four 4″ conduits leading to Stations 1315 and 1310, respectively. Floor drains were provided for the cubicles. The pipe alignment for this station was intricate in that it involved two different angles cut on each end of the pipe sleeves for lining up the working points of both the stations and detectors. At the point of convergence, it was necessary to cut the pipes and weld the ends together to maintain alignment.

A total of 461 cubic yards of concrete was poured with an average 28-day cylinder break of 3,177 psi.

STATION:	1317
PURPOSE:	Alpha Recording Station
SITE:	Janet
USER:	DOD-13
PARTICIPATION:	5

The rehabilitation of existing GREENHOUSE Station 132-B was started for this Operation and known as Station 1317. This station was to be used for recording purposes in conjunction with Tower 5. Coaxial cable was to enter the station from detector Stations 1318 .02 and .03. Two new coaxial cable air dryers were required. Power requirements were 15 KW, 120/208 volt, 3-phase. Five timing signals and a go-no-go-circuit were to be provided. Rehabilitation started on 21 April 1956 and, at User request, was stopped at 50% progress due to the cancellation of the Pawnee event.

STATION: 1318.02
PURPOSE: Alpha Detector Station
SITE: Janet
USER: DOD-13
PARTICIPATION: 5

This station was to be a User-furnished detector mounted on a portable wooden skid and connected to Station 1317 with coaxial cable. On 16 May 1956 and at User request, work was stopped on this station at the progress stage of 67% complete because of the cancellation of the Pawnee event.

STATION: 1318.03
PURPOSE: Detector Station
SITE: Janet
USER: 5

This station was designed for use similar to Station 1316, Yvonne, with exceptions as noted below. The concrete bin was located on only one side of the detector cubicles, and only three each 3′ x 4′ x 3′-6″ detector cubicles were required. Three 12″-pipes were to be used with a clear line of sight to the working point of Station 5. The working point of the detector heads were to be 20″ above the cubicle floor. Progress of this station reached 67 percent when work was stopped due to cancellation of the Pawnee event.

STATION: 1319
SITE: Alpha Recording Station
SITE: Charlie
USER: LASL
PARTICIPATION: 18
CONSTRUCTION: 12-12-55/5-5-56
OCCUPANCY: 4-12-56

Station 1319 was a reinforced concrete building 26′ x 31′ x 15′ high with 5½ to 6½ feet thick walls. A tunnel 24′ x 16′ x 15′ high extended from one end of the building to the center of a 66′ long 3′-thick retaining wall. Approximately 10′ of earth covered the tunnel and building. Because of the high loadings, the main reinforcing was placed in two layers throughout most of the structure, and stirrups were installed in the manner of straight reinforcing in several layers and parallel to the main reinforcing. Within the building, two heavy lead doors required casters at the floor to support the weight. The tunnel entrance at the retaining wall contained a 3′-6″ x 9′-6″ steel-framed blast door.

Power was provided by two 30 KW, 120/208 volt, 3-phase portable diesel engine-driven generators mounted on a concrete slab approximately 45 feet from the station. One generator provided power for normal needs; the other was used as a stand-by unit. A 10 KW dummy load was tied into an automatic transfer switch so that the stand-by generator was loaded when not used for station power. Each generator was connected into a 36-circuit power panel through

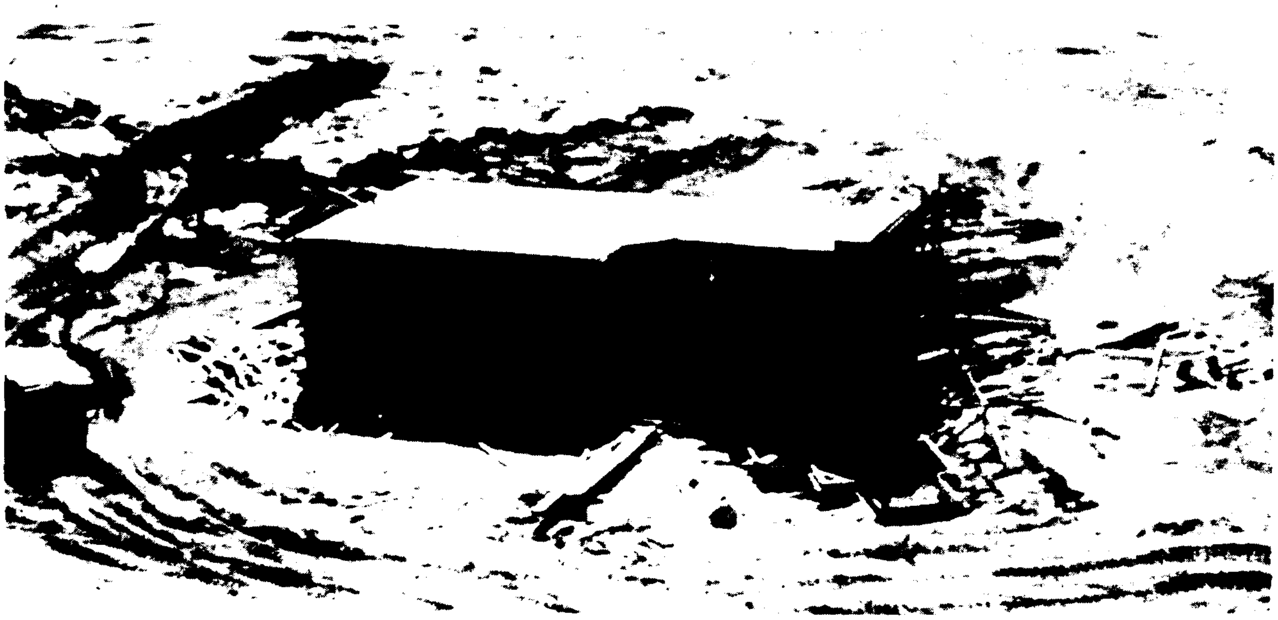


Figure 2-72. Station 1319 - 72% Complete

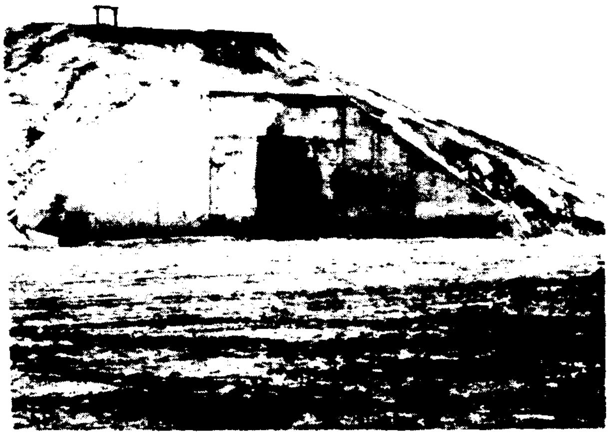


Figure 2-73. Station 1319 - 98% Complete

leads in 2-inch conduit. Conduits from this power panel carried circuits into the station for light and utility receptacles, thermostat and humidistat, and instrument power. Conduits were also led with wires from the timing cabinet to two explosion-proof links. A 16-circuit submarine cable from Dog terminated in a cast iron weatherproof junction box mounted outside of the station. From this box, 1½-inch conduit led to the terminal cabinet inside the station and carried the circuits for User signals, the door-closing signal at H-5 seconds, and a telephone.

The dehumidification equipment was located on a concrete pad outside of the station. A direct expansion-type coil, 2 square foot face area, 65,000 btu/hr and using Freon 12, was installed in the primary air system. An 822 cfm fan located on the equipment slab supplied air to the station through a 12-inch round steel duct. A 20" x 16" x 2" air filter in an aluminum housing was connected to the fan inlet. Exhaust was through a 12-inch round steel pipe duct with two 90-degree bends for radiation protection. The Freon 12 refrigerant system had a dx coil and a 5.4-ton capacity air-cooled compressor. A refrigerant liquid receiver was installed below the condenser. A 10 KW air duct heater was used to reheat primary air.

Two 18"-square 2"-thick steel-plate sliding doors mounted in steel housings and held in open position with ⅛-inch wire rope connected to explosive blast links provided for closing the air openings prior to the blast. A fuel supply system for the generators consisted of a 1,000-gallon steel tank, all welded, 6'-11" diameter, 7'-6" long and with fuel lines to and from the engines.

No serious difficulties were experienced with this large Station. The tying of the closely spaced reinforcing bars was time-consuming. An airlift shuttle service was required between the construction site and the camp on Fox to reduce time lost in travel.

A total of 822 cubic yards of concrete was poured with an average 28-day strength of 4,200 psi.

STATION:	1320
PURPOSE:	Detector and Recorder
SITE:	Dog
USER:	LASL
PARTICIPATION:	10, 11, 12 and 13
CONSTRUCTION:	1-14-56/5-3-56
OCCUPANCY:	5-14-56

The station was existing building, CASTLE Station 1210 to which was added a concrete wall at the front and roof for radiation shielding; a reinforced concrete building at the rear; and a sight tube structure in the forward area.

The shield wall extended up the forward wall and over the roof for half the width of the existing building and its entire length. This new wall was doweled into the existing roof and wall.

The reinforced concrete building began at the rear wall of the existing structure and extended back 31' to a 90'-long retaining wall; the building was 48' wide and the walls and slabs were 3 feet thick. A large opening was provided in the rear wall to permit installation of equipment. This opening was provided with a steel-framed blast panel 7' x 8' high which would normally remain closed. Access to the addition was provided by means of a steel-framed blast door 4' x 8' high with additional access by means of a vestibule containing an interior steel-framed blast door 2'-6" square.

The tunnel of the existing building was damaged during prior events and was removed. The new tunnel was incorporated within the addition. In order to allow the addition to act as a unit with the existing building in resisting blast load, the roof, base slab, and exterior side walls were doweled into the existing structure. An exterior monorail hoist was installed over the rear blast door. Mounted on the roof of the new addition, at the rear, was an exhaust pipe housing of reinforced concrete, 9' x 25' long x 4' high, with two steel hydraulically-operated blast-resistant vent doors.

In front of the existing station was a reinforced concrete baffle wall and retaining wall

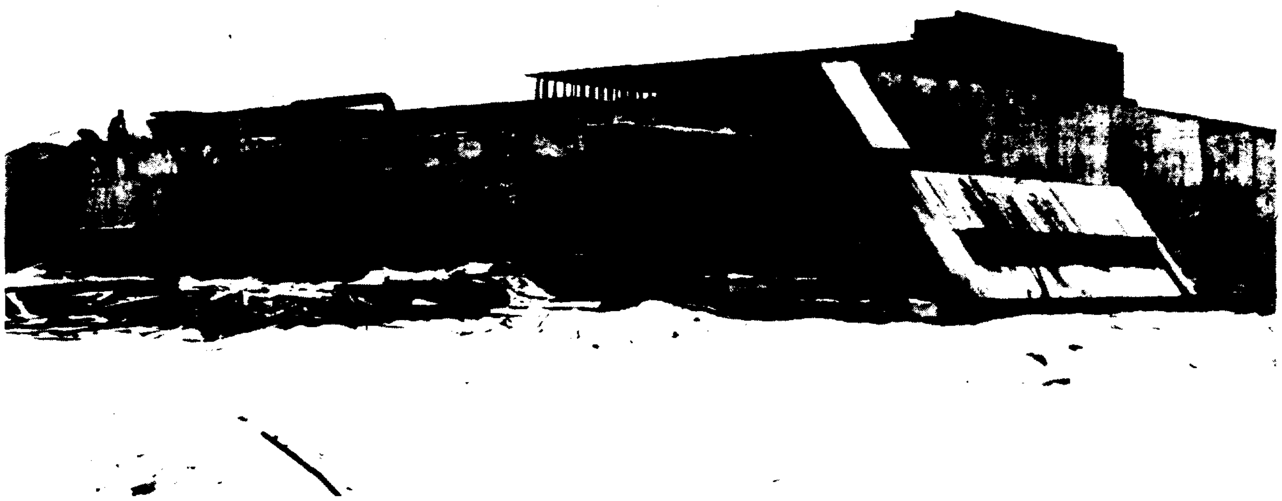


Figure 2-74. Station 1320 - 97% Complete

with a sighting tube assembly 30′ x 26′ long x 13′ high. A similar structure was previously located here but was damaged and required replacement. The existing piles were utilized and eleven new steel piles were added. Within the structure were four 12″ pipes used as sighting tubes. These were horizontal and each terminated in a steel blast door having a domed cover plate. Because of the high intensity of anticipated pressure and waves, the forward face of the structure was sloped in an attempt to resist uplift of the leading edge. Additional precaution was taken by driving 12′-long sheet piling on the forward areas using welded dowels to tie into the concrete.

The entire station was covered with earth fill to a height of 14′ above the new building addition. As a precaution against wave action, which incidently was anticipated as being of a high magnitude, the leading face of the fill was sloped and covered with sand-cement sandbags which were then wetted down to form a bonded mass.

Power to station 1320 was provided by two 100 KW, 120/208 volt, 3-phase, diesel-driven units equipped with an automatic transfer switch for supply by a normal or stand-by generator. The various generator and motor control circuits were run through conduits to the control and distribution panels. The engine control panel was connected to an EG&G relay which was extended to the timing terminal cabinet for engine shutdown. A User-furnished Bogue Set in conjunction with a Contractor-furnished battery rack provided power for the station at H-hour.

Signal circuits were installed in an existing 3-inch conduit to the timing terminal cabinets in the generator and utility rooms, respectively. Telephone communication to this station was provided by circuits from timing Station 75.01 through existing conduit stub-out and terminated in two phone jacks in the utility room. A total of three timing, two phone, and one monitor circuits was utilized.

To provide ventilation in the new generator room, a 9,060 cfm axivane fan was installed at ceiling, with a 30-inch square opening through the north wall for the air inlet. Exhaust air was removed through a 42-inch square opening in the ceiling leading to the concrete duct on the roof. This duct also contained the diesel exhaust pipes and a 10-inch air exhaust from the utility room. Blast doors were installed at each end of the duct.

Two salt water circulating pumps, 170 gpm self-priming horizontal centrifugal type, were used to supply cooling water for the refrigerant condensers of the air conditioning equipment and the heat exchangers of the diesel engines of the generator sets. These pumps obtained water from a 30-foot deep well near the station. A 2,200-gallon fuel tank of ⅜-inch steel plate was buried in concrete adjacent to the station, a ¼-ton hoist on a monorail was provided in the detector room and a 2-ton chain hoist, 10-foot lift on a 12-inch I-beam, was located at the entrance of the station.

A total of 1,146 cubic yards of concrete was poured, with an average 28-day strength of 4,300 psi.

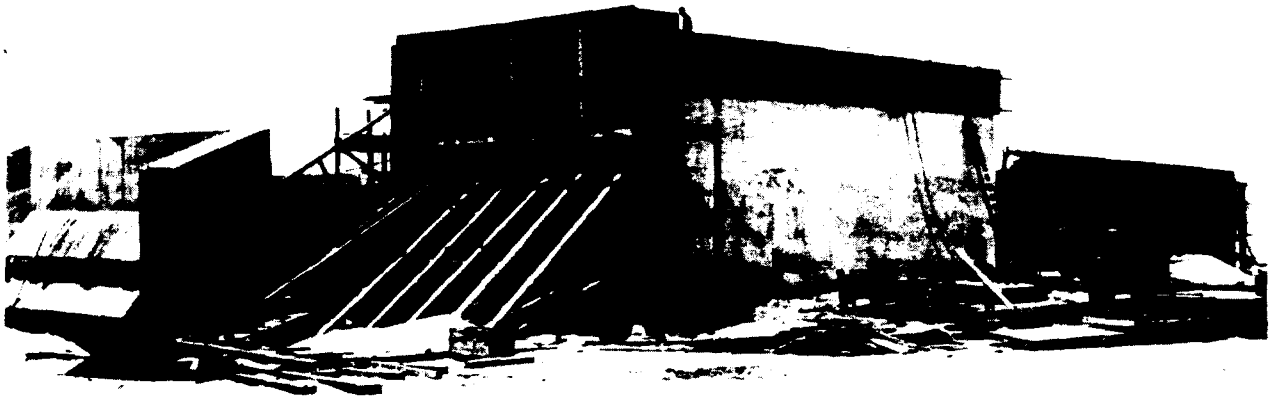


Figure 2-75. Station 1320 - 97% Complete

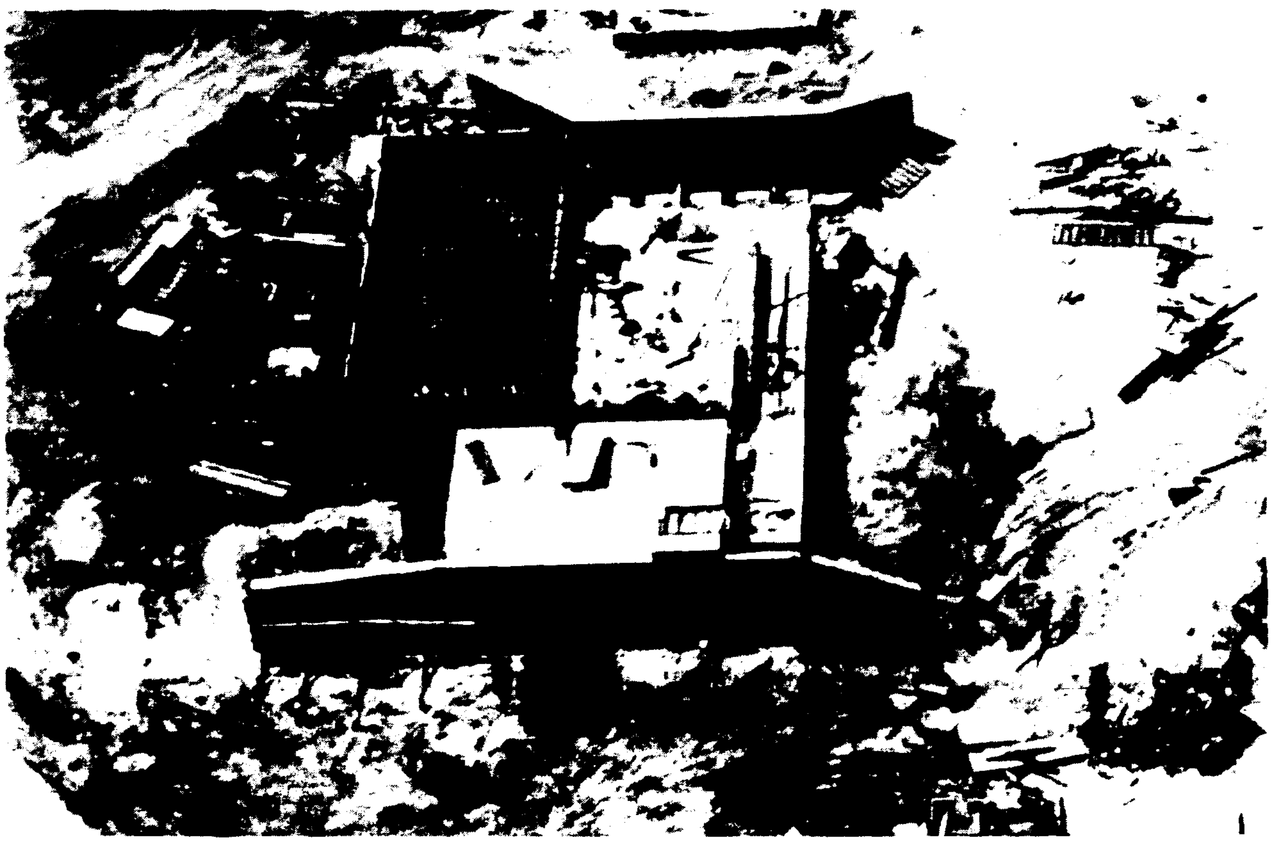


Figure 2-76. Stations 1320 and 1321

STATION: 1321
PURPOSE: Collimating Baffle for Remote Alpha Detector
SITE: Dog
USER: LASL
PARTICIPATION: 10, 11, 12 and 13
CONSTRUCTION: 2-15-56/5-4-56
OCCUPANCY: 4-14-56

Station 1321 was a heavy reinforced concrete wall located 75 feet forward of Station 1320. The concrete wall was supported by 12-inch H-piles and protected from wave action by sheet piling. Holes, with steel cover plates located in the wall, served as a line of sight from the pipe collimators in Station 1320 to the zero locations of the barges. This wall was required to withstand all of the Bikini events. Existing CASTLE Station 1211 was demolished prior to the construction of this station. A total of 138 cubic yards of concrete was poured with an average 28-day strength of 3,800 psi.

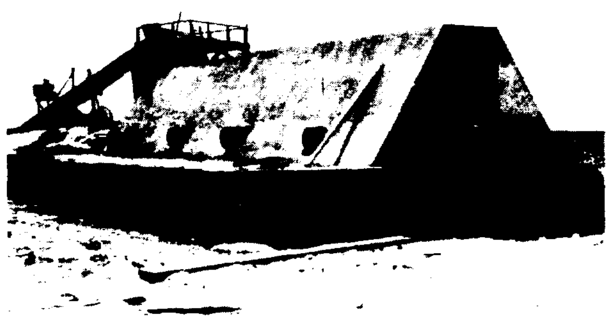


Figure 2-77. Station 1321 - 66% Complete

STATION: 1330
PURPOSE: VHF Dish Antenna
SITE: Elmer
USER: DOD-13
PARTICIPATION: All Eniwetok Events Except Osage

Station 1330 consisted of a 10-foot-diameter dish-type antenna mounted at the 92-foot level of CASTLE Tower 1301, and two trailers located at the base of the station. Styroflex cable ⅞-inch in diameter connected the antenna and to one trailer. One 40 KW generator was User-supplied and 20 KW, 3-phase, 120/208 volt stand-by power from the island distribution system was provided for each trailer. Four timing signals and a telephone with extension were installed for one of the trailers. All equipment was User-furnished.

STATION: 1331
PURPOSE: VHF Dish Antenna
SITE: Nan
USER: DOD-13
PARTICIPATION: 18

Station 1331 was a 10-foot-diameter dish-type antenna mounted at the 50-foot level of the Station 70 tower. Styroflex cables ⅞ inch in diameter extended from the antenna to room 18 in Station 70.

STATION: 1332
PURPOSE: VHF Dish Antenna
SITE: Nan
USER: DOD-13
PARTICIPATION: 10, 12, 13 and 22

This station was a 10-foot-diameter dish-type antenna mounted at the 105-foot level of the Station 70 tower. A wave guide and ⅞ inch Stryoflex cable extended from the antenna to Room 18 of Station 70.

STATIONS: 1333.01 thru 1333.03
PURPOSE: Horn-Type Antennas
SITE: Off Dog, on Barge Stations 10, 12 and 13
USER: DOD-13
PARTICIPATION: 10, 12 and 13

These stations were horn-type antennas mounted on top of the barge cabs. Coaxial cable extended from the antenna to the barge zero location. Power in the amount of 1 KW, 120-volt, single-phase was supplied from the barge station generators. Timing signals of minus 45 minutes and minus 15 minutes were required.

STATIONS: 1334.01 thru 1334.09
PURPOSE: Parabolic Antennas
SITES: Various
USER: DOD-13
PARTICIPATION: 1, 2, 3, 4, 6, 7, 22 and 24

This series of stations consisted of 5′ x 6′ User-furnished parabolic antennas mounted on the outside of the various zero stations. Power requirements consisted of 1 KW, 120-volt, single-phase and were obtained from each individual zero station power supply. Timing signals of minus 45 minutes and 15 minutes were required.

STATION: 1336.04
PURPOSE: VHF Dish-Type Antenna
SITE: Irene
USER: DOD-13
PARTICIPATION: 23
CONSTRUCTION: 3-26-56/4-28-56

This was a User-furnished 10′ diameter dish-type antenna mounted on top of two 12″-diameter 77′-high pipes and located adjacent to Station 23. The poles were mounted in 4′ x 6′ x 2′-thick reinforced concrete footings guyed by six ½-inch cables tied to 3′-6″ x 3′-6″ x 3′-6″-deep anchor blocks. Coaxial cable extended from the antenna to the station zero point. Power requirements consisted of 1 KW, 120-volt, single-phase which was supplied from the Station 23 source. Timing signals of minus 45 minutes and minus 15 minutes were provided. A total of 16 cubic yards of concrete was poured.

STATIONS:	1341.01 thru 1341.12
PURPOSE:	Detectors
SITES:	Dog thru George
USER:	LASL
CONSTRUCTION:	5-2-56/5-4-56
OCCUPANCY:	5-4-56

Each station in this series was a 6 foot length of 6″ standard pipe driven flush with the grade and capped with a wooden cover which had a lead brick suspended beneath it and a sandbag on top.

STATIONS:	1350 and 1351
PURPOSE:	Collimating Baffles
SITE:	Yvonne
USER:	DOD-13
PARTICIPATION:	24
CONSTRUCTION:	3-13-56/3-19-56

These stations were concrete collimating baffles. The Station 1350 baffle was 5′-4″ x 19′-6″ x 1′-6″ thick with a window opening 1′-4″ x 3′ and a round hole 9-7/8 inches in diameter. The baffle was mounted on a concrete slab 5′ x 5′-4″ x 1′-8″ thick. The Station 1351 baffle was 12′ x 22′ x 1′-6″ thick with two window openings 2′-6″ x 3′ and an opening at the top of 2′-7¾″ x 8″. The baffle was mounted on a slab 6′-6″ x 12′ x 1′-8″ thick. The center line of the window openings was at elevation plus 17 feet, which was the line of sight between Station 1316 and the working point of Station 24. One baffle was located 50 feet and the other 525 feet away from the front of Station 24. Twelve cubic yards of concrete were poured for Station 1350 and 15 cubic yards for Station 1351.

STATION:	1510
PURPOSE:	Cloud and Fireball Photography
SITE:	Janet
USER:	DOD-15
PARTICIPATION:	4, 5 and 23

This station comprised User-furnished photo tubs mounted on existing GREENHOUSE Station 69, requiring 10 KW, 120-volt, single-phase power and minus 15 minutes, minus 15 seconds, and minus 5 seconds timing signals plus an interlock and spare.

STATION:	1511
PURPOSE:	Cloud and Fireball Photography
SITE:	Yvonne
USER:	DOD-15
PARTICIPATION:	6, 7, 19 and 24
CONSTRUCTION:	3-19-56/3-26-56

Station 1511 was existing GREENHOUSE Station 77 and consisted of a reinforced concrete structure 4′ x 4′ x 13′-6″ long in which three User-furnished photo tubs were mounted. The station faced towards the working point of Stations 6, 7, 19 and 24.

Power in the amount of 6 KW, 120-volt, single-phase was supplied from Station 77. Minus 15 minutes, minus 15 seconds, and minus 5 seconds timing signals, an interlock and a spare were required. A total of 15 cubic yards of concrete was used.

STATION:	1512
PURPOSE:	Cloud and Fireball Photography
SITE:	George
USER:	DOD-15
PARTICIPATION:	10, 11, 12, 13, 18 and 22
CONSTRUCTION:	3-12-56/4-20-56

This station consisted of User-furnished photo tubs mounted on top of Station 1528. Three 1/2″-thick steel plates 2′-7″ square were mounted on the roof of Station 1528 in order to support the photo tubs. Power in the amount of 6 KW, 120-volt, single-phase was required. Minus 15 minutes, minus 15 seconds, and minus 5 seconds timing signals plus an interlock and spare were provided.

STATIONS:	1513, 1515 and 1516
PURPOSE:	Cloud and Fireball Photography
SITES:	Wilma, William and How
USER:	DOD-15
PARTICIPATION:	1, 2, 3, 4, 5, 19, 24, 10, 11, 12, 13 and 22
CONSTRUCTION:	12-15-55/5-24-56

These stations were steel towers, 14′ square x 75′ high, with an enclosed cab at the 75-foot level. Two sides of the cab contained metal roll-up doors which operated by timing signals and closed after the shock wave had passed. Angles were provided in the cab roof to support User-furnished cameras. Access to the cab was by steel stairs within the tower. Station 1516 was existing and required only the addition of a new cab plus power and timing signals. The Station 1513 tower was removed from Janet and erected on the existing GREENHOUSE station footings at Wilma.

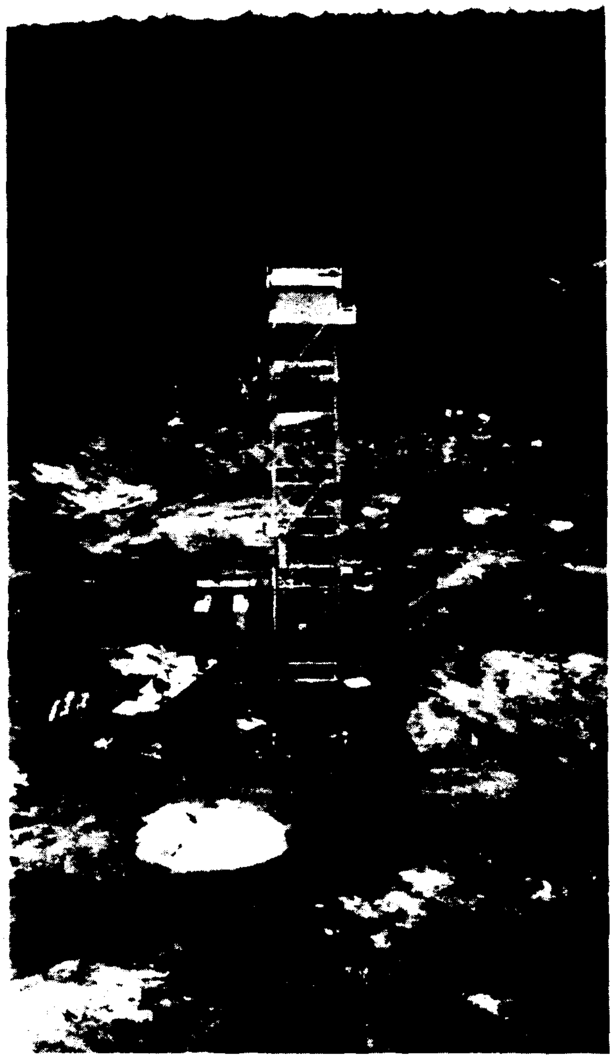


Figure 2-78. Station 1516

Power requirements for Station 1513 and 1515 were 10 KW, 120/208 volt, single-phase. For Station 1516, 8 KW, 120/208-volt, 3-phase power was provided. Timing signals for Station 1513 consisted of two each of the following: minus 15 minutes, minus 15 seconds, minus 5 seconds, an interlock and a monitor pair plus two spares. Stations 1515 and 1516 were identical except only one pair each were required.

A total of 8 cubic yards of concrete was poured for Station 1513, 85 cubic yards for Station 1515, and 7-1/2 cubic yards for Station 1516.

STATION:	1514
PURPOSE:	Tower for Cloud and Fireball Photography
SITE:	Mack (Eniwetok Lagoon)
USER:	LASL
PARTICIPATION:	1, 2, 3, 4, 6, 7, 19, 23 and 24
CONSTRUCTION:	3-17-56/6-30-56

Station 1514, located on coral head Mack in Eniwetok Lagoon, was a 75-foot steel tower erected on an existing platform supported by steel piling. To strengthen the platform of this station, new crisscross bracing was installed below the water line to a depth of 32 feet. A 14′ x 14′ enclosed cab for housing User-furnished cameras was located at the top of the tower. Roll-up metal shutters were on three sides of the cab and a wall containing two hinged windows and a door was on the remaining side. These shutters, windows, and door were arranged to remain open until the shock wave had passed and then to close automatically by a timing signal. The floor of the cab extended 30 inches on the north and east sides to permit working space for adjusting camera lenses. The roof of the cab was capable of supporting a 1,000-pound load distributed over 4 square feet.

An elevator with a capacity of 2,000 pounds and a 4′ x 5′ platform was provided which operated by a hoist drum with ¾″-diameter wire rope. A steel ladder was also installed for access.

Racks of aluminum angles and of sufficient strength to carry an 8,000-pound load distributed over 20 square feet were provided for mounting cameras within the tower cab.

Within the base of the tower, living quarters of wood frame construction were provided with sufficient space for four bunks, four lockers and a hot plate, refrigerator, sink and table. A field-type latrine and a 500-gallon stainless steel tank for fresh water were also provided. Alongside of the tower platform was a generator platform 27′ x 13′ which also had to be braced. A 550-gallon fuel oil tank of 5/16″ boiler plate was supported by two steel saddles. Mooring provisions were provided so that boats could be tied to either platform.

A 25 KW generator provided for an 8 KW instrument load and the utility requirements. Ten pair of timing signal wires were installed to provide for minus 15 minutes, minus 15 seconds, and minus 5 seconds signals. A 16-pair submarine cable was terminated in a signal cabinet at the base of the tower.

STATION: 1517
PURPOSE: Cloud and Fireball Photography
SITE: Nan
USER: DOD-15
PARTICIPATION: 10, 11, 12, 13 and 22
CONSTRUCTION: 3-12-56/7-20-56

This station was an existing cab located on a 300′ tower, CASTLE Station 1300. The cab was rehabilitated and new roll-up doors were installed which were similar to those in Stations 1513, 1515 and 1516. Power requirements were 8 KW, 120/208-volt, 3-phase. Minus 15 minutes, minus 15 seconds, and minus 5 seconds timing signals plus an interlock were provided.

STATION: 1518
PURPOSE: Bhang Meters
SITE: Elmer
USER: DOD-15
PARTICIPATION: All Eniwetok Events
CONSTRUCTION: 4-4-56/4-7-56

Existing IVY tower Station 301 was rehabilitated and known as Station 1518 for this Operation. The work consisted of rehabilitating the elevator and roll-up doors, spot painting the entire tower, installing a 6″ x 4″ x 3/8″ x 12′ long aluminum camera rack angle on the cab roof, and building a 2′ x 4′ x 2′-6″-high wooden work bench for the generator shed.

Power requirements were 8 KW, 120/208-volt, 3-phase. Minus 15 minutes, minus 15 seconds, and minus five seconds timing signals, plus an interlock were provided.

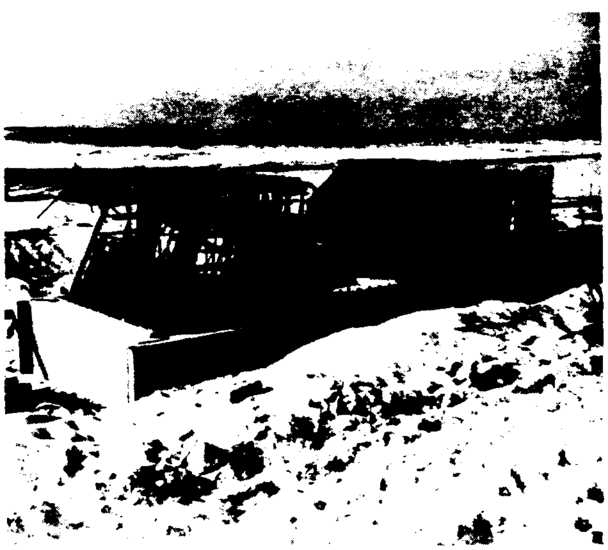


Figure 2-79. Station 1519 - 13% Complete

STATION: 1519
PURPOSE: Cloud and Fireball Photography
SITE: Able
USER: DOD-15
PARTICIPATION: 18
CONSTRUCTION: 2-20-56/5-16-56

This station was identical to Station 910 except that the front wall at the camera port was at a different vertical angle.

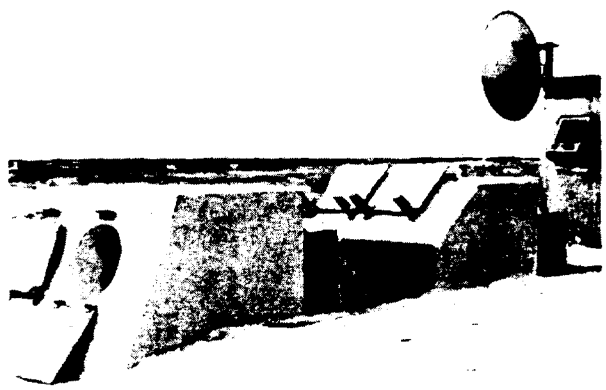


Figure 2-80. Station 1519

STATION: 1520
PURPOSE: High-Speed Photography
SITE: Yvonne
USER: LASL
PARTICIPATION: 24, 6 and 7
CONSTRUCTION: 12-19-55/4-20-56

This station was a reinforced concrete bunker 60′ x 36′ x 15′ high with 3 foot-thick walls and slabs designed to withstand pressures occasioned by the Stations 24, 6 and 7 events. The station contained three instrument rooms, an entrance corridor, a photo slot structure, and an attached utility room. Two steel-frame camera shelves with aluminum tops 1½′ and 2½′ were located in Room 2 so as to orientate the cameras with eight 10″-diameter pipe sleeves in the concrete wall leading to Room 3. A helium exhaust manifold was provided at each camera shelf with vents leading through the roof. In Room 3, four steel columns extending from floor to ceiling were used as mounts for turning

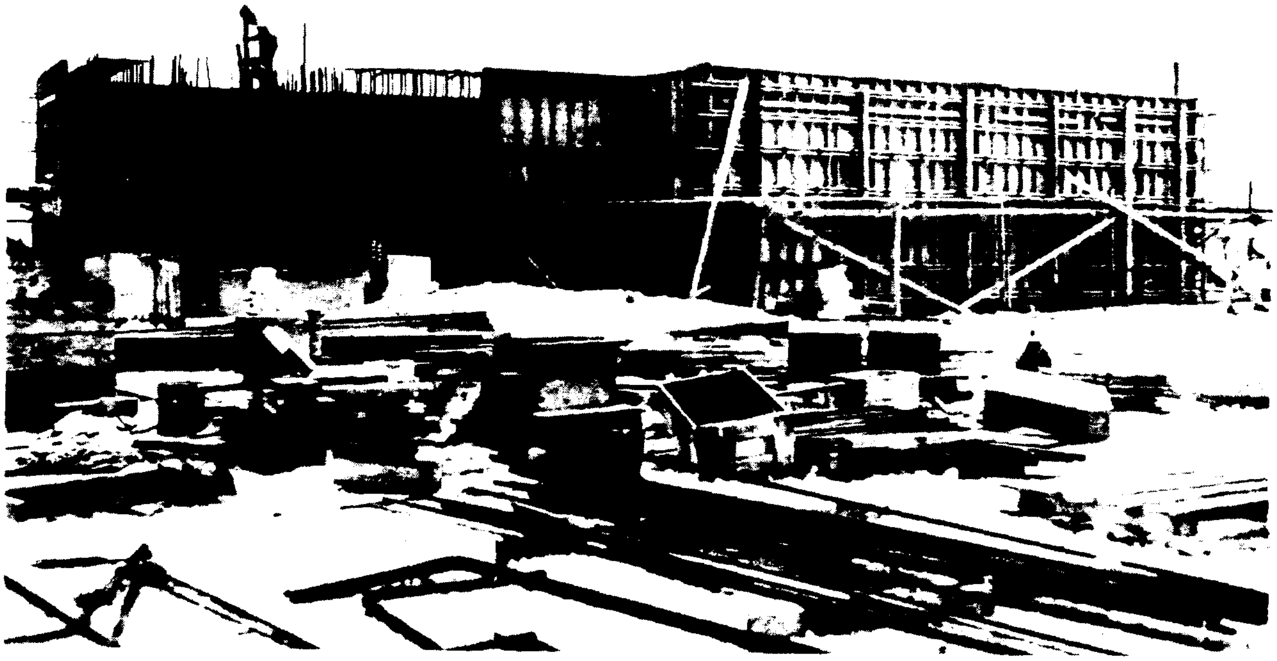


Figure 2-81. Station 1520 - 28% Complete

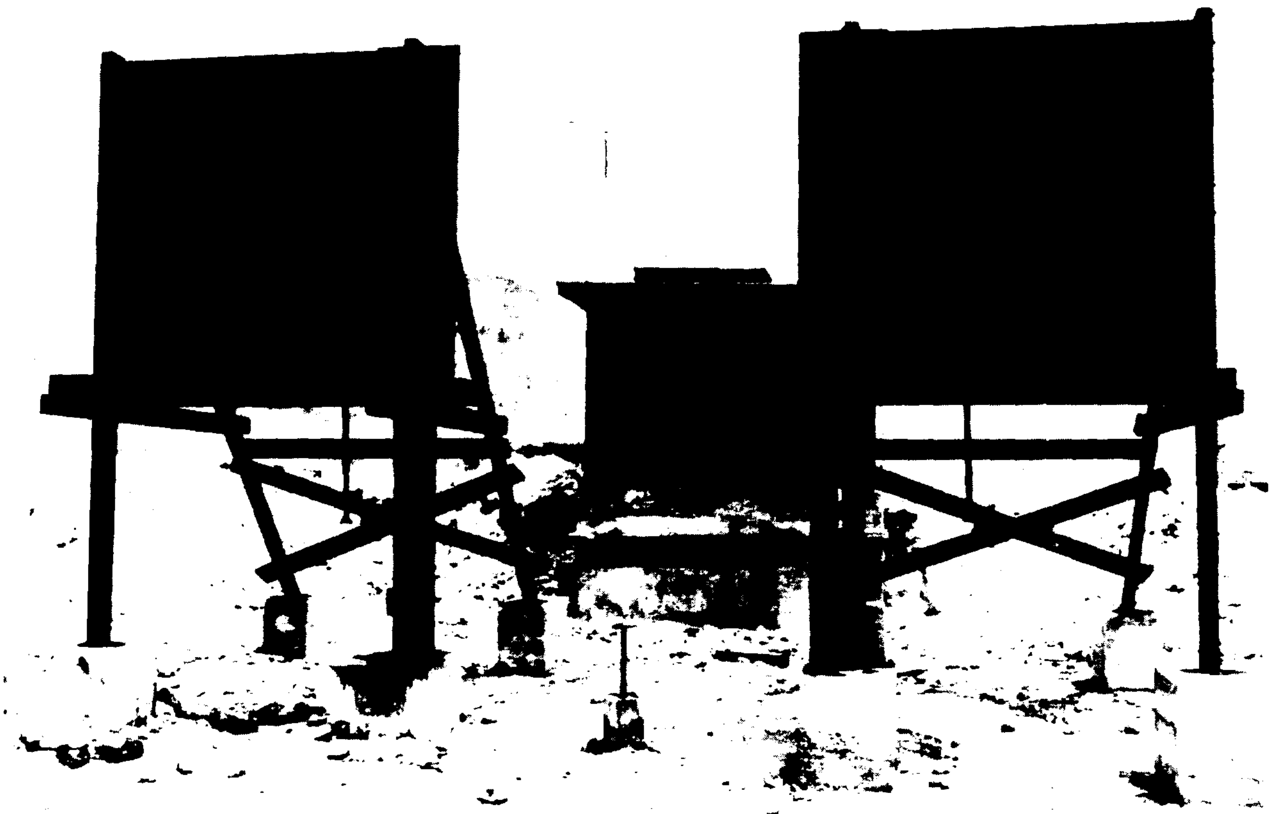


Figure 2-82. Station 1590 - Station 1520 (Background)

mirrors. The mirrors were aligned with the photo slot structures, each of which consisted of two steel sight tubes 13 foot long with a 6′ x 6″ opening. These tubes were embedded in concrete with the long axis of the tubes at right angles to Stations 24, 6 and 7. The interiors of these openings were provided with hinged plywood covers and the exteriors with guillotine-type blast covers which could be closed by a timing signal. A hydraulic cylinder arrangement was provided for opening these blast covers, and hydraulic dash pots were used to absorb the shock of closing.

Located in front of the viewing slots was Station 1590, which in conjunction with billboard type baffle Stations 1591 to 1596, was used to collimate the light path from Station 24.

A steel blast door was required for the corridor entrance and a lead-filled blast door was provided between Rooms 2 and 3. Other doors were of plywood with light ventilation louvers.

Power was supplied from the island distribution system through a 120-ampere fuse cutout, then through a 45 KVA dry-type transformer at 4160 - 120/208-volt, 3-phase. User-furnished special relays and panels were installed by the Contractor.

A 1400-cfm ventilating fan was used for the utility room, with a pneumatic-operated butterfly valve installed in the air inlet duct.

A direct expansion coil 2 square feet in face area was installed in the air supply to dehumidified areas. Also installed in this duct were 1′-8″ x 1′-4″ x 2″ filters for moisture elimination, a 10 KW reheat coil, and a 650 cfm primary air fan. The freon - 12 refrigerant system consisted of a DX coil, 67,500 btu compressor unit, and a matching water-cooled condensor. Two vertical centrifugal self-priming 18-gpm pumps circulated salt water for cooling to the refrigerant condenser.

A total of 605 cubic yards of concrete was poured. The concrete cylinder breaks for 28 days averaged 4,326 psi.

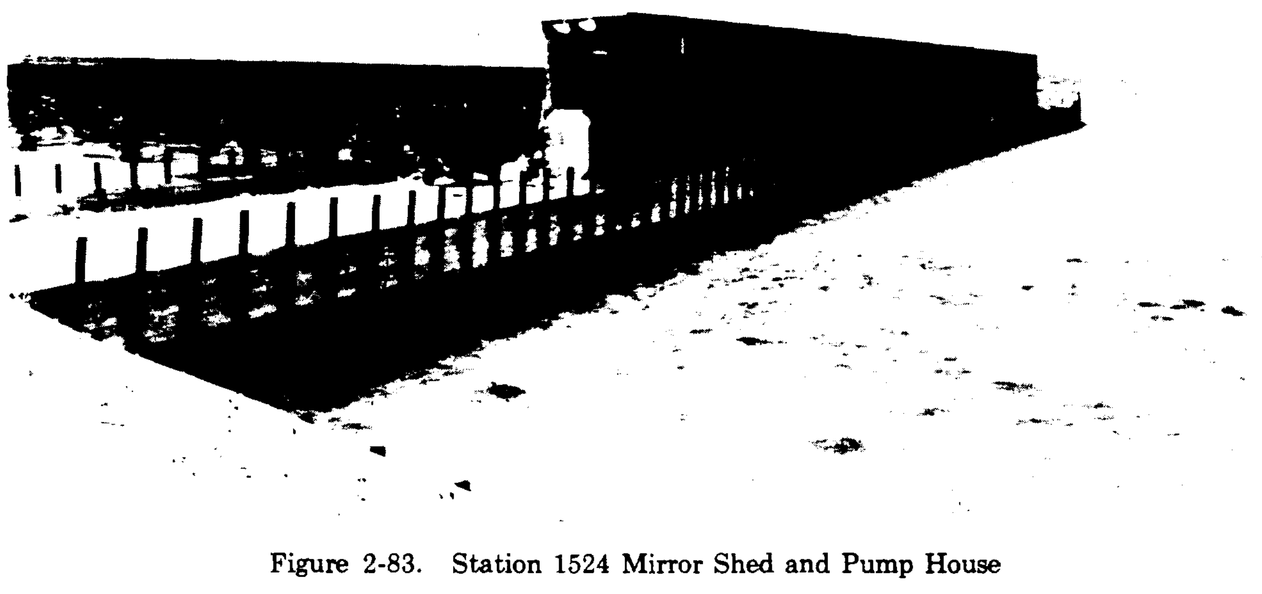


Figure 2-83. Station 1524 Mirror Shed and Pump House

STATION: 1524
PURPOSE: Vacuum Array
SITE: Yvonne
USER: LASL
PARTICIPATION: 24
CONSTRUCTION: 11-5-55/4-25-56

This station consisted of a two-story building 324′ x 12′-6″ wide and 17′ high, forming a pump and mirror house from which a 38 vacuum pipe array led to the working point of Station 24, a distance of 500 feet. The first story of the building consisted of six pump houses spaced along the length of the building; the second floor consisted of a 313′ x 10′ room which housed the vacuum manifold and mirrors for each pipeline. The mirrors, located at elevation plus 20′-6″, reflected light from the mirrors at the 38 pipe ends and in turn sent this reflection to camera Station 1520 through openings in the front wall of Station 1524. Beginning at Station 1524 and progressing toward Station 24, the 38 pipes were 12-inch diameter for a distance of approximately 410 feet, later changed to 10-inch diameter for an additional distance of approximately 76 feet, and then reduced to 7-inch pipe for the remaining distance of approximately 25 feet, to the working point of Station 24.

The mirror house structure rested on the pump houses and on intermediately-spaced columns at the rear wall facing away from Station 24. The second story roof and floor and rear walls of both stories were wood framed. Since the pump houses were 32 feet apart, the second-story rear walls were suported on 12-inch I-beams which spanned to 6-inch steel pipe columns spaced between the pump houses. The front walls of both stories consisted of 18-inch-thick reinforced concrete, and the span between

Figure 2-84. Interior Mirror Shed - Station 1524

Figure 2-85. Station 1524 Pipe Support Bases

the pump houses consisted of a reinforced concrete I-beam the height of the second story. The concrete flanges of the I-beam were used to give lateral stability to the 32-foot span and were extended the full length of the building. To give lateral stability to the entire building, the end walls of the pump houses were extended 2′-6″ to form buttresses. Because the building utilized mirrors, settlement was a critical consideration.

To prevent settlement, the walls of the pump houses, which supported the entire structure, were extended down to the solid coral and supported on mat foundations. The 24-inch diameter vacuum manifold on the second floor was supported on steel beams which spanned between the longitudinal 12-inch I-beams and the concrete I-beams.

The 38-pipe array was supported on 17 steel frame bents, most of which were spaced 31 feet at center and laid parallel to the mirror house. The pipes were spaced 7′-9″ apart at the mirror house where they were at the same elevation and focused at various points within Station 24. This situation proposed a problem of supporting the pipes near Station 24 where they converged together. It was decided to use solid steel plate walls with holes for the pipes as bents at locations within 150 feet of Station 24. Close to Station 24 and where the pipes were low, the steel walls were 25/32-inch plate, 18′ to 30′ long and 13′ high. These bents rested on reinforced concrete foundation walls which extended down to coral. The steel wall bent located 25 feet from Station 24 was a fixed-type support and was required to take the thrust from 125 feet of the pipelines. This was accomplished by bracing back to a steel wall bent 12 feet behind which in turn was secured to the ground. To prevent buckling and movement of this fixed bent, numerous bar stiffeners were welded to the steel plate and placed in such a manner as to miss all the pipes. This resulted in an almost random looking pattern on the bent. In all, there were 7 steel plate bents of which three rested on foundation walls and four on 8′ to 9′-high steel-framed structures composed of 6-inch pipe columns, 12-inch I-beams, and 3-inch angle braces. The remainder of the 17 bents consisted of angle supports for each pipe which rested on steel-framed structures similar to those for the four steel plate walls.

Figure 2-86. Station 1524 - Under Construction

In order to provide stability, the bents were braced in pairs and to one another and rested on spread footings which extended down to and were doweled into the coral to prevent settlement and lateral movement.

In order to establish and maintain the necessary pipe alignment, adjustable roller and fixed supports provided vertical and horizontal adjustments with the mean position set for the established level of each support. Expansion and contraction of the pipes and the manifold in the mirror house, due to temperature and pressure changes, were compensated for by using all metal expansion joints.

The vacuum pipes led to the 24" manifold in the mirror house from which 16" lines led to six User-furnished vacuum pumps and one roughing pump. The pumps were capable of maintaining a 0.1 micron vacuum. Cooling water

Figure 2-87. Station 1524 - First Row of Steel Pipe Supports Erected

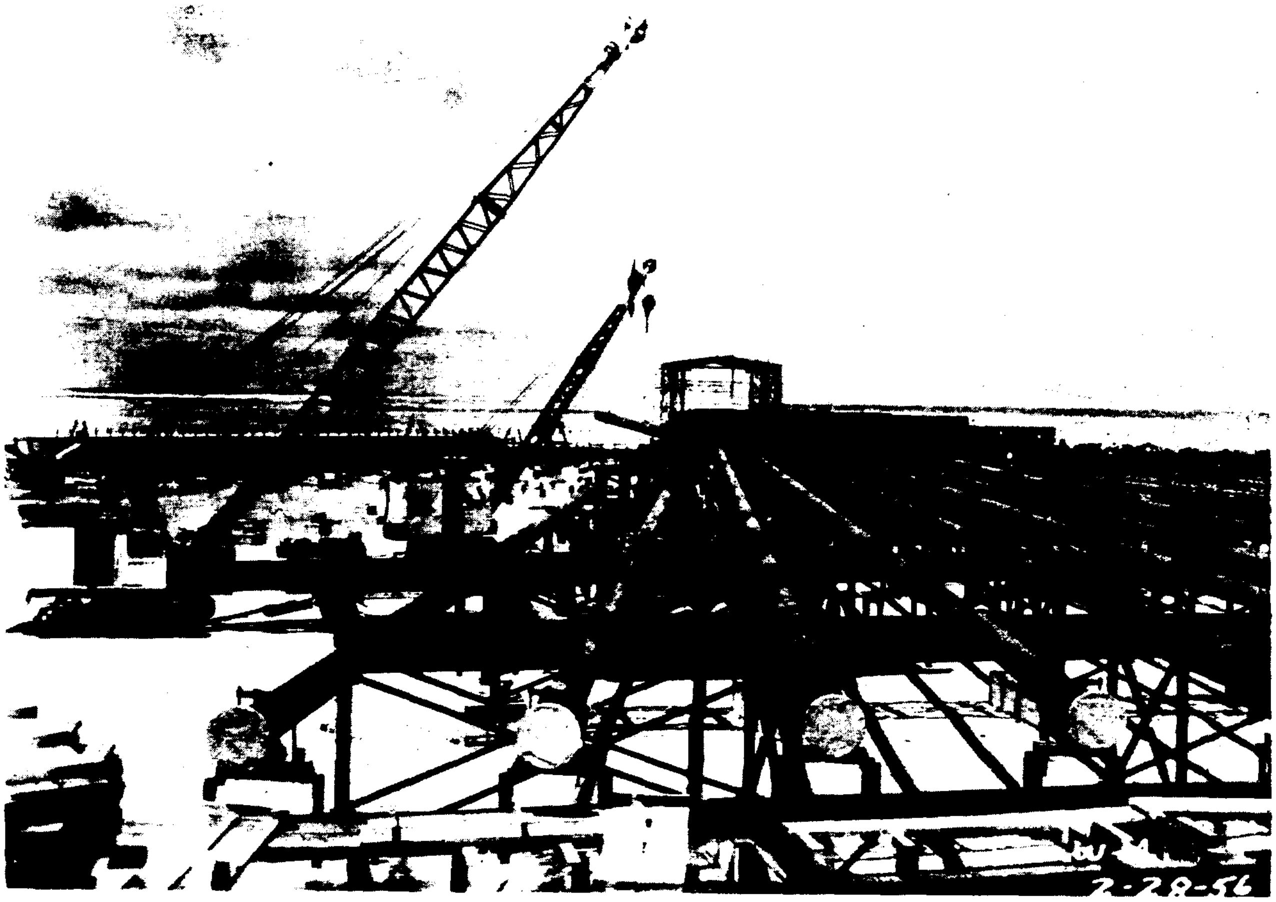


Figure 2-88. Station 1524 - 60% Complete

for the vacuum pumps was supplied from a well located on high ground because the water on the reef was filled with sea moss.

The station was located and oriented in accordance with User criteria. This required the construction of man-made island and a causeway connecting to site Yvonne. This construction is further discussed under Causeways, Section IV of this chapter.

Power for Station 1524 was supplied by 3# 4/0 KV direct burial cable from a transformer at Station 1818.09 and terminated in a power center in Station 1524 consisting of primary distribution oil fuse cutouts 5,000 volt, 3-phase, 100-amp gang-operated, and a 300 KVA oil-filled transformer with a 4,160-volt primary and 120/208-volt, 3-phase secondary. The unit also consisted of a low voltage panel with three 300-amp trip, 3-pole circuit breakers. This power unit was installed in a transformer room. Other equipment in the room consisted of two distribution panels, PA & PB, a signal cabinet, a telephone cabinet, and an EG&G relay. Various lines in conduit were provided for pumps, floodlights, general lighting signals, and phones.

Forms for the bases of the bent systems were prefabricated then set on the reef at low tide. Two transit mixers were removed from their truck chassis and mounted on trailers. This eliminated considerable down time for maintenance of trucks and permitted working during higher tide levels than would otherwise have been possible.

All welders used on the pipe arrays were first qualified for this work. The work was accomplished in two shifts. The first shift was used to erect pipe bents, position and align the pipe, then tack weld the interconnecting collars. Masking tape was then placed over the joint to keep out moisture; the night shift completed the welding of the pipe system. When the system was completed and tested, no leaks because of weld failures occurred; a few leaks were found in the pumping system. After the leaks were repaired no difficulty was experienced in maintaining the specified vacuum.

STATION: 1528
PURPOSE: High-Speed Photography
SITE: George
USER: DOD-15
PARTICIPATION: 10, 11, 12, 13 and 18
CONSTRUCTION: 12-21-55/5-5-56
OCCUPANCY: 3-12-56

The work for this station consisted of rehabilitating and modifying existing CASTLE Station 1342. The station was a photo bunker of massive concrete construction, which was equipped with dehumidification units and had a steel drop blast door with an opening that led to a series of mirrors which reflected images down a chimney to cameras. Modifications included constructing a new photographic dark room, adding camera mount beams, deepening the concrete ledge in the chimney slot, providing an electric hoist, installing a 500-gallon fuel storage tank, and supplementing the air conditioning and electrical systems. The large camera shutter door was modified to eliminate the bounce at closing and also so that it could be operated from within the station. Power requirements were 10 KW, 120/208-volt, 3-phase. Minus 15 minutes, minus 1 minute, minus 15 seconds, and minus 1 second timing signals were required.

STATIONS: 1540.01 and 1540.02
PURPOSE: Cloud Tracking Cameras
SITES: William and Wilma
USER: DOD-15
PARTICIPATION: All Bikini and Eniwetok Events
CONSTRUCTION: 2-17-56/5-10-56

These stations were 5′ x 5′ x 4″-thick concrete pads for mounting User-furnished theodolites. No power or timing signals were required. Station 1540.01 was first constructed in accordance with the plan location but as this location did not provide the required clear line of sight to Station 18, it was relocated at Station 1515.

STATION: 1541
PURPOSE: Fireball Photography
SITE: Alice
USER: DOD-15
PARTICIPATION: 23

Station 1541 was a camera mount located on top of existing CASTLE Station 1343. A 2½ KW. 110-volt, single-phase generator with an extension cord to the second floor was provided. Four pair of timing signal wire were terminated in the second floor room of the station.

STATION: 1580.01
PURPOSE: Weather Radar
SITE: Elmer
USER: DOD-15
PARTICIPATION: All Eniwetok Events

Station 1580.01 was a 4′ x 8′ wooden platform mounted on wooden poles, 40 feet above the ground. A User-furnished radar unit was placed on the station. On the ground below the platform was a shelter 4′ x 1′-6″ x 2′ high in which a 5 HP motor generator set was housed. Power of 208-volt, 3-phase, 4-wire was provided to the motor generator. Conduit for 33 conductors was run from a weatherproof junction box on the platform to a junction box inside of Station 71.

STATION: 1580.02
PURPOSE: Weather Radar
SITE: Nan
USER: DOD-15
PARTICIPATION: All Bikini Events
CONSTRUCTION: 4-11-56/4-11-56
OCCUPANCY: 4-11-56

This station was a User-furnished radar unit mounted on a new platform at the 37½′ level of the existing Station 70 tower. A User-furnished and-installed motor generator set was installed in Station 70. Conduit for thirty-three User-furnished conductors was run from a junction box at the radar platform to Room 1 of Station 70.

STATIONS: 1590 and 1591 thru 1596
PURPOSE: Mirror House (1590) and Baffles (1591 thru 1596)
SITE: Yvonne
USER: DOD-15
PARTICIPATION: 24
CONSTRUCTION: 2-18-56/4-21-56

Located in front of Station 1520 was a wood frame building 11′ x 37′ x 7′ high with a concrete foundation 11′ x 37′ x 5′ thick which was known as mirror house Station 1590. Inside this station was a plywood baffle with its end wall containing two slots which were the beginning of a series of six wooden billboard-type baffles that extended to within 1,000 feet of Station 1524 and collimated the light path from Station 24. These six baffles were Stations 1591 thru 1596. The distance in front of the Station 1590 working point for each baffle station was as follows: 1591 - 50′, 1592 - 100′, 1593 - 250′, 1594 - 500′, 1595 - 2,125′ and 1596 - 4,508′. In size, Station 1591 was 8′ x 8′, Station 1592 was 28′ x 8′, Station 1593 was 12′ x 8′, Station s which were mounted on the outside he transformer shelter. These receptacles l power to the station by way of port-ds. One 3/C #12 portable cord was in- for the overhead lights. One 4/C #12 cord was installed for six 120-volt, nase receptacles. One 3/C #6 portable s installed for a 120-volt, single-phase, receptacle (tagged instrument power).

weather-proof 120/208-volt, 3-phase, 60 ceptacle was mounted on the outside 'all of the station. Power was provided receptacle by a 4/C #6 portable cord. 1½" conduits were installed in the east the station to provide entrance for ten aluminum coax. Underground cables stalled from Stations 1611 to 1612.

ver for the instrument load consisted of 120-volt, single-phase. No timing signals quired.

otal of 106 cubic yards of concrete was

)NS:	1613 and 1614
'SE:	Collimator Baffles
	Irene
	DOD-16
CIPATION:	23
'RUCTION:	1-25-56/4-22-56

ese stations were concrete baffle walls, and one 11′ long x 16′ high x 1 foot)ne wall was located 170 feet and the 30 feet from Station 23. There were six s in the face of these walls which coin-ith the six lines of sight between the point of Station 23 and the six detec-tions in Station 1612. No power or ignals were required. A total of 14 cubic concrete was poured. When the stations ured, 12-inch square blockouts were left collimator pipes in order to give Station to settle. After waiting two weeks, 8-inch r pipes were grouted in and lined up e zero point on Station 23.

)N:	1630
'SE:	Electromagnetic Measurements
	Bruce
	DOD-16
CIPATION:	All Events
'RUCTION:	3-27-56/4-28-56

ition 1630 was an octagonal-shaped structure 32′ on a side x 15′-6″ high. les were open, and the roof was con- l of plywood, covered with copper, and heavy layer of bitumastic paint. Around imeter of the roof there were soldered copper radial wires which sloped to the ground at an angle of 81 degrees from the vertical, and which were anchored to 1″-diameter copperweld ground rods and clamps. Sufficient space existed under the main structure roof for a User-furnished trailer. A 12′ x 22′ x 10′ wooden building located adjacent to the station was built for use as a "Bogue" generator shelter. Power requirements consisted of two 25 KW, 120/208-volt, 3-phase generators and the User-furnished Bogue set. Four pair of timing signal wire were required. A total of 15 cubic yards of concrete was poured.

STATION:	1810
PURPOSE:	Mirror Imaging Station
SITE:	Yvonne
USER:	LASL
CONSTRUCTION:	12-2-55/4-16-56

Station 1810 was utilized for mirror imaging and was located in Room B and part of Room D within Station 1310. Room D was divided by two wooden partitions 4 feet apart from wall to wall and floor to ceiling, with doors in the center. Room B was divided into three separate rooms: one isolated screen room 9′-6″ x 11′ with a 20,000 ohm resistant, a large instrument room, and a light channel room 2 feet wide the full length of Room B.

STATIONS:	1811 thru 1816, 1819, 1818.01 thru .09, 1841 and 1817.02
PURPOSE:	Spectroscope Measurements
SITE:	Yvonne
USER:	LASL
PARTICIPATION:	24
CONSTRUCTION:	12-14-55/4-21-56

Basically this was a pipe array consisting of 16″ vacuum pipe Stations 1811 and 1812; 24″ vacuum pipe Station 1813; 12″ vacuum pipe Station 1819; a beam splitting and turning mirror Station 1814; beam turning and focusing Station 1815; end point structure Station 1816; single pumping Stations 1818.01 through 1818 .09 and double pumping Station 1841. The pipelines were required to be pumped down to a vacuum of between 0.1 and .01 microns. Station 1811 was 16-inch-diameter pipe approximately 4400 feet long which was led from Station 24 to Station 1810, a recording station in Room B of Station 1310. Station 1812 was 16-inch-diameter pipe approximately 4000 feet long which led from Station 1810 to a junction with the 24-inch pipeline Station 1813. The junction point designated Station 1814 contained a mirror which split a light beam. The 24-inch pipe of Station 1813, approximately 860 feet long, led from the working point of Station 24, thence to this junction Station 1814

Figure 2-89. Stations 1591 through 1594

1594 was 44′ x 8′, Station 1595 was 28′ x 8′ and Station 1596 was 292′ x 11′-6″. Each baffle was set on concrete blocks. To offset the undermining of the slab of Station 1590 by high tides, a retaining wall was required. Station 1590 was reconstructed after the LaCrosse and Erie events. The concrete poured for these baffle stations varied from 5 cubic yards for Station 1591 to 126 cubic yards for Station 1596.

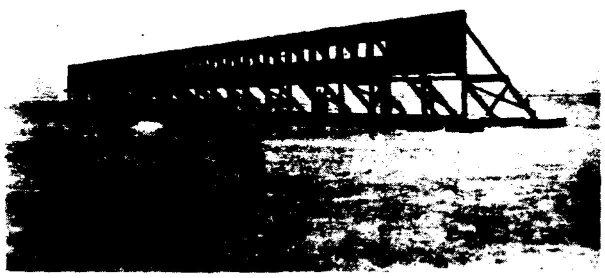


Figure 2-90. Station 1596

STATION: 1610
PURPOSE: Neutron Detector Chest
SITE: Irene
USER: DOD-16
PARTICIPATION: 23

Station 1610 was a neutron detector encased within approximately 100 tons of lead brick. A lead collimator pipe connected the detector to the working point of Station 23. Coaxial cable was run from the detector to Station 1612. No power or timing signals were required.

STATION: 1611
PURPOSE: Temperature, Tin
Alpha Measu ne
SITE: Irene
USER: DOD-16
PARTICIPATION: 23
CONSTRUCTION: 2-7-56/5-26-56

This was an existing concrete designated Ivy Station 200. For RE the building was rehabilitated and 32′ detector room with 4′-thick ll corridor connecting to the main struct added. Three rooms were screened afte ing the existing sheet copper lin forced air and dehumidification sy m stalled with heaters in each room. A s well supplied cooling water for the d fication equipment. Power requirem ts KW, 120/208-volt, 3-phase. A U 15 KW battery generator set was Timing signals of minus 45 minutes. minutes, minus 1 minute, minus 5 minus 5 seconds, minus 1 second, n test signal were provided. This station habilitated again after the Seminole d and was used for the Apache event. h rehabilitation consisted of installi 75 KW generators, rehabilitating the oil cutout and power panels, and replac aged cables and wiring. A total 7 yards of concrete was poured.

STATION: 1612
PURPOSE: Neutron Dete o
SITE: Irene
USER: LASL
CONSTRUCTION: 1-23-56/5-19-5

Station 1612 was a reinforced structure 20′ x 10′ x 11′ high with wi and parapet retaining an earth f and 40 foot long Z-shaped woode t inforced with steel at three locations from the rear of the station. The fron the station was 6′-thick concrete a six 6″ diameter pipe holes which e le brick shields on the inside face. Concr walls identified as Stations 1613 and 1 located between this station and t for use in collimation. A 15′ wide c c form was constructed along the fron the station. The station was covere feet of earth.

Power for Station 1612 was s p Station 23 by three #1/0 direct bur cables, terminating at a 30 KVA tr which was installed in a shelter ad e tunnel entrance of Station 1612. volt, 3-phase power panel was also in the transformer shelter. Power was from the power panel to five weat r-and then to a mirror Station 1815 where the light beam was reflected and picked up at Station 1830. Station 1819 was 12-inch-diameter pipe which was joined to Station 1811 pipeline at the working point of Station 24 and then extended approximately 150 feet beyond Station 24 to a concrete baffle wall designated Station 1816.

An adjustable baffle with a 1-inch-diameter hole in the center was inside of the Station 1811 pipeline and was located at a point 600 feet from Station 24. Additional baffles at approximate 40-foot centers beginning at Station 24 were inside the Stations 1811, 1812 and 1813 pipelines with 13¼-inch-diameter openings in the baffles for Stations 1811 and 1812 and 21¼-inch-diameter openings in Station 1813.

Station 1814, the junction of the 1812 and 1813 pipelines, consisted of a Y-shaped pipe

Figure 2-92. Prefabricating Footings for Stations 1811 and 1812

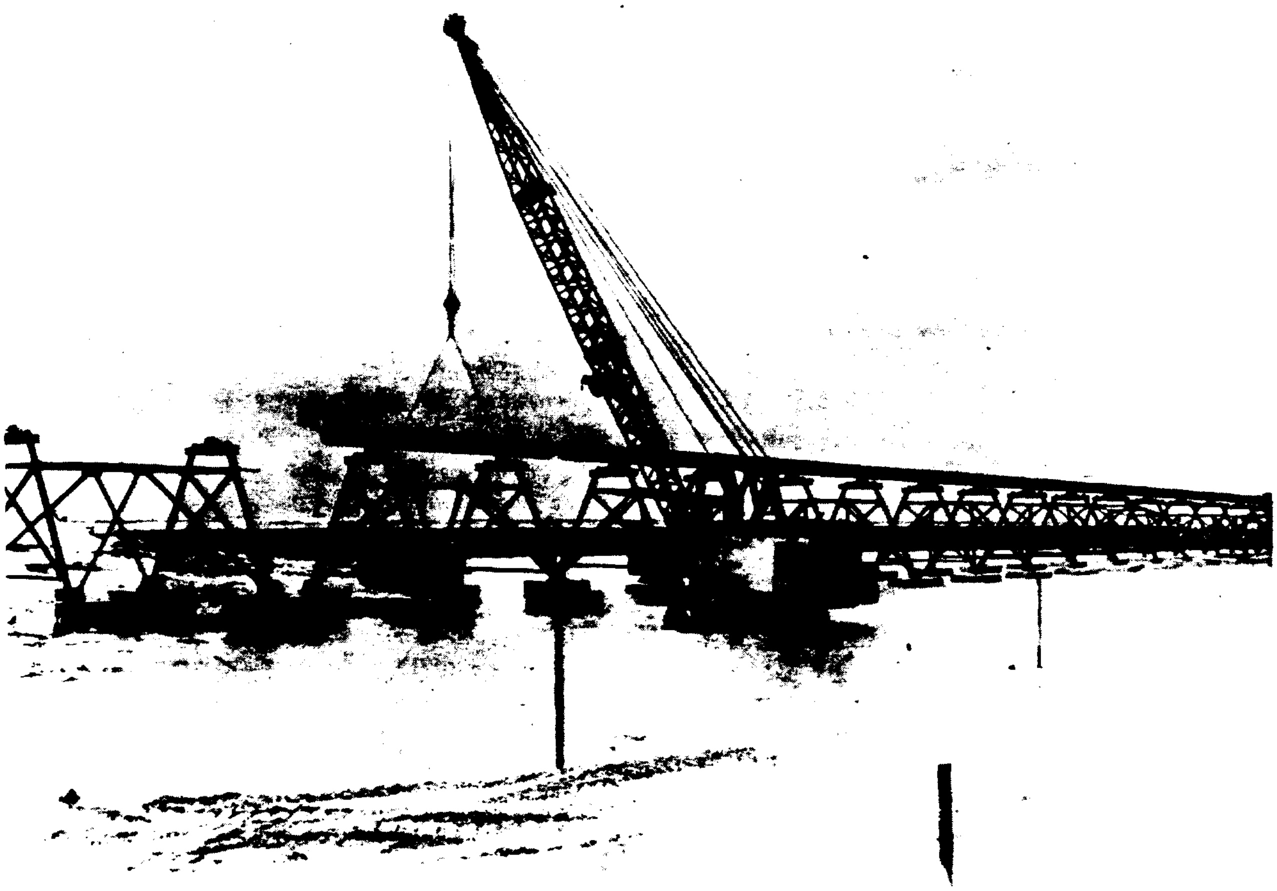


Figure 2-91. Station 1813 - 40% Complete

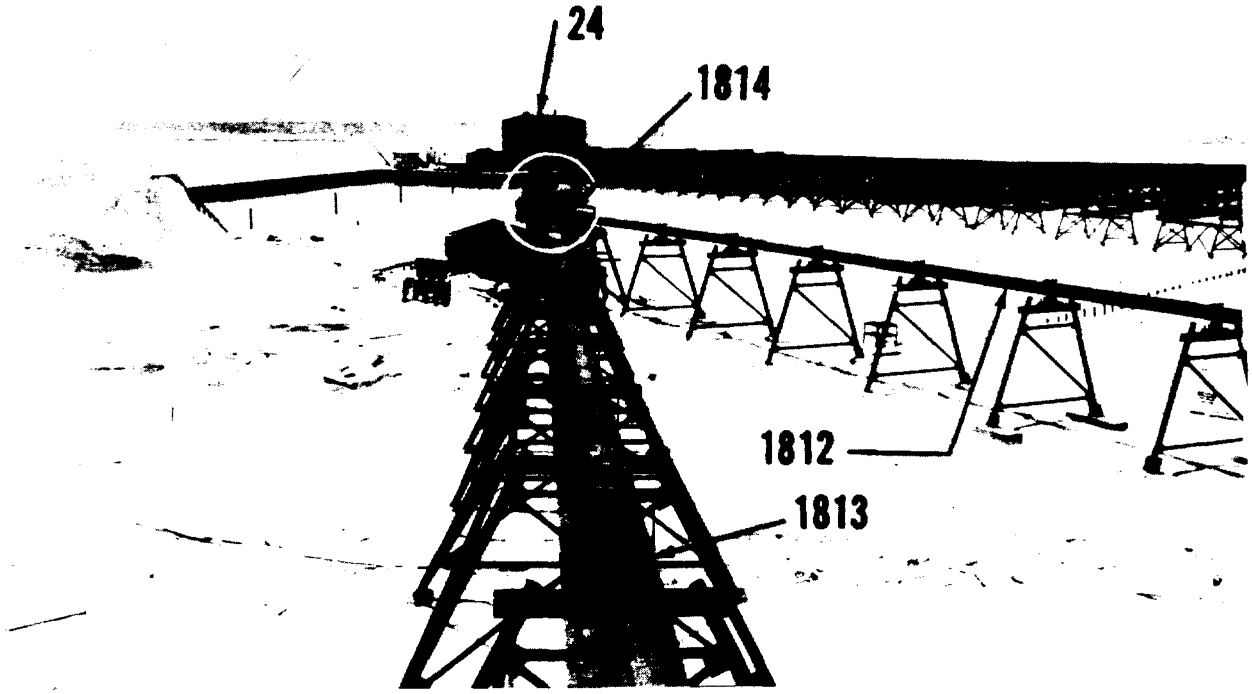


Figure 2-93. Stations 1812, 1813 and 1814

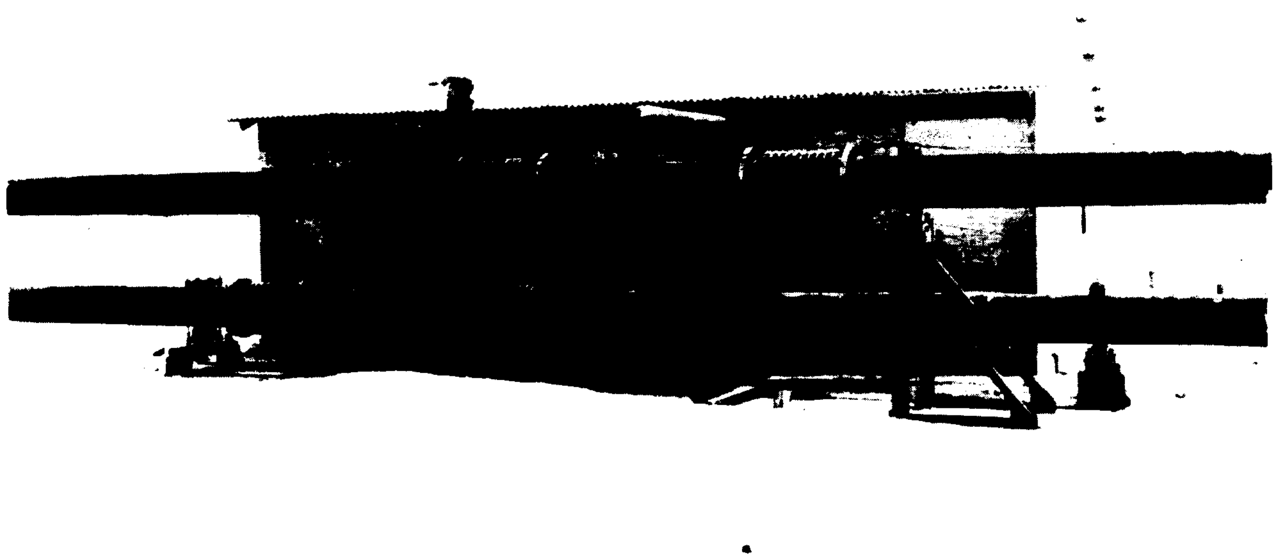


Figure 2-94. Stations 1811 and 1812 Pipe Connections to Station 1841

section furnished by the Users which permitted the ray of light to be split by means of mirrors into 1812 and then continue to 1813. The "Y" section was mounted on two 6′ x 18′ x 12′-high steel frames set on concrete bases.

Station 1815 consisted of three steel towers approximately 7′ x 8′ x 25′ high using standard 6″-pipe for its legs, which were enclosed with weatherproof plywood houses having plexiglass windows. The User-furnished mirrors were mounted on the steel towers.

Station 1816 consisted of two L-shaped 4′ thick reinforced concrete blast walls set on a 4′ thick reinforced concrete slab in which the Station 1819 pipe ended.

Located at intervals along the pipelines were the pumping stations (Station 1818.01 through 1818.09, 1817.02 and 1841) containing User-furnished pumps for producing the required vacuum. The pumps were mounted on 16′ x 21′ x 4″-thick concrete slabs with a plywood house for cover.

Project 18 pipelines were essentially a long laboratory quality vacuum chamber designed to maintain close alignment and be gas tight. Alignment was assured by roller supports that were adjustable in both horizontal and vertical directions. Gas tightness resulted from incorporating approximate 700′ lengths of welded spool, which had bolted flange joints with O-ring gaskets to all metal bellows expansion joints. Fixed anchors midway between the expansion joints maintained the position of each pipe spool. Pump stations and junction points along each line also had expansion joints on both sides of each station and the pipe at these same locations was rigidly anchored. The pipeline supports consisted of welded steel "A" frames spaced 20 feet on center and were constructed of 6-inch pipe columns and angle bracing. The supports were braced one to the other and supported on 2′ x 2′ x 6′ isolated concrete footings. Support heights varied from approximately 3 to 13 feet to allow for grade variation. All of these stations were located and oriented by the Users, and from their infor-

Figure 2-95. Stations 1815 Mirror Towers

mation the working point coordinates were computed by the Contractor. Due to the function of each station, location was established within second order accuracy (1:10,000). In the case of Stations 1811, 1812, 1813 and 1819 (pipelines) the User required a line of sight through the pipes. In order to accomplish this, the elevations were corrected to compensate for the curvature of the earth. These values were computed and recorded to indicate the various points on these stations and to show the actual and corrected values for elevations.

Criteria for vacuum pumping stations required a continuous flow of cooling water be maintained for the pumps in the event of power failure or when closing any water pump. To accomplish this, a pressure tank system for each vacuum pump was designed, using a pump with a 127-foot head at zero delivery and putting an orifice in the tank discharge for restricting the flow to the required minimum amount of water with a pressure head of 35 feet. The total quantity of water flowing for five minutes was arbitarily chosen as approximately 100 gallons in order to size the storage tank.

Stations 1812 and 1813 had no electrical installations. Stations 1814, 1815, 1816 and 1819 each had one local phone on a common loop. Power was supplied to Station 1841 from Station 1310 through a 4-inch conduit with three #500 MCM conductors which were installed from the utility unit substation in Station 1310 and terminated in a power panel within Station 1841. Power for Station 1817.02 was supplied from a 112.5 KVA, 3-phase, 4,160-120/208-volt transformer located near Station 24, through a 2-inch conduit with #4 conductors which terminated in power panel "PA" within the station. Power to Stations 1818.04 thru .07 was supplied by a 1½-inch conduit with four #4 conductors from a 45-KVA, 3-phase, 4,160-120/208-volt transformer located near the subject station and terminated in a 120/208-volt, 3-phase, 4-wire, lighting panel "LA". Power to Station 1818.01 was supplied from a transformer in Station 1524 through four #2 direct burial conductors. Stations 1818.05 and .06 were fed by 45-KVA, 3-phase, 4,160-120/208-volt transformers located between Stations 1818.03 and .09 through four #2 direct burial conductors which terminated in lighting panel "LA."

The electrical work for Station 1818.09 was the same as for Station 1818.06, except that the station was fed from a 15-KVA, 4160-120/208-volt, 3-phase transformer which was installed 30 feet from the south wall of the station. No timing signals were required.

The cubic yards of concrete poured for each station were as follows: Station 1811, 310 cubic yards; Station 1814, 39 cubic yards; Station 1815, 99 cubic yards; Station 1816, 166 cubic yards; Stations 1818.01 thru .09, 1818.02 and 1841, 104 cubic yards and Station 1819, 4 cubic yards.

Prior to shipping the pipe overseas, the interiors were grit-blasted and cleaned with acetone, then blown with hot air to ensure clean and rust-free pipe. The interiors of the pipe were fitted with a square paper tube impregnated with a rust inhibitor and the pipe ends were then capped and sealed. On arrival at the Jobsite the pipe was inspected and found to be clean and free of rust. However, while stored in the pipe yard awaiting installation, moisture collected inside the sealed pipe and rusting started. The pipes had to be again grit-blasted, cleaned with acetone, and blown with dry air, then recapped until they were required for reinstallation. A shortage of grit at the Jobsite required that 12 tons be airlifted in order that the work would not be delayed.

STATION:	1830
PURPOSE:	Camera Station
SITE:	George
USER:	DOD-18
PARTICIPATION:	11 and 13
CONSTRUCTION:	12-12-55/5-5-56
OCCUPANCY:	3-12-56

Existing CASTLE Station 1550, a two-story heavily-reinforced concrete structure was rehabilitated and modified to provide for Station 1830. The lower floor contained generators, dehumidification equipment, telephones, timing cables and a signal system. The upper floor contained cameras which were sighted through three drop-type blast doors. The generator engine exhaust, dehumidifier intake, and outlets were closed by blast doors with a tensioned spring closing device.

A new dehumidification unit was installed, corroded fuel lines were replaced, and a fuel tank was buried adjacent to the building. The drop-type blast doors operated satisfactorily after new gaskets were installed and the latches overhauled. The blast doors operated by tensioned springs after release by a built-in blast link proved to be unsatisfactory. Therefore, a frame constructed of a 60- pound rail was welded to the outside of the door frames in such a way that the doors could be released by blast links held in tension between the frame and the door. This method worked satisfactorily.

Power requirements were 27 KW, 208-volt, 3-phase. Timing signals plus a zero test signal were provided. Construction started 12 December 1955, beneficial occupancy was provided on 12 March 1956, and completion was effected on 5 May 1956. Final completion of the Station was delayed due to a shortage of plumbing and electrical fixtures.

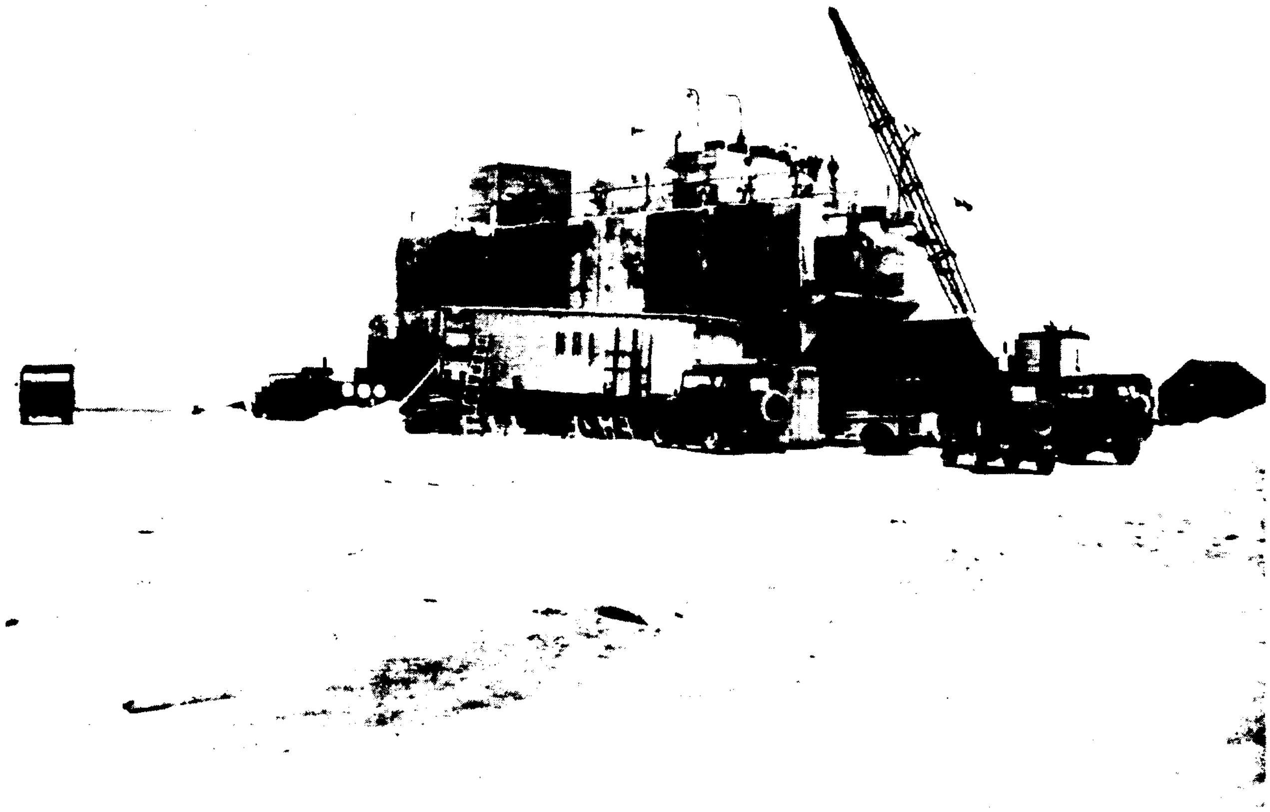


Figure 2-96. Station 1830

STATIONS: 1831.01 and 1831.02
PURPOSE: Light Rafts
SITE: Dog (in Lagoon)
USER: LASL
PARTICIPATION: 11 and 13
CONSTRUCTION: 4-17-56/6-13-56

The stations were 21′ x 44′ pontoon barges made up of 21 Navy cubes welded together with 3″ x 3″ x ¼″ L-brackets. Mounted on the deck was a two-foot high 19′ x 29′ platform consisting of a wooden floor supported on a steel-framed grid. A standard 14′ square tent was erected on this platform. Around the platform extended a continuous plywood railing from the barge deck to 2½ feet above the platform. The railing was solid. The tent contained a 6′ x 10′ roll-up steel door on one end, mounted on a steel frame 11′ high by 18′ long located on the outside of the tent end wall. Two 12″-diameter searchlights were mounted on the deck so as to be aligned on Station 1830.

One station was located between a point 300 to 2,000 yards past Barge 13 and on a line extending from the center camera port of Station 1830, GEORGE, through a point 50 to 100 yards from the barge location toward Station 1320, DOG. The other raft was located 300 to 2,000 yards past Barge 11 and on the line extending from Station 1830, GEORGE, but through a point 100 to 200 yards from the barge location toward Station 1320, DOG. The movement of the raft station at center was limited within a horizontal area having a 15-foot radius for the station associated with Barge 13 and 25-foot radius for the station with Barge 11. The pitch and yaw were limited so that the base of a 20-degree right circular cone projecting from the raft would cover the center part of Station 1830, GEORGE. To accomplish this the barges were equipped with mooring winches at each corner supported on a diagonal frame. From each winch ½″ mooring cable was led to buoys tied to concrete anchor blocks, which were in turn attached to 500-pound anchors with 180 feet of chain.

Stations 1831.01 and 1831.02 were identical electrically. Power to each of the stations was supplied by a 10 KW, 120/208-volt, 3-phase gasoline engine generator. A one-inch conduit with four #8 conductors was installed from the generator to a 12-circuit lighting panel. One 10-amp, 120-volt, 3-wire receptacle was installed for radio use and a signal cabinet was mounted over the radio receiver bench. A ¾-inch conduit with two #12 conductors was installed from the signal cabinet to an EG&G relay. For this relay, a ¾-inch conduit with two #12 conductors terminated in a reversing magnetic starter. A one-inch conduit with seven #12 conductors was installed from the starter to the door closer unit which consisted of a ½ HP motor and two limit switches. Power was provided from the lighting panel by a ¾-inch conduit with three #12 conductors. The door was opened and closed by radio signal. A 20-amp, 120-volt, single-phase , 3-wire receptacle was installed for each User-furnished 1500-watt searchlight.

STATION: 1910
PURPOSE: Instrument Shelter
SITE: Yvonne
USER: DOD-19
PARTICIPATION: 6
CONSTRUCTION: 4-21-56/4-26-56

Station 1910 was existing IVY Station 810.09. It consisted of a concrete pit with inside dimensions of 2′-6″ x 2′-6″ x 4′ deep and with a top made of steel plate. A new steel blast door, conduit, a ground rod and a minus 1 second timing signal were provided. No power was required.

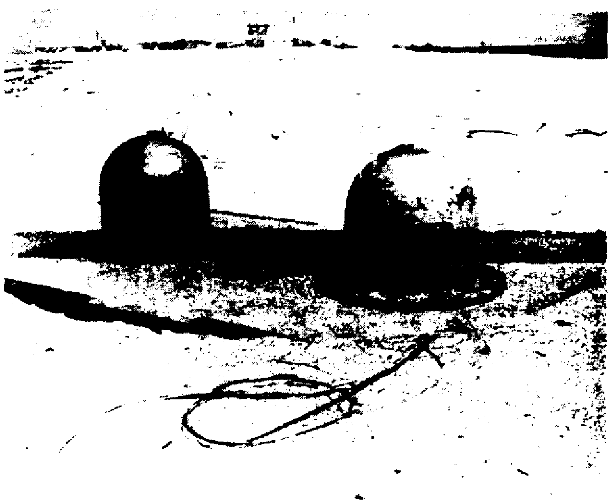


Figure 2-97. Stations 1911.01 and 1911.02

STATIONS: 1911.01 and 1911.02
PURPOSE: Blast Effect Study of Two Devices
SITE: Yvonne
USER: DOD-19
PARTICIPATION: 6
CONSTRUCTION: 4-19-56/4-27-56

These stations were two cylinders of ¾-inch-thick steel having a hemispherical top. The inside diameter was 2′-6″ and the height was 2′-9″. Each cylinder was mounted on an 8′ x 12′ x 2′-thick reinforced concrete foundation and had a steel base which was isolated from the cylinder wall. Cable from each of these stations was placed in an 18″ V-type ditch which led to Station 1910. A total of 18 cubic yards of concrete was poured.

STATIONS: 1920.01 thru 1920.03
PURPOSE: Radiation Samples
SITE: Yvonne
USER: DOD-19
PARTICIPATION: 6
CONSTRUCTION: 5-21-56/5-27-56

These stations were three 2-inch O. D. pipe brackets extending beyond the tower legs of Station 6. One bracket was 25 feet long located at the 275-foot level of the tower and two were 20 feet long at the 250-foot and 225-foot levels, respectively. Each bracket was guyed with ⅜-inch cables extended from the tower. User-furnished spheres were mounted on these suspensions by crossarms at the ends of the pipes. No power or timing signals were required.

STATIONS: 1925.02 thru 1925.06
SITE: Ruby
USER: UCRL
PARTICIPATION: 3

This station was a series of 5′ x 5′ x 1′-9″-high concrete blocks with 38-inch diameter 8-inch thick steel discs in the center. They were prefabricated at Elmer and lifting rings were installed in the blocks to facilitate transporting them to a User-designated location around Station 3. A total of 14 cubic yards of concrete was poured.

STATIONS: 2141.01 thru 2141.06
PURPOSE: Detector Stations
SITE: Ruby and Pearl
USER: UCRL
PARTICIPATION: 3
CONSTRUCTION: 6-28-56/6-28-56

These stations were User-furnished and-installed detectors hooked to a reclaiming cable installed by the Contractor. Stations 2141.01

thru .03 were located at Ruby and Stations 2141.04 thru .06 were on Pearl. A 60-pound, 8'-long rail pile was driven approximately 6' deep into the reef at the point of recovery on Ruby. The end of the recovery cable was secured to an existing rail pile which was driven into the reef for the coaxial crossing used in the Mohawk event.

STATION: 2200
PURPOSE: Recording Station
SITE: Sugar
USER: UCRL
PARTICIPATION: 22
CONSTRUCTION: 10-28-55/3-12-56
OCCUPANCY: 3-12-56

Criteria required the reuse of existing CASTLE Station 2200. An engineering check was made of the structure, which was designed for 75 psi, to determine whether it would withstand the expected overpressures of 100 psi and the required rehabilitation. No additional reinforcing was necessary. The work involved the following major items: installed Cope trays in Rooms A, B and C; installed User-furnished coaxial cable and dryers, and fabricated and installed a User-designed coaxial cable manifold; installed dehumidification units in Rooms B and C; drilled a 19" hole in the west wall for installation of two new 5" conduits, cleaned ten existing 3" conduits and renewed electrical wiring; erected a 16' x 32' type B-2 tent on a concrete slab adjacent to the station; rehabilitated the existing salt water well and supplied power for the utilities from a 100 KW generator and for instruments from two 20 KW generators located in Station 2210. One phone was installed in the tent with an extension to a trailer; five timing signal pair of cable were terminated in a signal cabinet within the tunnel of the station. Completion of this station was delayed due to a shortage of certain electrical items.

STATION: 2201
PURPOSE: Recorder Station
SITE: Sally
USER: UCRL
PARTICIPATION: 1, 2, 3 and 4
CONSTRUCTION: 10-3-55/4-27-56

Existing CASTLE Station 2201 was rehabilitated and known by the same identification

Figure 2-98. Station 2201 - Utility Room

number for this Operation. It was necessary to remove the earth cover over the station prior to effecting rehabilitation.

A cooling and ventilating system with a capacity of 1,500 CFM and a 1,000 gallon tank for storing generator fuel were installed inside the station. The existing sump was used and a new 150 gpm sump pump was installed.

Electrical work included relocating ten existing 2½" conduits and installing 34 new 2½" conduits and two new 6" conduits from the side of Station 2201 to CASTLE Station 2211. The existing electrical panel was relocated from Room B to the Utility corridor. Three new electrical receptacles that were duplicates of the existing receptacles were installed in Room B. Cope trays, 12" x 25", were suspended 12" below the ceiling in Rooms A and B. Power was supplied from the main powerhouse through a 150 KW transformer. Auxiliary power was provided by one 35 KW and a 10 KW Diesel generator with a manually operated transfer switch.

A 16′ x 32′ type B2 tent was erected on an existing concrete slab. A 200-amp, 3-pole breaker was added to the main utility power panel. The breaker was to open at H-minus one minute by EG&G signal.

STATION:	2210
PURPOSE:	Generator Station
SITE:	Sugar
USER:	UCRL
PARTICIPATION:	22
CONSTRUCTION:	10-4-55/5-5-56
OCCUPANCY:	4-7-56

Figure 2-99. Station 2210 Retaining Wall and Concrete Shield

This was a generator station consisting of one 10 KW, 220-volt, 3-phase generator and one 35 KW, 220-volt, 3-phase generator for instrument power of Station 2200. Voltage regulation of the generators was required to be within approximately one per cent accuracy and their locations had to be within 50′ from Station 2200. The station had two concrete wing walls for retaining sand as protection and a 6′-high x 6′-thick concrete curtain wall to electrically shield the utility power from the instrument power. In addition, the generators were required to have a remote control panel in Station 2200.

A delay in construction was experienced due to difficulties connected with receiving electrical equipment.

STATION:	2211
PURPOSE:	Generator Station
SITE:	Sally
USER:	UCRL
PARTICIPATION:	1, 2, 3 and 4
CONSTRUCTION:	11-3-55/4-27-56

Station 2211 was a generator station containing one 10 KW generator and one 35 KW generator for instrument power of Station 2201. An engineering study was made to determine whether it would be less expensive to expend the generators or to protect them in a shelter. If they were to be expended, several additional generators would be required. As a result of the study, a concrete shelter 14′ x 24′ x 8′-3" high, with a slab and roof 4′ thick, was constructed, which had wing walls 85′ long, 21′ high and 3′-6" thick. A 4′ x 6′-high 6"-thick concrete wall to electrically shield utility power from instrument power was also provided. Voltage regulation within one per cent was required. A remote control panel was located in Station 2201. A total of 382 cubic yards of concrete was poured.

STATIONS:	2220.01 and 2220.02
PURPOSE:	Long Range Detector
SITE:	Sugar
USER:	UCRL
PARTICIPATION:	22
CONSTRUCTION:	1-20-56/5-24-56
OCCUPANCY:	3-14-56

These stations consisted of concrete foundations 5′ x 8′-4" and 3′ thick which were required to support detectors with a load distributed into three bearing surfaces, each approximately 240 inches square and supporting a 6.7 kip load. To the rear of each foundation was a 5′ x 4′ x 2′ deep copper-lined capacitor pit with four 3" galvanized pipe sleeves 6" on center and 8" above the floor of the pit. Anchor bolts in

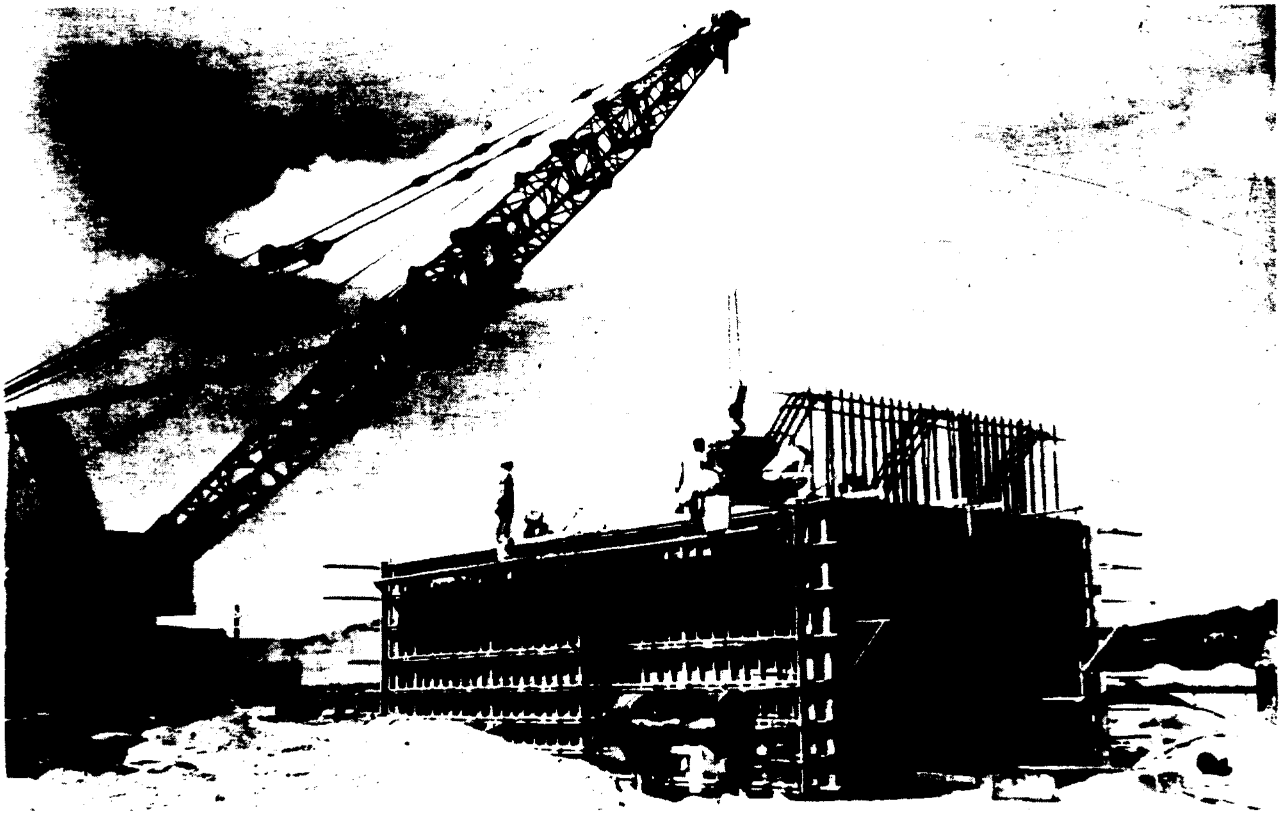


Figure 2-100. Station 2211 - 40% Complete

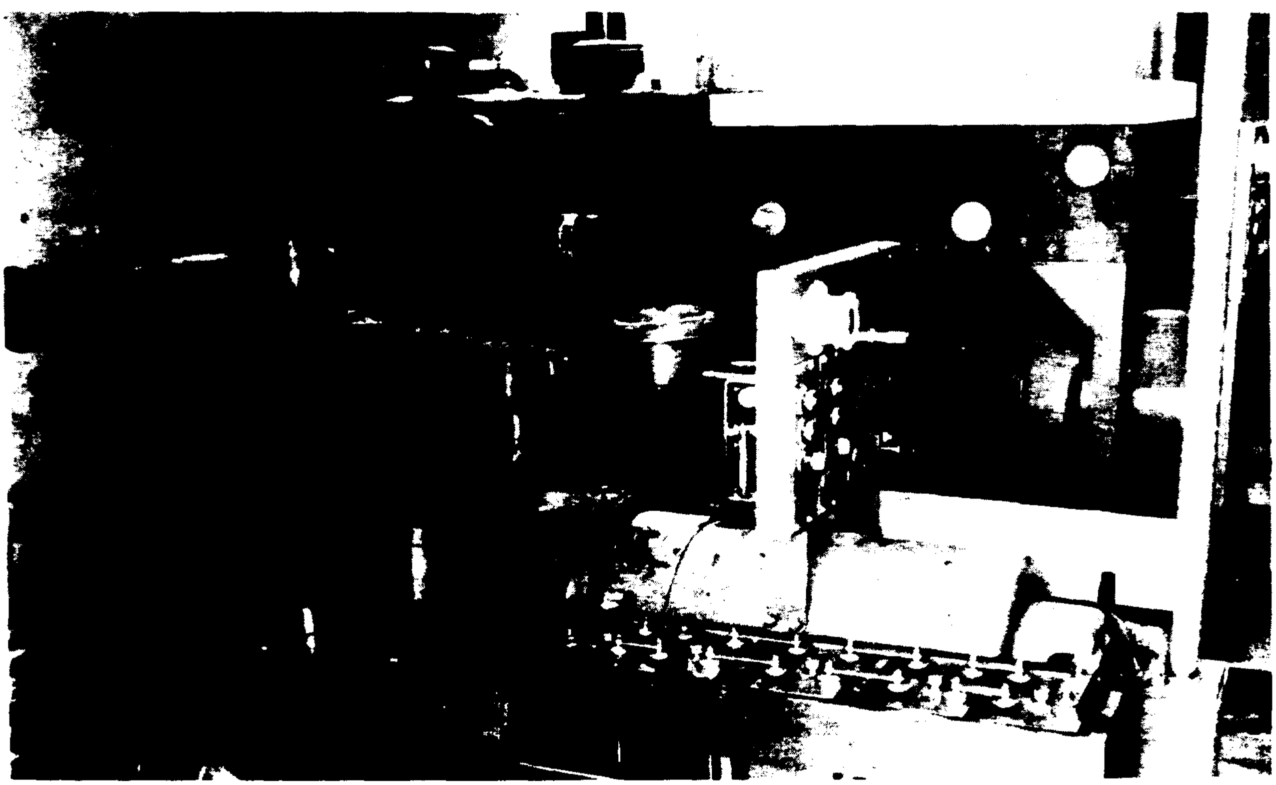


Figure 2-101. Station 2211 - Generator Installation

Figure 2-102. Station 2220.02

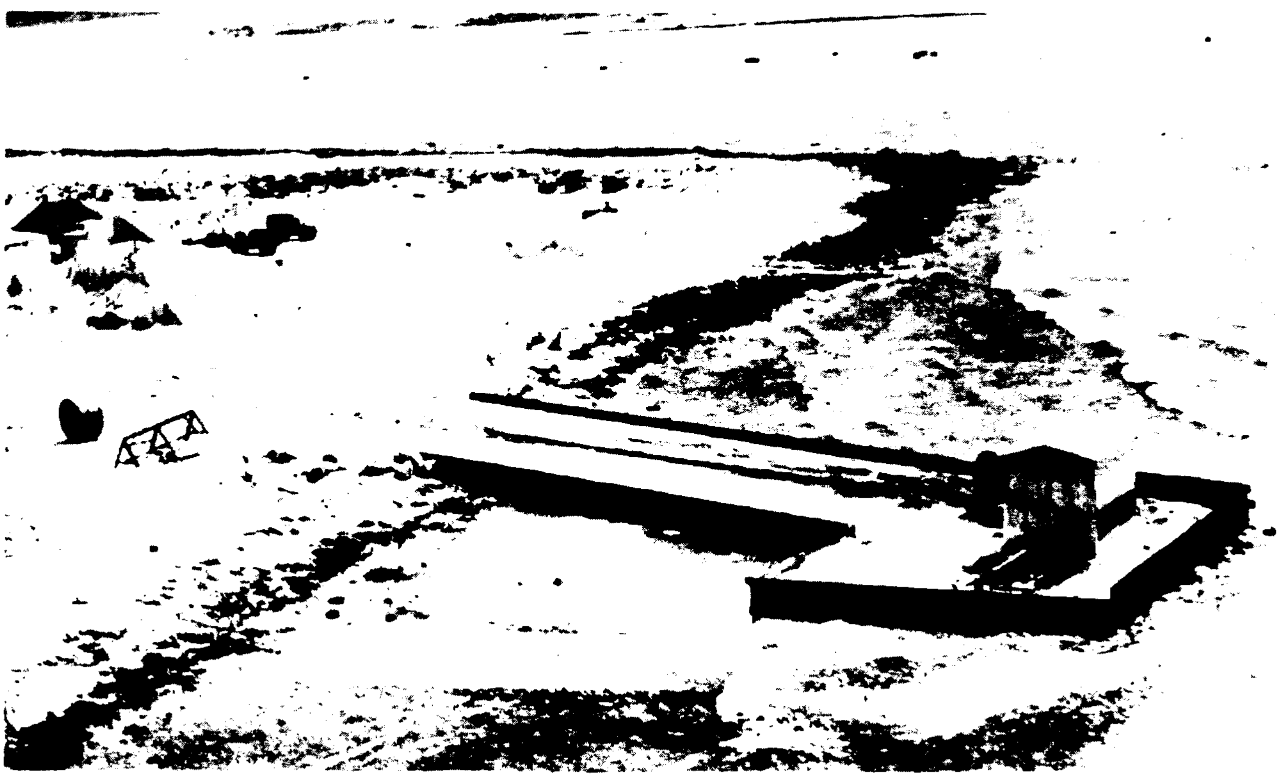


Figure 2-103. Station 2220.01 - 72% Complete

the foundation provided for securing the detectors. The foundations and pits were covered with a weather-proof enclosure made of light structural steel framing and corrugated aluminum sheeting and roofing. Located at the front of each foundation were four pipe support pedestals for carrying sight tubes. A causeway of standard Jobsite design, was constructed on the ocean side of the island in order to reach Station 2220.01. Station 2210 supplied the required 3 KW power. Sheeting and roofing were removed prior to and replaced after the Cherokee event.

STATIONS:	2221.01 thru 2221.04
PURPOSE:	Lead Detector Station
SITES:	Sally (2221.01 thru .03) Ruby (2221.04)
USER:	UCRL
PARTICIPATION:	1, 2, 3 and 4
CONSTRUCTION:	4-21-56/4-27-56

These stations were lead detector assemblies and appurtenances which were approximately 4′-4″ x 10′-4″ and 4′-8″ high containing a lead wall in the center and protected by a concrete box-like structure. Four collimator pipe supports were required for each station. Stations 2221.01, .02 and .03 at Sally were located on an existing concrete slab. To obtain the required elevation, it was necessary to remove some of the concrete and reinforcing from the slab. For Station 2221.04, Ruby, a two-foot retaining wall was required on the ocean side in order to hold the required sand cover. High tides undermined the backfill; consequently, riprap was placed 15 feet from the station. The windward side of each station was protected by a temporary wall approximately 16′ x 23′.

Two 2½″ conduits were run from Station 2201 to each detector of Stations 2221.01 thru 2221.03. Ten direct burial cables were run from Station 2221.04 to Station 2201. A 5 KW generator located adjacent to Station 2221.04 provided the instrument and utility power at this station. A total of 94 cubic yards of concrete was required.

STATION:	2231.02
PURPOSE:	Connector Pit
SITE:	Sally
USER:	UCRL
PARTICIPATION:	2
CONSTRUCTION:	11-4-55/12-24-55

This station was a coaxial cable connector pit of concrete construction and was 7′ x 8′ x 4′ deep with 11″-thick walls at the bottom tapering to 8″ walls at the top. It was provided with ladder rungs, a wooden cover, pull rings, two 5″ deep x 5′-6″ long slits at opposite ends, and was covered with earth fill. A total of six cubic yards of concrete was poured.

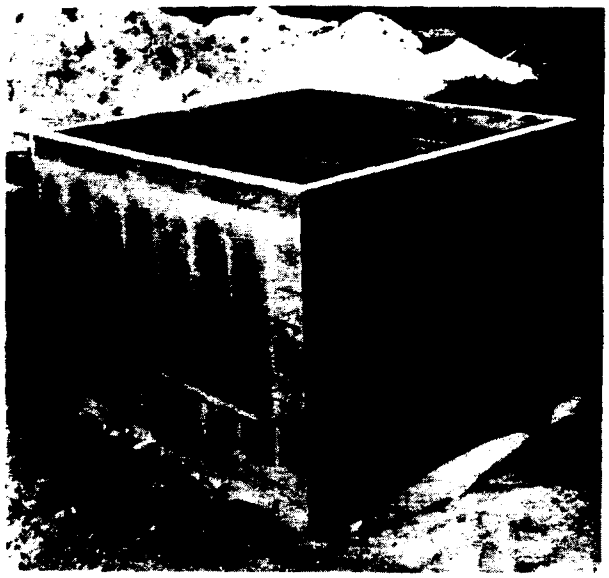


Figure 2-104. Station 2231.02 - 99% Complete

STATION:	2250
PURPOSE:	Concrete Collimators
SITE:	Tare
USER:	UCRL
PARTICIPATION:	22
CONSTRUCTION:	11-4-55/5-23-56
OCCUPANCY:	3-22-56

This station was a reinforced concrete collimating baffle 24′ wide, approximately 21½′ high and 2′-6″ thick, located 55′ east of the Station 22 working point. It contained three holes and one notch in the side for collimator sight tubes. These tubes were required to be accurately aligned with Station 22. Five 4″ conduits were run from Station 22 to the underside of Station 2250. A total of 76 cubic yards of concrete was poured with an average 28-day strength of 3050 psi.

STATIONS:	2251.01 and 2251.02
PURPOSE:	Collimator Towers
SITE:	Sally
USER:	UCRL
PARTICIPATION:	3
CONSTRUCTION:	12-1-55/3-28-56

These stations were steel towers prefabricated in sections then erected to support lead collimating discs on a platform approximately 8′ square. Station 2251.01 was 12.5′ high and Station 2251.02 was 32.6′ high; both were erected on concrete footings. Both towers were dismantled for the Stations 1 and 2 events, then re-erected for the Station 3 event. To ensure stability of the tower legs during dismantling and re-erection, a #11 rebar rod was welded from leg to leg at the base. The Contractor

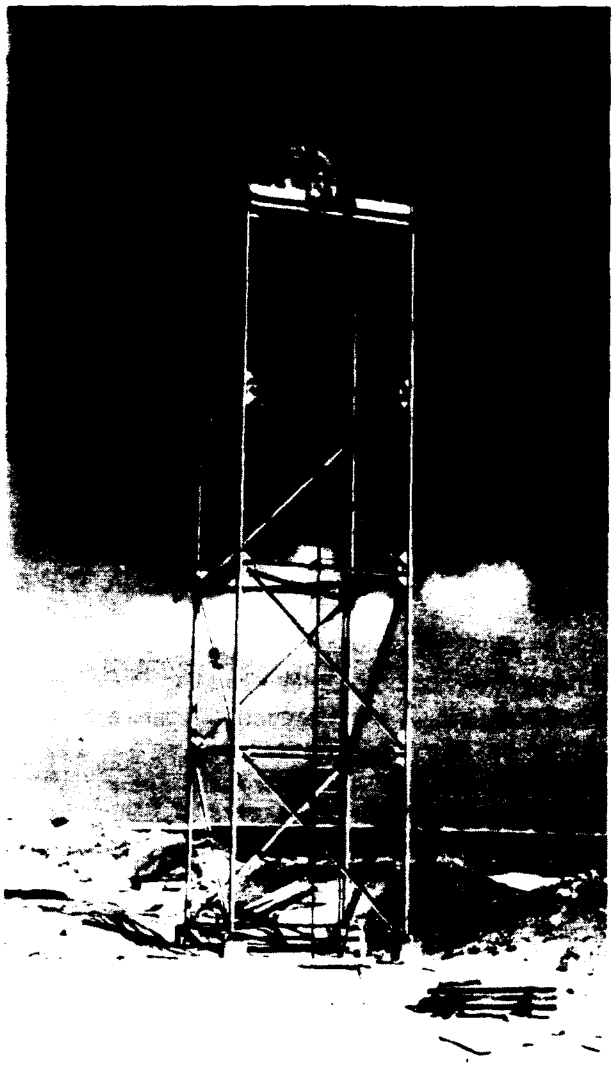


Figure 2-105. Station 2251.02

furnished the lead collimating discs and stands. The disc for Station 2251.01 was 64″ in diameter, 6″ thick, and contained a 6½″ diameter hole in the center. The disc for Station 2251.02 was 42″ in diameter, 6″ thick, and contained a 6¼″ diameter hole in the center. Twelve cubic yards of concrete were used.

STATIONS:	2260.01 thru .06
PURPOSE:	Concrete Collimators
SITES:	Tare, (2260.01 thru .04) Sugar, (2260.05 and .06)
USER:	UCRL
PARTICIPATION:	22
CONSTRUCTION:	11-4-55/5-24-56
OCCUPANCY:	3-22-56

These stations were reinforced concrete collimating baffles 15′ wide and 2′-6″ thick with heights determined by the required elevations at the top of the baffles. The elevations ranged from plus 18.0 feet for Station 2260.06 to plus 28.86 feet for Station 2260.01. The working points of the baffles were required to be at the center line and on the nearest face of Station 22. Station 2260.01 had two holes and the remaining stations had one hole. Forms for these stations were prefabricated at Nan. The footing excavations for Stations 2260.05 and 2260.06 contained as much as 18″ of water at high tide. In pouring these footings, the pour was started in one corner and continued progressively across the footing, thus forcing the water ahead of the concrete.

STATIONS:	2300 and 2301
PURPOSE:	Photo Bunkers
SITES:	Peter and Tilda
USER:	UCRL
PARTICIPATION:	3 and 22
CONSTRUCTION:	10-17-55/5-5-56
OCCUPANCY:	4-6-56

Existing CASTLE Stations 2300 and 2301 were modified and rehabilitated. A buttress was placed behind each structure to enable it to

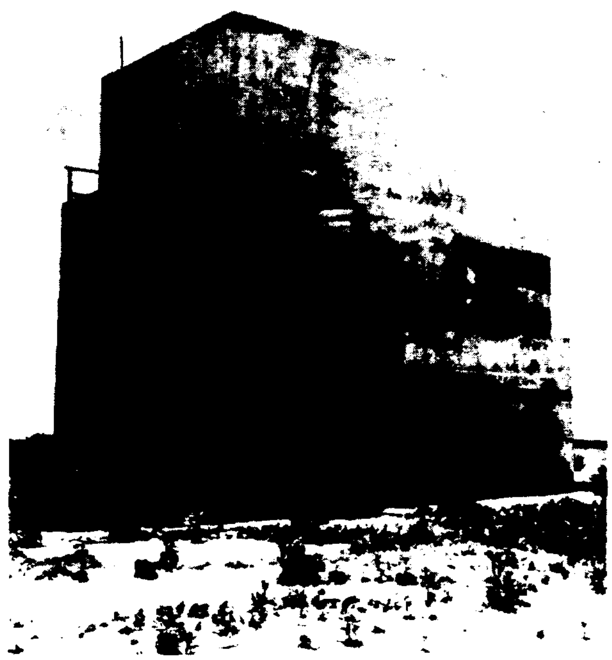


Figure 2-106. Station 2300
Before Modification

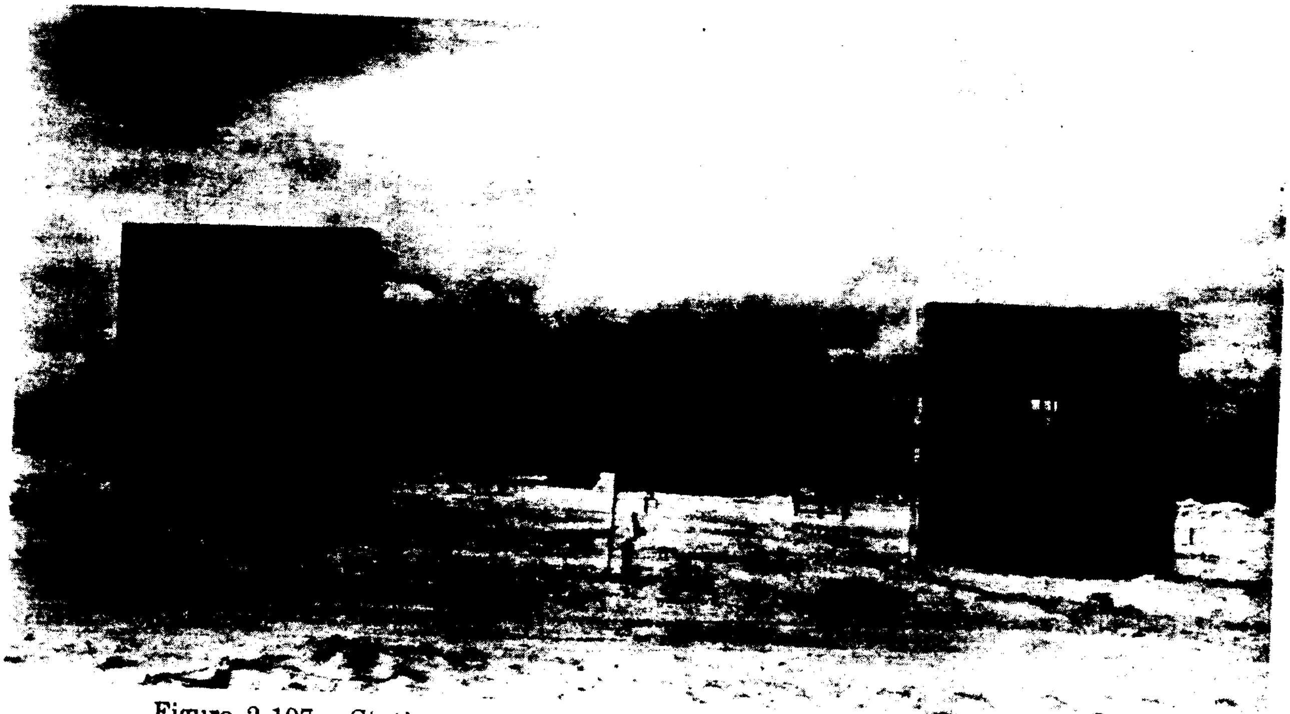


Figure 2-107. Stations 2260.01 (Left) - 2260.02 (Right) and 2250 (Center)

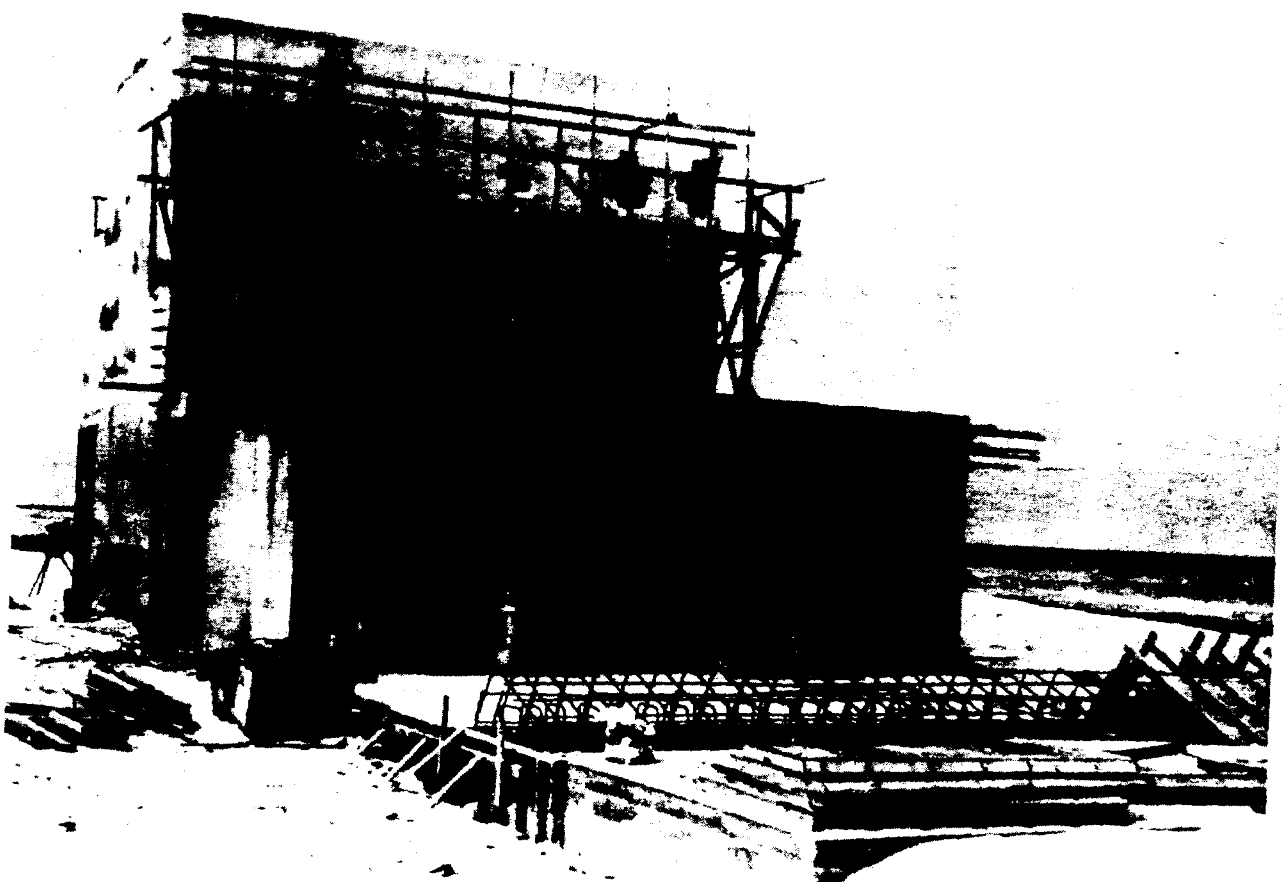


Figure 2-108. Station 2300 - 83% Complete

withstand expected overpressures. The buttress was formed of six concrete thrust blocks from which six 14-inch 142 #WF beams extended upward to the top of the wall. An equipment room of reinforced concrete 19′ x 32′ x 12′ high with 1′-6″ walls was added to each station. In this room was placed dehumidifying equipment, two generators, and a helium gas system using six User-supplied manifolds. The piping from helium bottles to manifolds was required to be approximately the same lengths, and criteria required that the leakage of helium not exceed 1 CFH of gas at standard pressures and temperatures during a 24-hour period.

It was necessary to remove the old wiring and pull new wires. Holes were drilled through the heavy existing east wall for running hydraulic and electrical connections between existing structure and the new equipment room. A plywood dust cover was fitted in the chimney of the existing structure with removable plywood covers at one end of the dust cover to provide access. Two ¼-ton electric hoists were mounted: one on the boom above the entrance to the station, the other above the hatch between Rooms 1 and 2. New door latch assemblies were designed, fabricated, and installed for the blast doors of the 24′ wide camera port. New type latches were required so that the blast doors would be gas-tight when closed. Work benches, access ladders and stairways, storage shelves, fuel tanks, compressed air systems for blast door operation, and salt water pumps were also required.

Power for Station 2300 was furnished by two - 35 KW generators installed in the equipment room. Power for Station 2301 was furnished from the island distribution system through a 35 KVA transformer installed in the equipment room. Sixteen-pair timing signals were terminated in Station 2300 and six pair terminated in 2301. A telephone with an extension to a trailer was provided at each station.

In Station 2301 there was a noticeable amount of spalling of the existing limonite caused by oxidation of the metal pellets. All such loose material was chipped out and the affected surface was treated with a coat of bitumastic for waterproofing. Completion of these stations was somewhat delayed because of late equipment delivery.

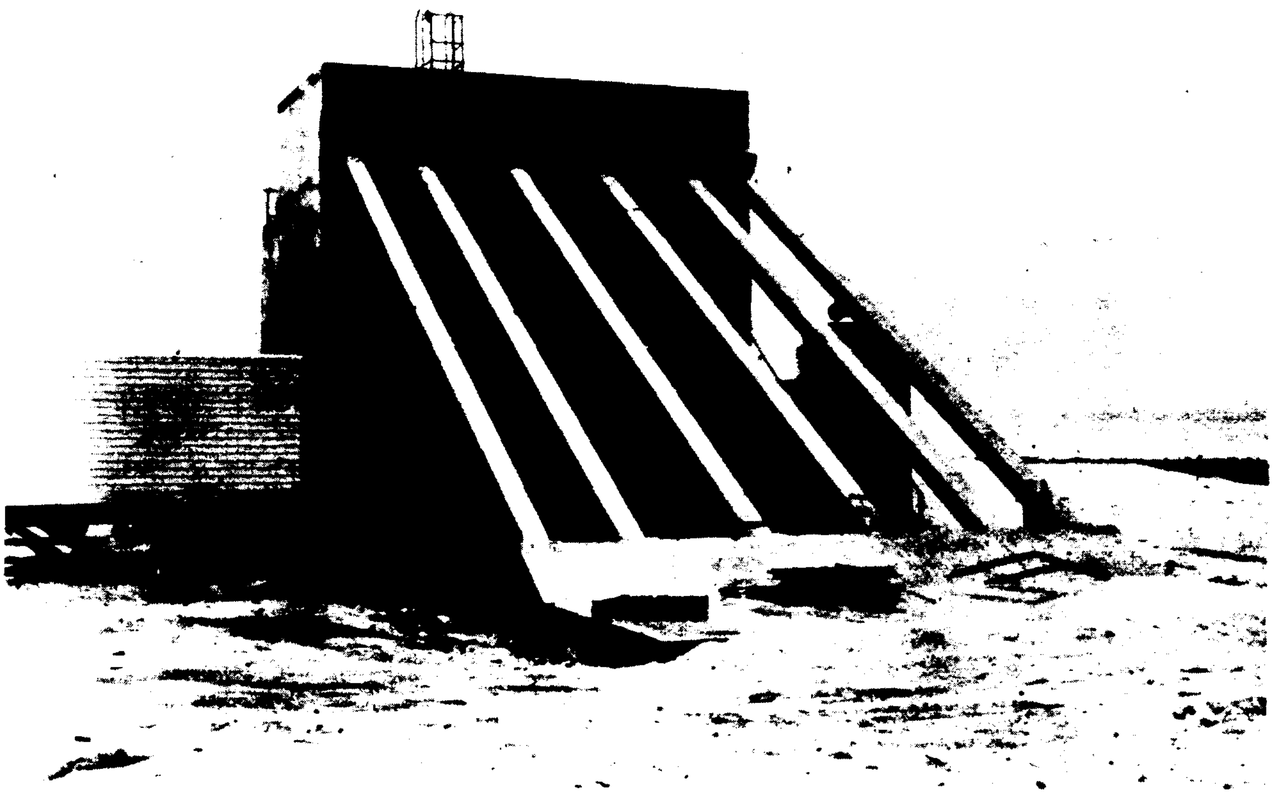


Figure 2-109. Station 2300

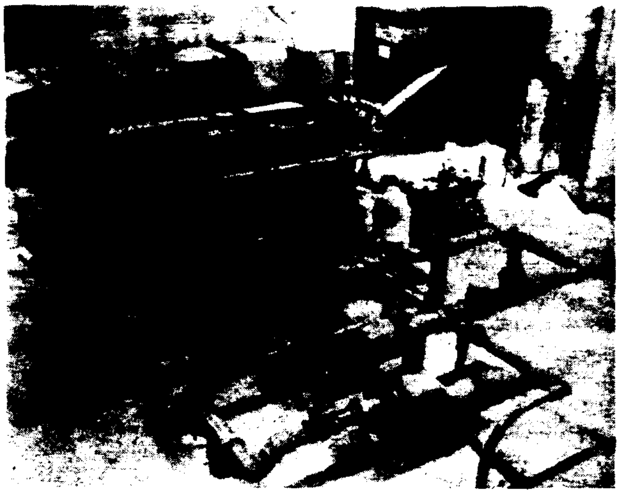


Figure 2-110. Station 2301 Equipment Room

STATION: 2310
PURPOSE: Vacuum Pipe Array
SITE: Tare
USER: UCRL
PARTICIPATION: 22
CONSTRUCTION: 1-24-56/5-24-56
OCCUPANCY: 4-4-56

Station 2310 consisted of the following: two 300-foot vacuum pipes which emanated from the front wall of Station 22; a mirror house at which the 300-foot pipes terminated; four vacuum pipes with approximate lengths of 81′, 72′, 63′ and 54′ which emanated from the north wing wall of Station 22; and four mirror houses at which the four vacuum pipe array terminated.

Figure 2-111. Station 2310

The 300-foot vacuum pipes consisted of 4", 8" and 12"-diameter thin wall steel pipe, supported and braced in Station 22 by a steel column, hangers at the front wall of Station 22, and 14 steel H-frame supports. Provisions were made in the support system to resist the lateral thrust of the vacuum pipes, to allow for longitudinal movement by use of expansion bellows, and for horizontal and vertical adjustment of the pipes. The approximate size of the supports was 17' high by 10' wide. On the side of and about midway along the pipe lengths, a concrete base and wood shelter were provided for two vacuum pumps.

The mirror house for the 300-foot array was a plywood structure approximately 12'-8" x 14'-8" and 9'-4" high at the front and sloping to 8'-4" at the rear wall. The front of the mirror house contained two 16"-diameter ports with a 16"-diameter 4-foot long sheet metal tube in each. A steel mirror support extended from the ground and through the floor which was braced with a cross beam at elevation plus 22.92 feet. The mirror house also contained two structural supports for two 565-pound User-furnished lead pipes 18" in diameter and 24 feet long which were located directly behind the port holes in the face of the building.

The second pipe array consisted of 8"-diameter pipes supported by seven steel H-frame supports. Provisions were also made for the lateral thrust and for vertical and horizontal adjustment. An elevated wooden platform 10'-6" x 6' and 9' high and a 4' x 4' x 4' concrete block were provided for vacuum pumps.

The four mirror houses were of plywood construction with dimensions as follows:

(A) 12'-4" x 5'-6" x 7'-0"- high;

(B) 5'-0" x 4' x 7'-0" high;

(C) 5'-0" x 4'-6" x 7'-0" high;

(D) 5'-0" x 4'-6" x 7'-0" high.

The front of each mirror house contained a 10"-diameter port in which a 10"-diameter 2' long sheet-metal tube was located. Extending from the ground and through the floor of each mirror house was an 8"-diameter steel mirror support topped with an 8" standard steel flange. The required elevation at the top of the mirror support was 23.00 feet plus or minus ½". The mirror supports were encased by 12"-diameter steel pipe which acted as a sun shield and thereby reduced expansion. The surfaces of all mirror houses facing Station 2300 were painted black.

Power was supplied from Station 22. No timing signals were required. A total of 60 cubic yards of concrete was poured with an average 28-day strength of 3750 psi.

STATION:	2311
PURPOSE:	Photo Pipe Array
SITE:	Ruby
USER:	UCRL
PARTICIPATION:	3
CONSTRUCTION:	2-27-56/5-28-56

This station consisted of three 8"-diameter pipes forming a vacuum pipe array which extended from the cab of 300-foot tower Station 3 to a steel grate platform located at the 262.5-foot level of the tower. A 2' x 4' x 4'-6" opening was made in the floor of the cab and angles were welded across the opening for securing the pipes at this level. Pipe supports were also provided at the 287.5 and 275-foot levels. The platform was prefabricated and designed to withstand a load of 60 psf. A pipe support was provided about 4 feet above the platform. The pipes were installed in approximate positions during May; the balance of the equipment was not installed until late June because of prior events. A safety railing was installed on the platform with access provided from the elevator or foot ladder. The pipes and pumps were User-furnished and Contractor-installed. A clear line of sight was required from mirrors at the bottom ends of the pipe to Station 2301. Power requirements were 10 KW for instruments and 10 KW for utilities and were furnished from two panels located in the cab of tower Station 3.

STATIONS:	2320.01 thru 2320.10
PURPOSE:	Fluor Station
SITE:	Tare
USER:	UCRL
PARTICIPATION:	22
CONSTRUCTION:	1-18-56/6-6-56

These stations were billboard-type structures 16' long, 8' high and mounted so that the intersections of their center lines were at an elevation of 16 feet. The stations were wood framed, set on concrete foundations, and covered with plywood, the faces of which were covered with flat black paint. Receptacles were provided for connecting the User-furnished fluors.

STATION:	2321
PURPOSE:	Plywood Fluor Billboard
SITE:	Ruby
USER:	UCRL
PARTICIPATION:	3
CONSTRUCTION:	4-20-56/5-16-56

This station consisted of 13'-wide structural steel platforms built on the elevator side of tower Station 3 and extending across one side of the

Figure 2-112. Station 2320 Series

tower at levels of 25′, 150′, 175′, 200′, 225′, 262.5′, 275′ and 287.5′. User-furnished fluors and power receptacles were installed on four of the platforms. The User-furnished and installed a mirror at the 200-foot level. Plywood panels 8′ x 8′ painted black were erected in back of the fluors and mirror. Access to each platform was provided through the elevator and a ladder. Electrical power was supplied by the island system via a panel located in the tower cab.

STATION:	3010
PURPOSE:	Fireball Study
SITE:	Tilda
USER:	DOD-30
PARTICIPATION:	1 and 2
CONSTRUCTION:	1-18-56/5-1-56

Station 3010 was a reinforced concrete structure 5′ x 6′ x 7′ high, inside dimensions. The building was covered with earth over the roof except at the front and rear walls. The rear wall contained viewing ports which were oriented on the Stations 1 and 2 cabs. The User furnished a 3½ KW generator. Minus 45 minutes and minus 1 second timing signals were required. A total of 60 cubic yards of concrete was poured for this station.

STATION:	3011
PURPOSE:	Fireball Study
SITE:	Sally
USER:	DOD-30
PARTICIPATION:	1
CONSTRUCTION:	11-8-55/4-30-56

This station consisted of a 12-inch diameter schedule 160 steel pipe extending from the base of a steel recording shelter to a point 10 feet from the underside of the Station 1 cab floor. The steel shelter was embedded in a 24′ x 24′ x 11′-thick concrete slab which provided footings for the tower and an elevator pit for Station 1. The pipe contained 15 instrument gages along its length. The instruments were wired to a recorder in the steel shelter at the tower base. Grout was required inside the pipe and the conduit carrying the instrument wiring was filled with insulating material. Steel access platforms were installed at seven locations along the pipes. A 25′ x 25′ area of rock 2 feet deep was placed over the top of the shelter to deflect and absorb blast waves. No power was required. Minus 1 minute and minus 15 seconds timing signals were furnished.

STATIONS:	3012.01 and 3012.02
PURPOSE:	Fireball Study
SITE:	Sally
USER:	DOD-30
PARTICIPATION:	1 and 2
CONSTRUCTION:	4-12-56/5-13-56

These stations were two User-furnished 75-mm recoilless rifles mounted on the roofs of Stations 1 and 2 and aimed to fire down at Stations 3013.01 thru 3013.03 which were located on the sides of the towers at the 175′ and 275′ levels. Power consisted of 1 KW, 110-volt, single-phase. Timing signals of minus 15 minutes, minus 5 minutes, and minus ½ second plus 1 millisecond were required.

STATIONS:	3013.01 thru 3013.03
PURPOSE:	75-MM Projectile Catchers
SITE:	Sally
USER:	DOD-30
PARTICIPATION:	1 and 2
CONSTRUCTION:	5-20-56/5-22-56

These stations were projectile catchers weighing approximately 2400 pounds each. Station 3013.01 was mounted on structural steel brackets at the 175-foot level of Station 2, Station 3013.02 was at the 275-foot level, and Station 3013.03 at the 175-foot level of Station 1. No power or timing signals were required.

STATIONS:	3014.01 and 3014.02
PURPOSE:	Projectile Catcher Basins
SITE:	Sally
USER:	UCRL
PARTICIPATION:	1 and 2
CONSTRUCTION:	4-2-56/5-23-56

These stations were concrete basins filled with water to catch the 75-mm projectiles fired from towers 1 and 2. Station 3014.01 was 10′ x 30′ x 6′ deep and Station 3014.02 was 10′ x 47′ x 6′ to 9′ deep. The stations were located at the foot of each tower. No power or timing signals were required. A total of 79 cubic yards of concrete was poured.

STATION:	3020
PURPOSE:	Recording Shelter
SITE:	Yvonne
USER:	30.2 (Sandia Corp.)
PARTICIPATION:	24
CONSTRUCTION:	1-3-56/4-28-56

Station 3020 was a reinforced concrete structure with inside dimensions of 10′ x 28′ x 7′-6″ high, and with 4′-thick walls and tapered wing walls on each side of the entrance. The station was covered with approximately 3 feet of earth with a 2:1 side slope. An area for batteries was provided. Unistruts located in the ceiling and walls secured the User equipment. A 16′ x 16′ tent was located nearby for project use. Power was supplied from the main island powerhouse to a substation outside of Station 3020 through a 100-amp, 3-phase oil fuse cut-out. Minus 45 minutes, 15 minutes, 1 minute, minus 15 seconds, and zero test signals were required. A total of 365 cubic yards of concrete was used which had an average 28-day cylinder break of 3,735 psi.

Figure 2-113. Station 3020 - 85% Complete

STATIONS:	3021, 3022, 3023 and 3024
PURPOSE:	Vulnerability Test
SITE:	Yvonne
USER:	30.2 (Sandia Corp.)
PARTICIPATION:	24
CONSTRUCTION:	2-10-56/4-19-56

These stations each consisted of two standard 5-inch pipes approximately 10 feet long embedded in 4′ x 4′ x 4′-4″ deep concrete footings and guyed with two ⅞-inch steel rods which were embedded in 4′ x 4′ x 3′ concrete anchor blocks. The rods were designed to give way upon the arrival of the shock wave. Between each pair of pipe towers, the User suspended a large device on cable which was designed to slip off of the pipe column tops when the shock wave arrived. Pipe gage mount towers with User-furnished gages were used in connection with these stations. Stations 3022, 3023 and 3024 had minus 45 minutes, 15 minutes, 1 minute, and minus 15 seconds timing signals. No signals were provided at Station 3021, and no power was required for any of these stations. Eighteen yards of concrete were used in Station 3021 and a total of 86 cubic yards was used in Stations 3022 thru 3024.

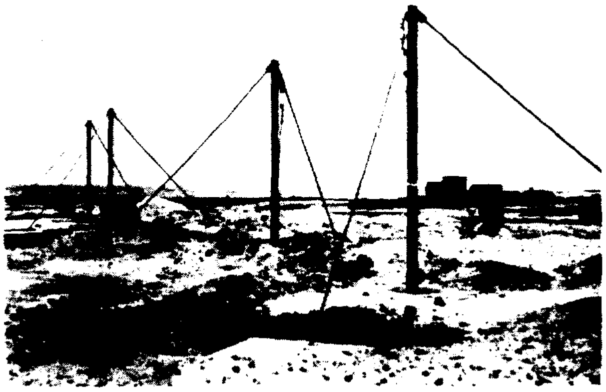


Figure 2-114. Station 3021 - 95% Complete

STATION: 3025
PURPOSE: Antenna Array
SITE: Elmer
USER: 30.2 (Sandia Corp.)
PARTICIPATION: 24

This station consisted of a standard floor flange on one leg of existing tower Station 1518; one 37 conductor cable and five ½-inch coaxial cables extended from this location to a trailer on the ground. A User-furnished antenna array was installed on the floor flange at the 85-foot level of the tower. Power requirements were 3 KW, 110/208-volt, 3-phase.

STATION: 3110
PURPOSE: Microbarograph Station
SITE: Oboe
USER: 31.1 (Sandia Corp.)
PARTICIPATION: All Bikini Events
CONSTRUCTION: 4-6-56/4-27-56

Station 3110 consisted of rehabilitating CASTLE Station 102 and installing a User-furnished 3½ KW generator.

STATION: 3111
PURPOSE: Microbarograph Station
SITE: Fred
USER: 31.1 (Sandia Corp.)
PARTICIPATION: All Eniwetok Events
CONSTRUCTION: 3-12-56/4-10-56

This station was two User-installed units placed one mile apart on the ocean side of Fred. A User-furnished direct burial signal cable was laid underground between the two units. An 8-man tent was erected which contained four center lights, full length work benches, and four duplex outlets with romex wiring at each side.

STATIONS: 3112.01 thru 3112.03
PURPOSE: Microbarograph Stations
SITES: Rongerik, Wotho and Ujelang Atolls
USER: 31.1 (Sandia Corp.)
PARTICIPATION: All

These stations were 8-man tents, one each at the above three Atolls. User-furnished cable was run in two directions on the ground from the User-furnished recording equipment in the tents to the detector heads.

STATIONS: 7411.01 thru 7411.09, 7412 and 7413
PURPOSE: Air Target Lights
SITES: Sally, Ruby, Pearl, Janet, Yvonne, Irene, Tare and Charlie
USER: TU 7.4
PARTICIPATION: 1 thru 7, 18, 19, 22 thru 24
CONSTRUCTION: 4-15-56/6-6-56

These stations were ground target lights forming a cross with each leg 400 feet long and 90 degrees apart. Three 150-watt spotlight lamps were placed on a wooden base on the ground and spaced at 50′ centers along each leg of the cross. A User-furnished radar reflector was installed near the center of each target array. Stations 7412 and 7413 were identical to the 7411 series except that each station contained a spotlight board at the target center and Station 7413 was 270 feet long on each leg. Power for all stations was furnished from each island supply by using a 9 KVA transformer, with the exception of Stations 7411.09 and 7412 which required a 10 KW engine generator. Timing signals turned off the lights at minus 5 seconds. A total of 3 cubic yards of concrete was poured for Stations 7411.01 thru .09 and Station 7412.

STATIONS: 7414.01 thru 7414.04
PURPOSE: Air Target Light Arrays
SITES: Zero Barges
USER: TU-4
PARTICIPATION: 10 thru 15
CONSTRUCTION: 5-1-56/6-25-56

These stations were twenty-six 150-watt flood lamps spaced evenly around the perimeter of the wooden handrail atop each barge station roof. In addition, a 10-foot high steel pipe was installed to support a User-furnished rotating beacon light. A User-furnished radar reflector was installed behind the target lights on a small roof deck of the barge. Power was supplied from the barge generators.

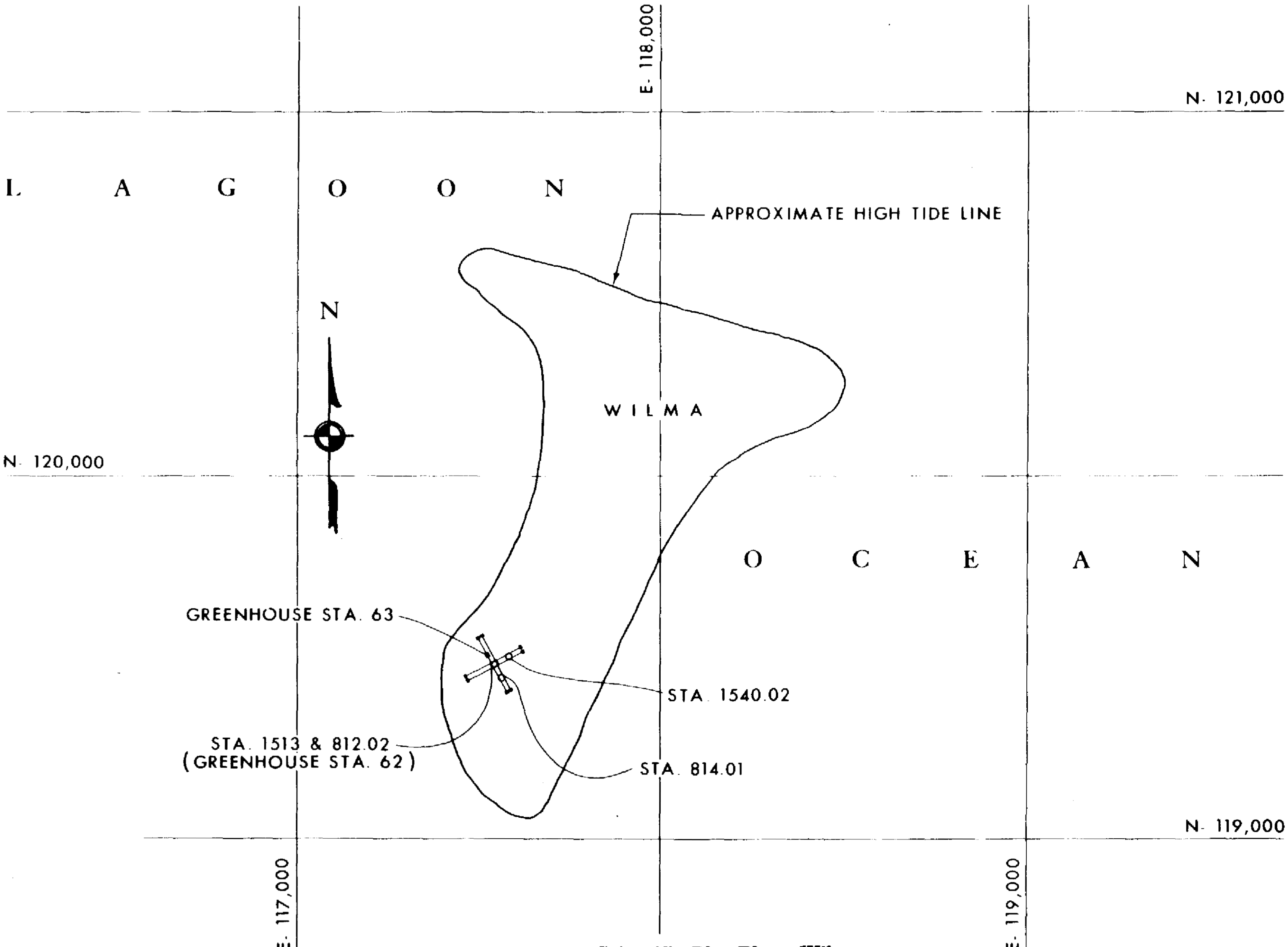
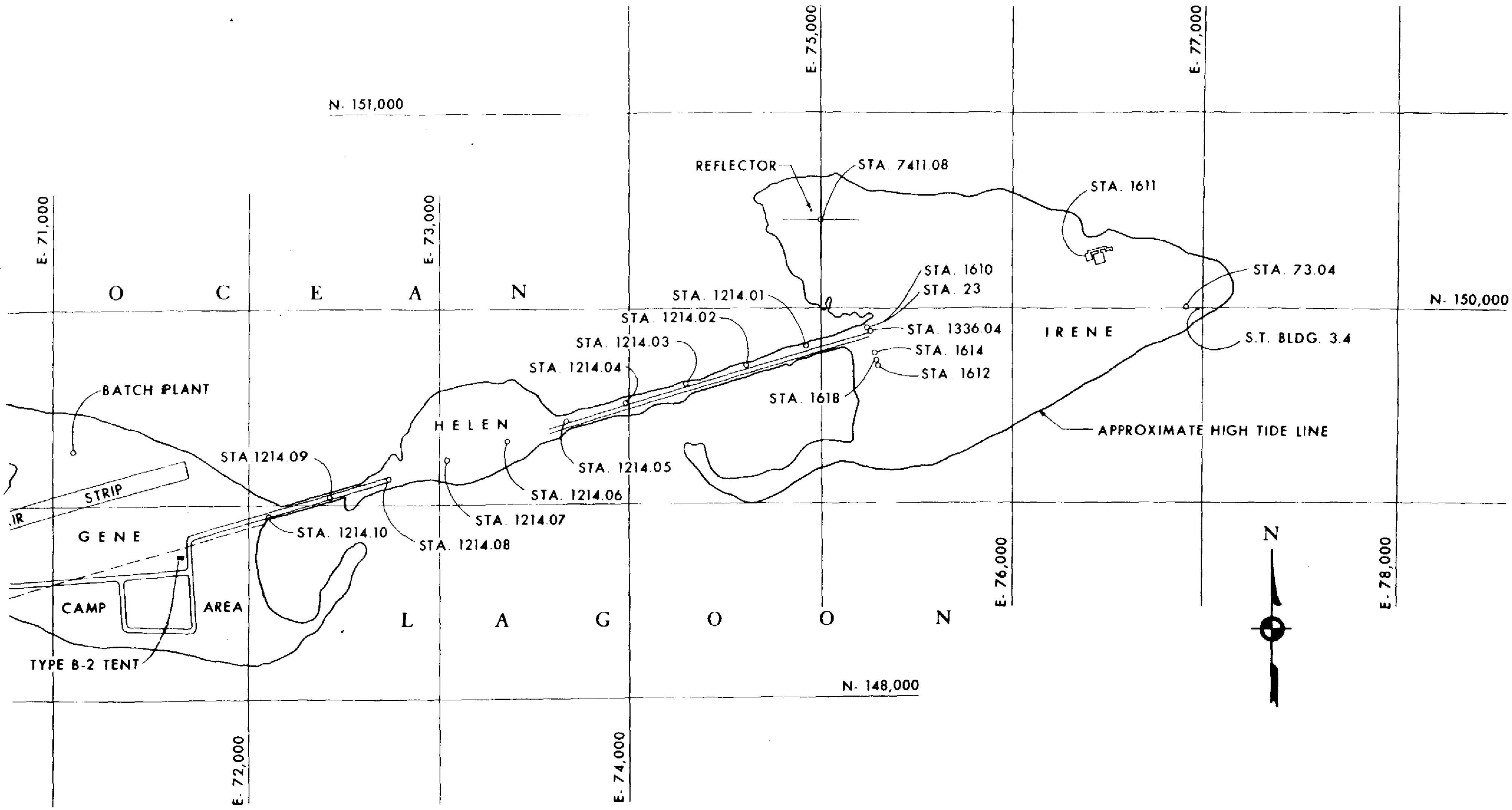


Figure 2-115. Scientific Plot Plan - Wilma



ıtific Plot Plan - Gene, Helen, Irene

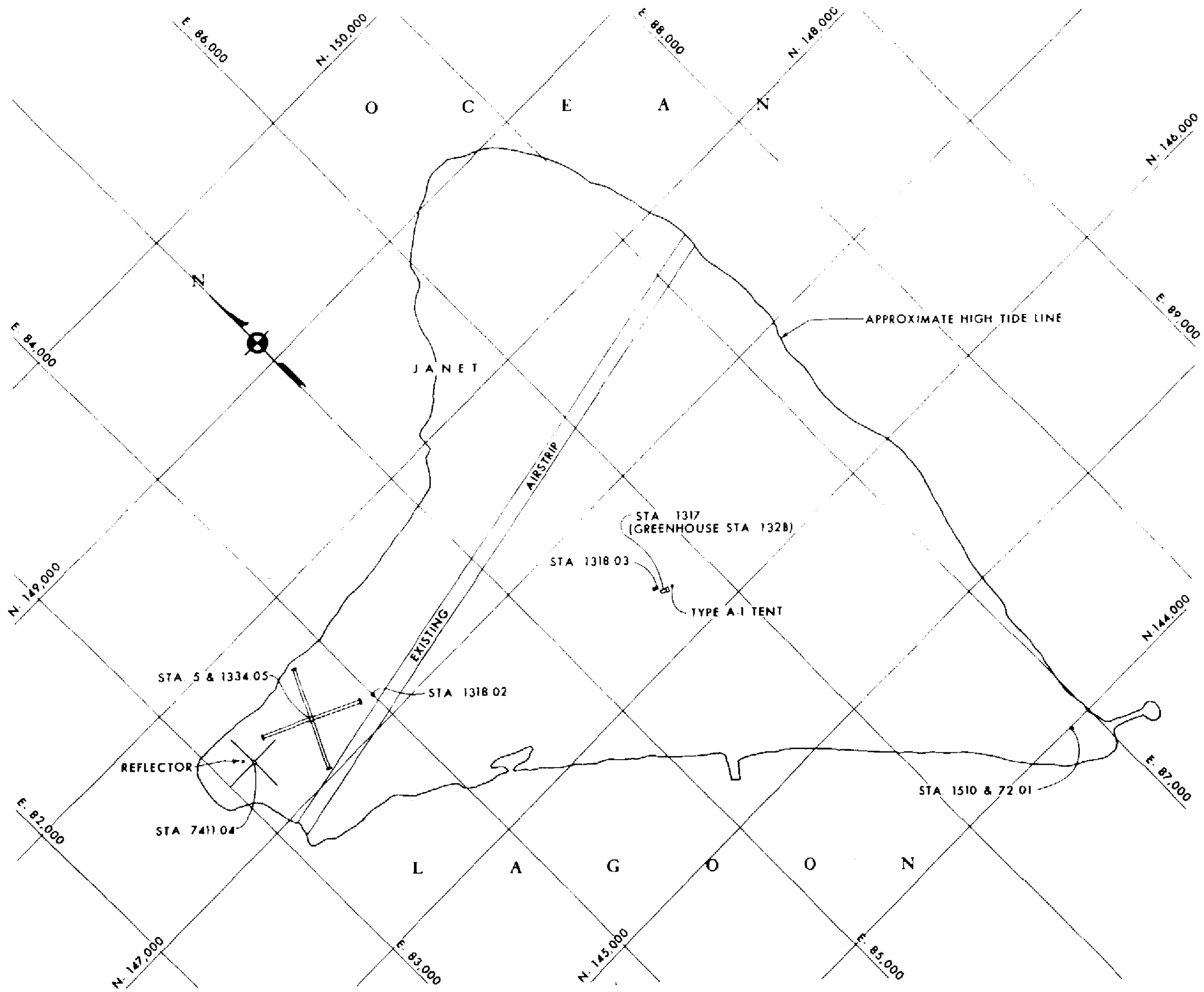


Figure 2-117. Scientific Plot Plan - Janet

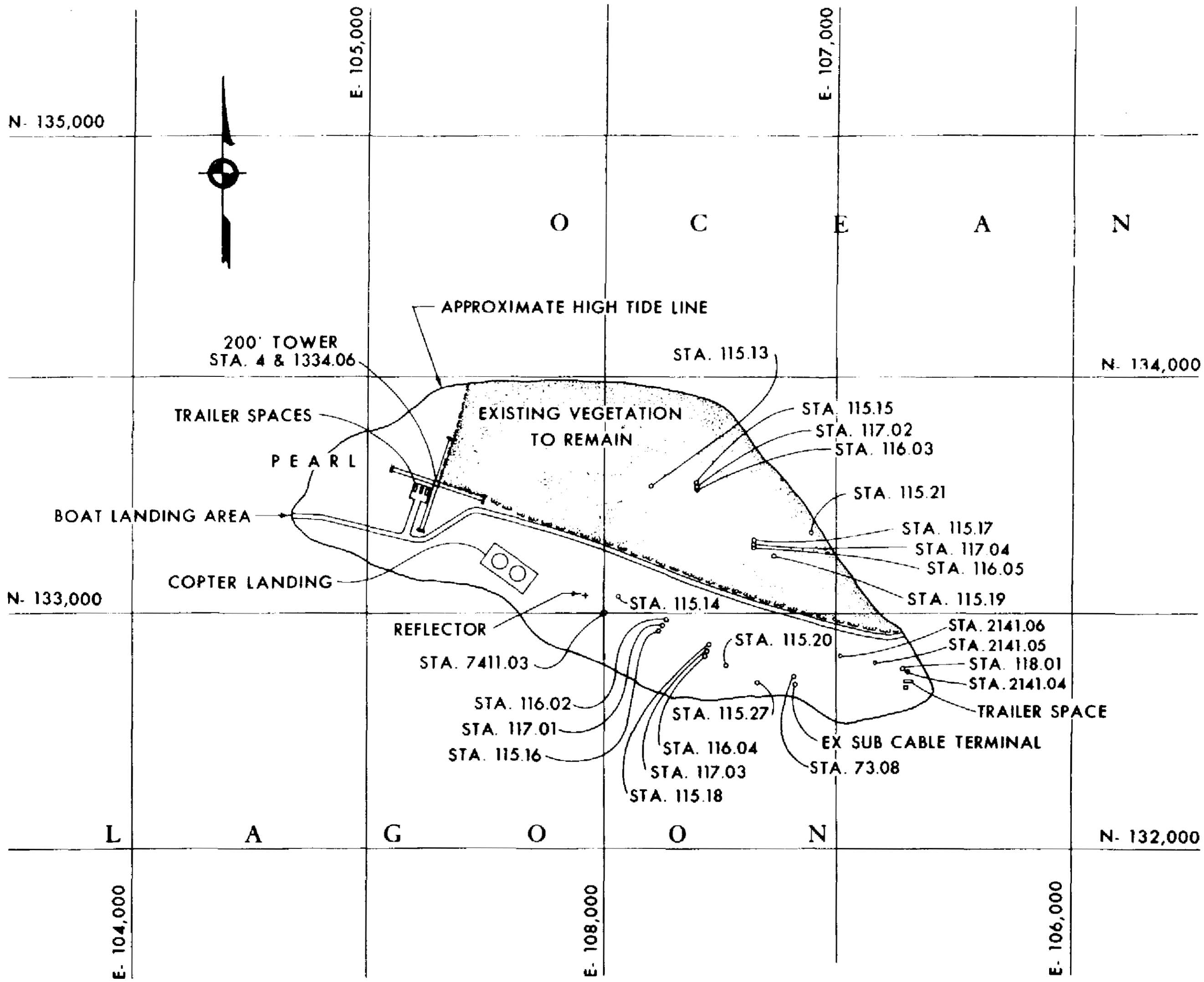
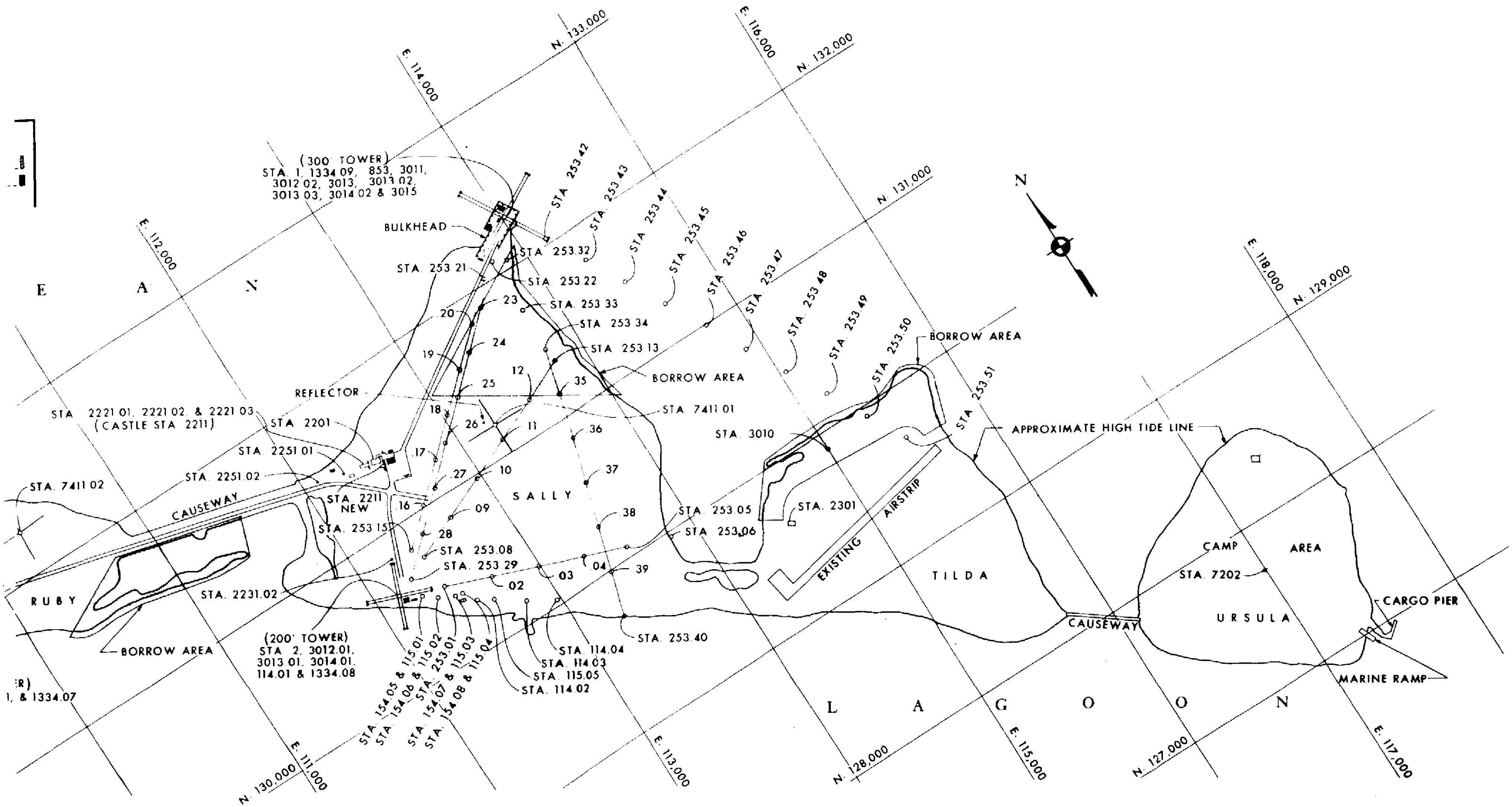
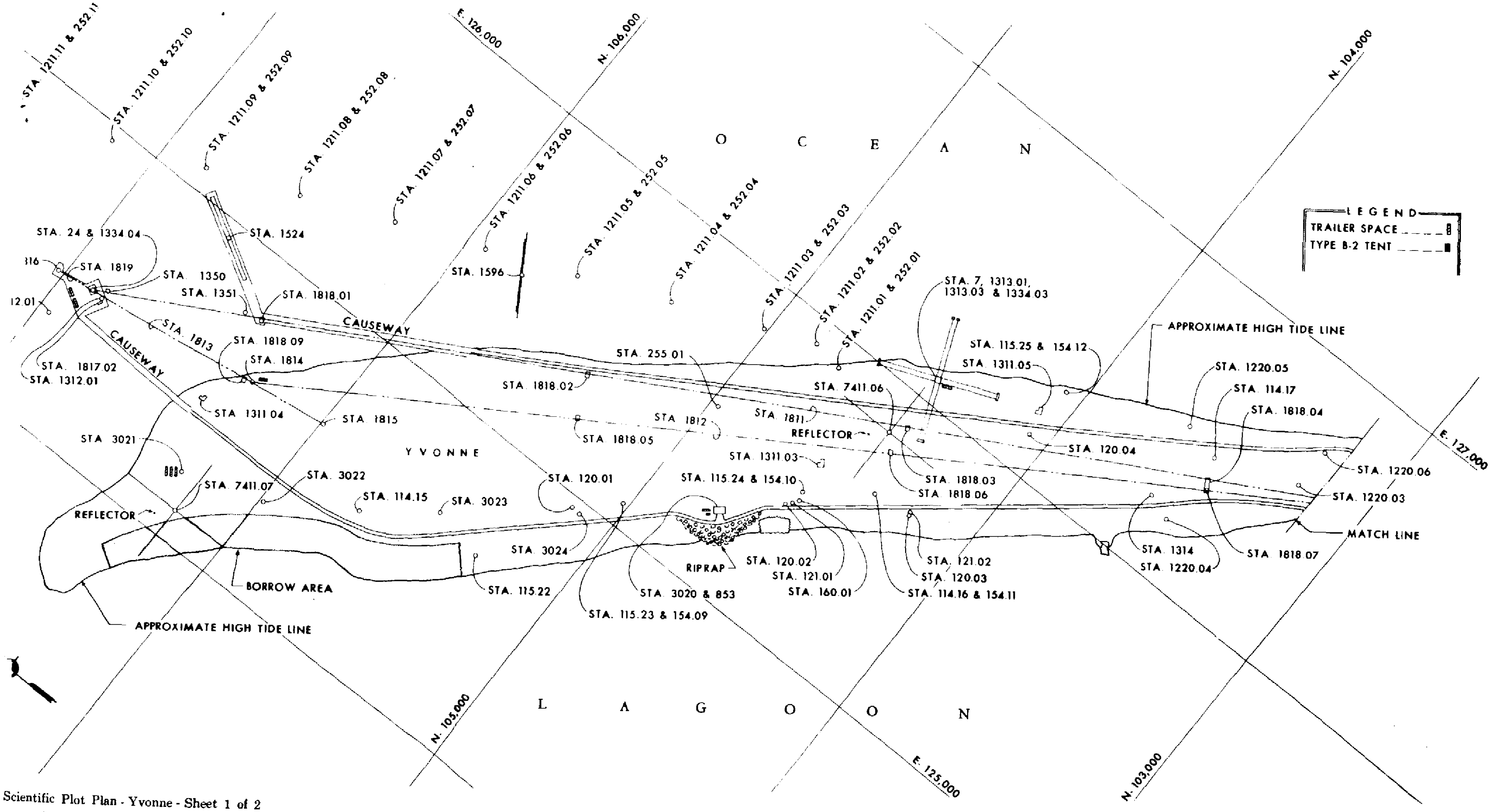


Figure 2-118. Scientific Plot Plan - Pearl

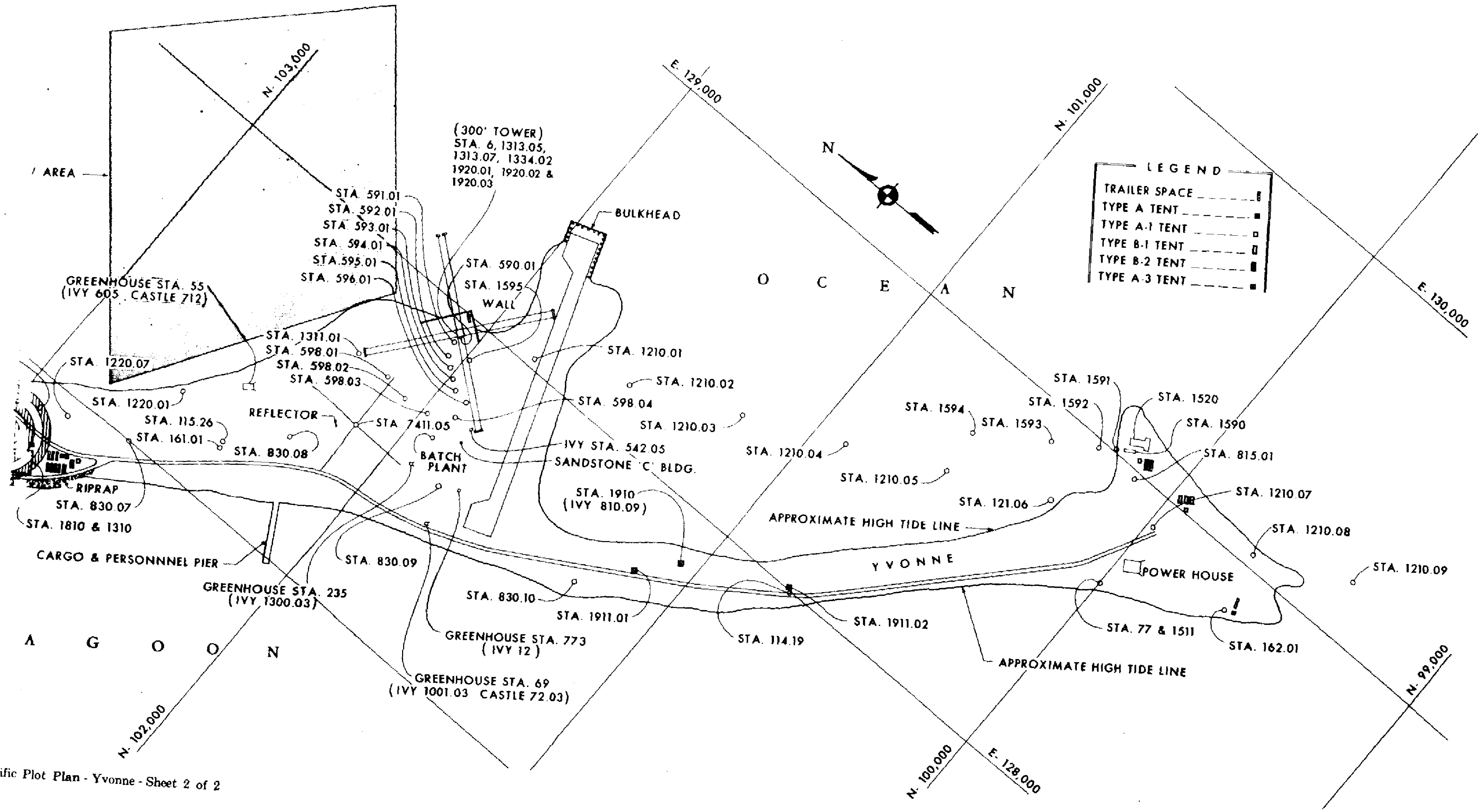


Plan - Ursula Complex

[redacted]



Scientific Plot Plan - Yvonne - Sheet 1 of 2



tific Plot Plan - Yvonne - Sheet 2 of 2

[redacted]

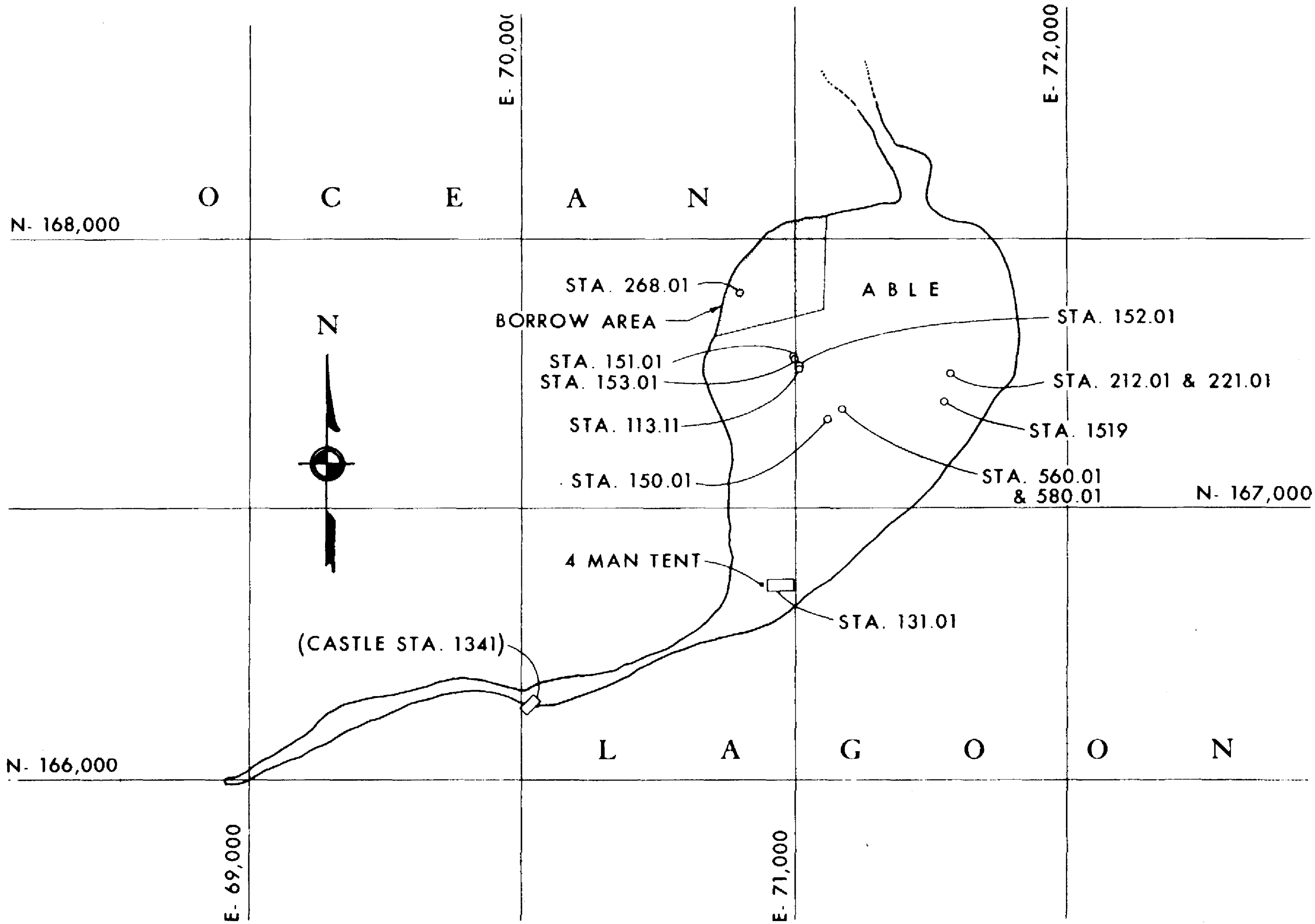


Figure 2-121. Scientific Plot Plan - Able

93

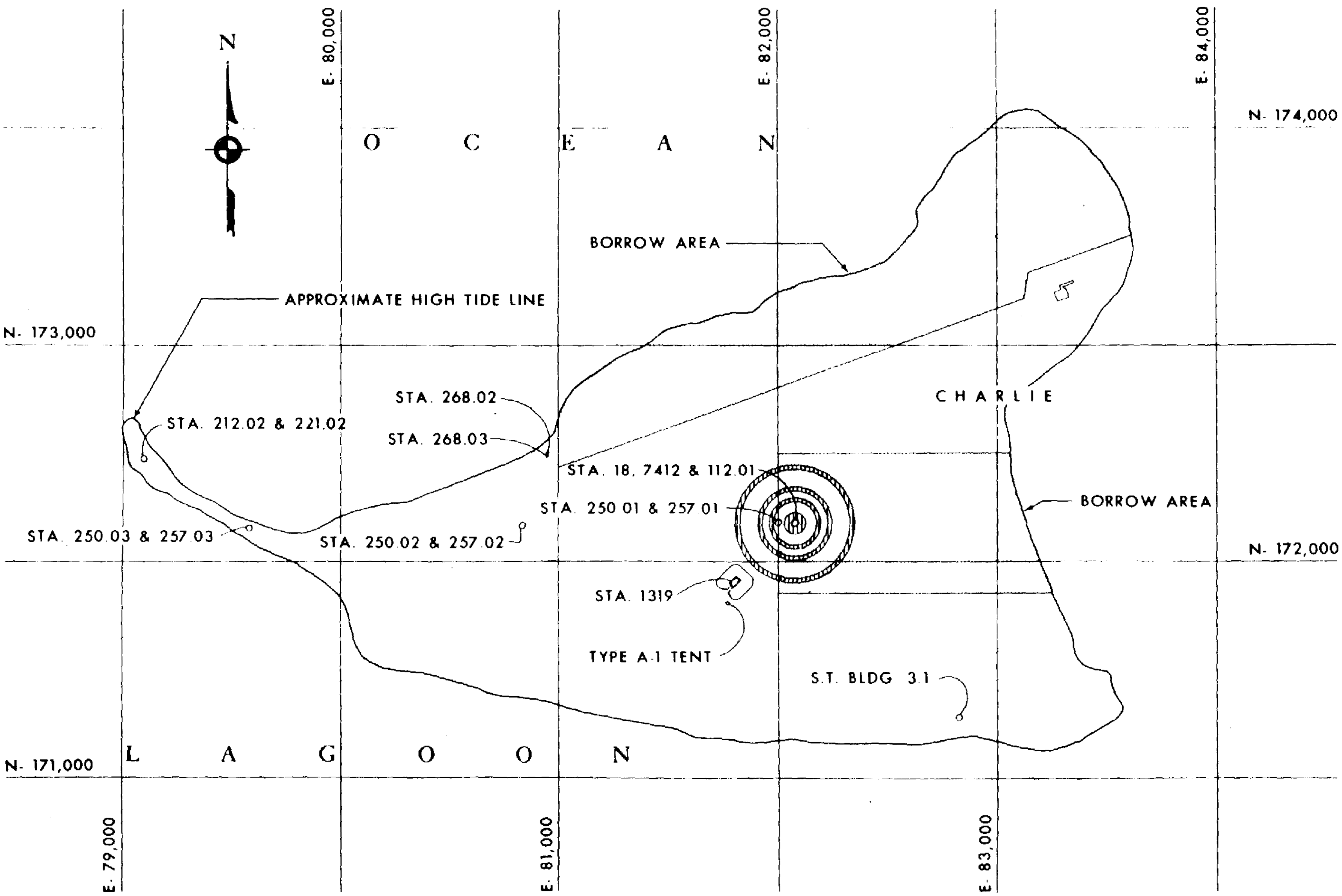


Figure 2-122. Scientific Plot Plan - Charlie

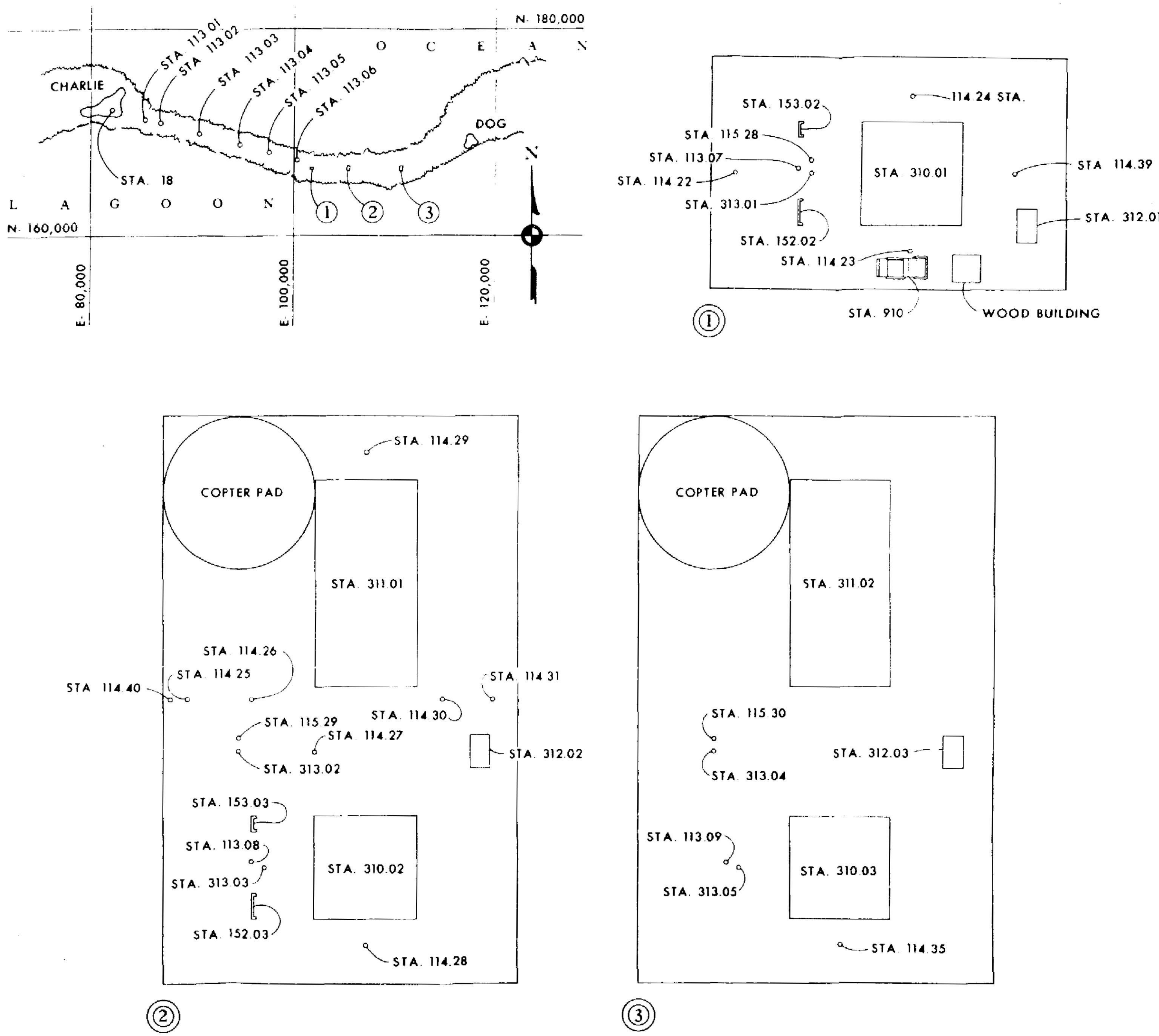
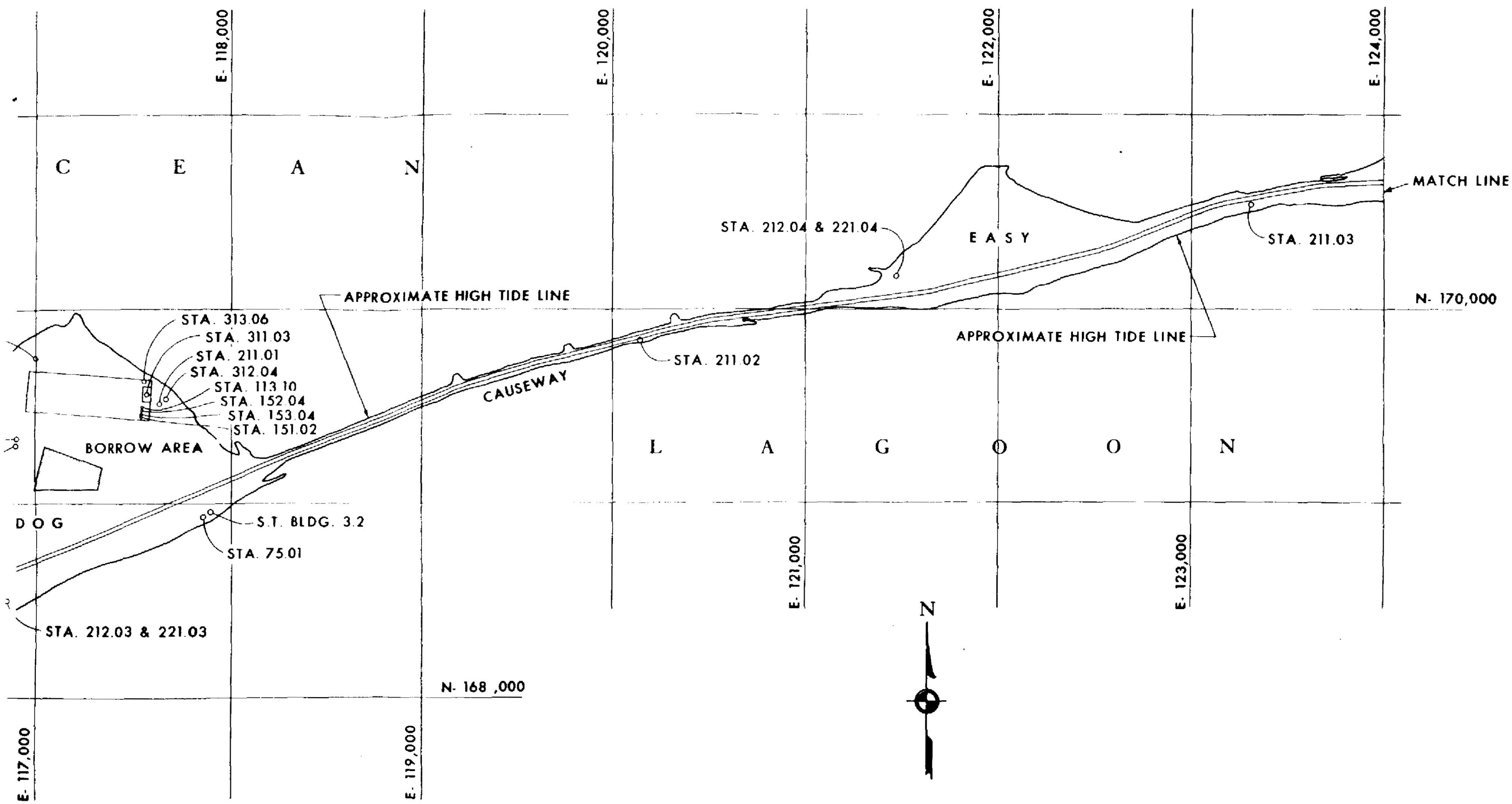
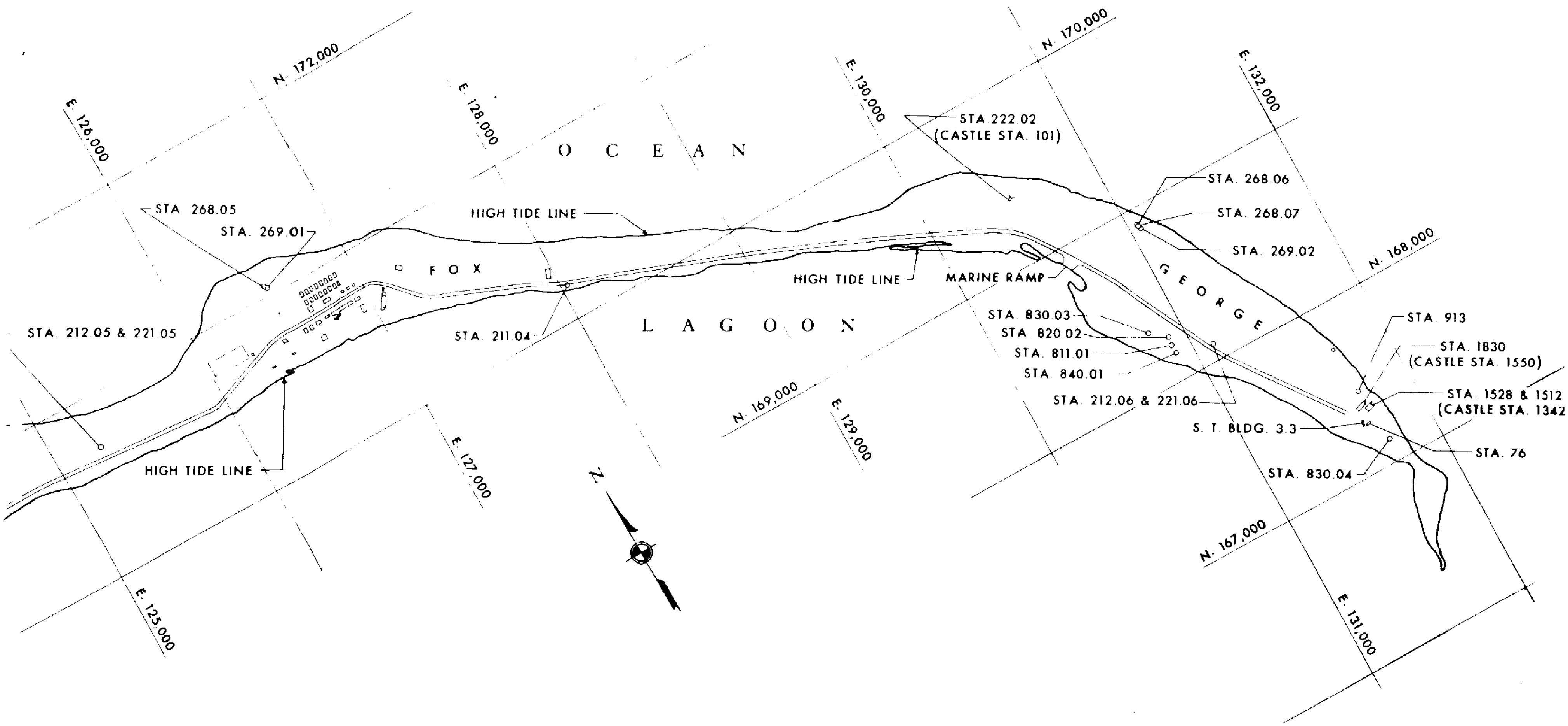


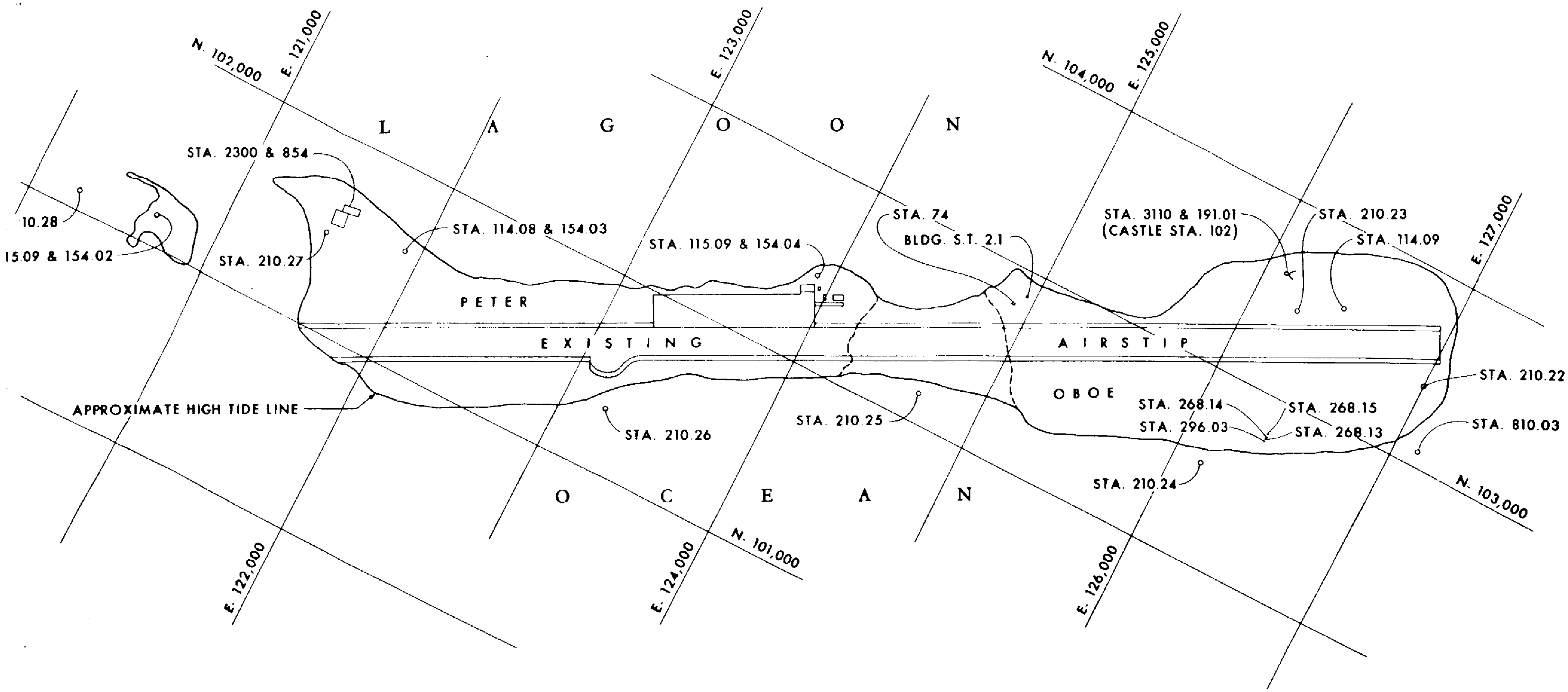
Figure 2-123. Scientific Plot Plan - Charlie-Dog Reef



ific Plot Plan - Dog-Easy

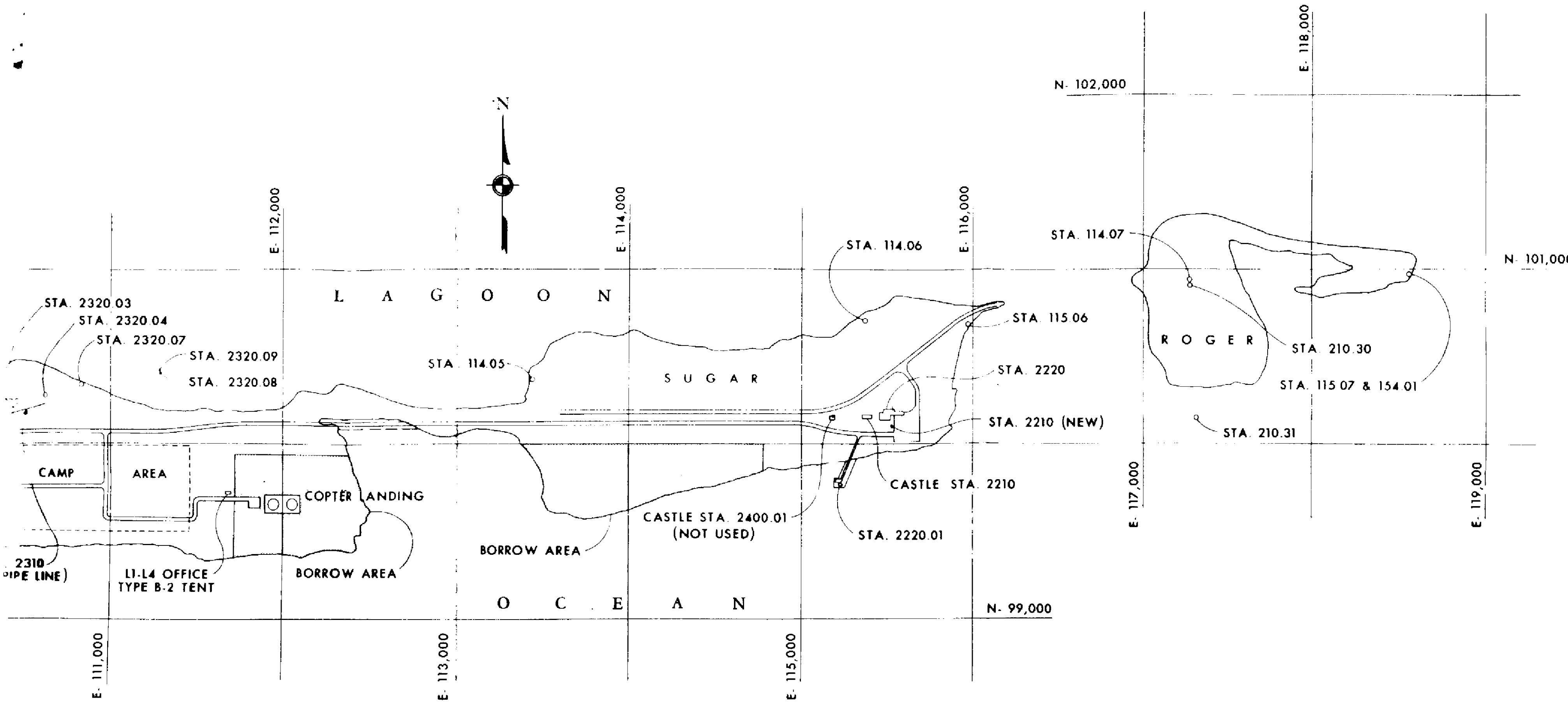


Scientific Plot Plan - Fox-George

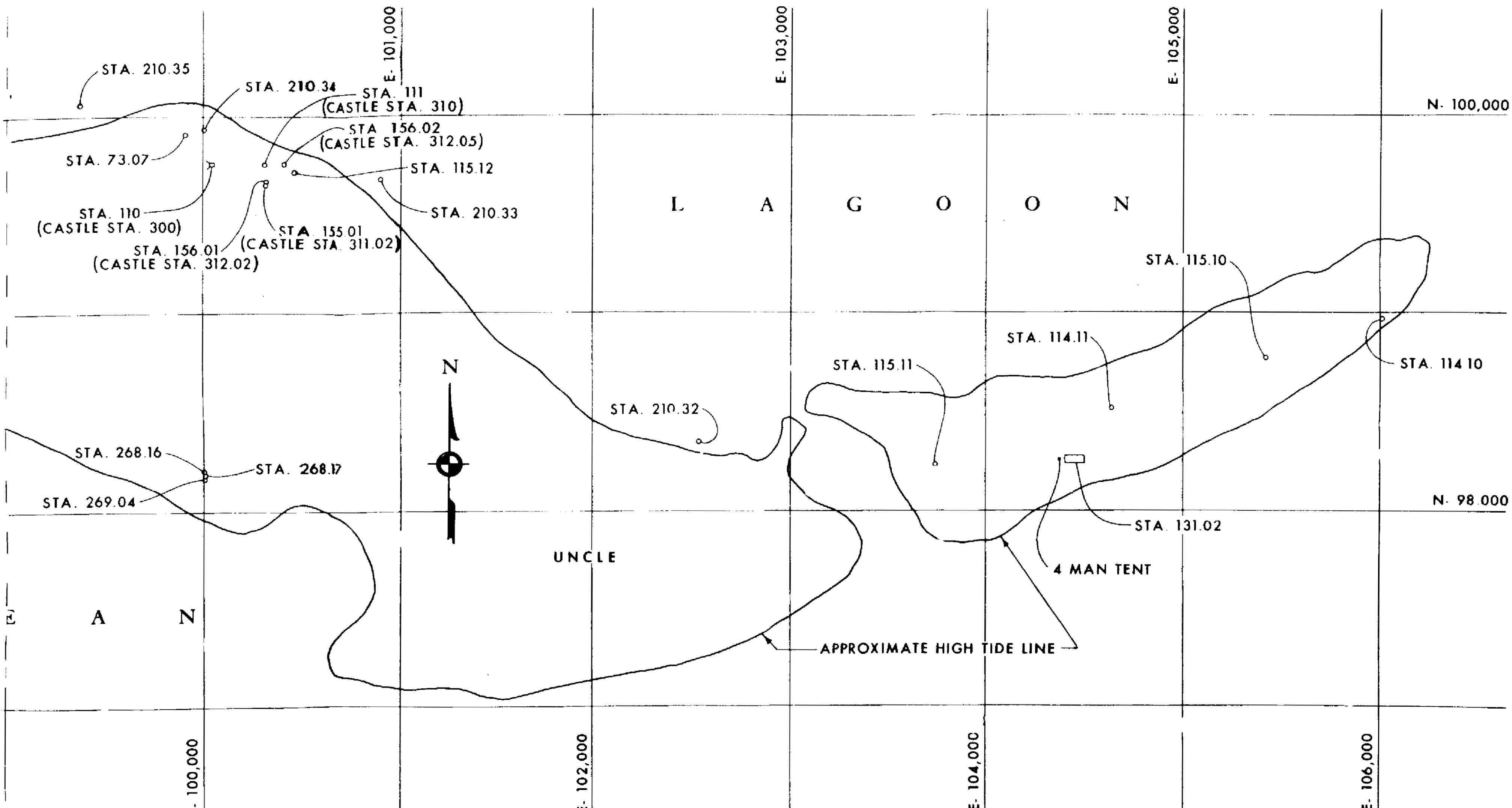


t Plan - Peter-Oboe

[redacted]



t **Plan** - Tare-Sugar-Roger



ific Plot Plan - Uncle

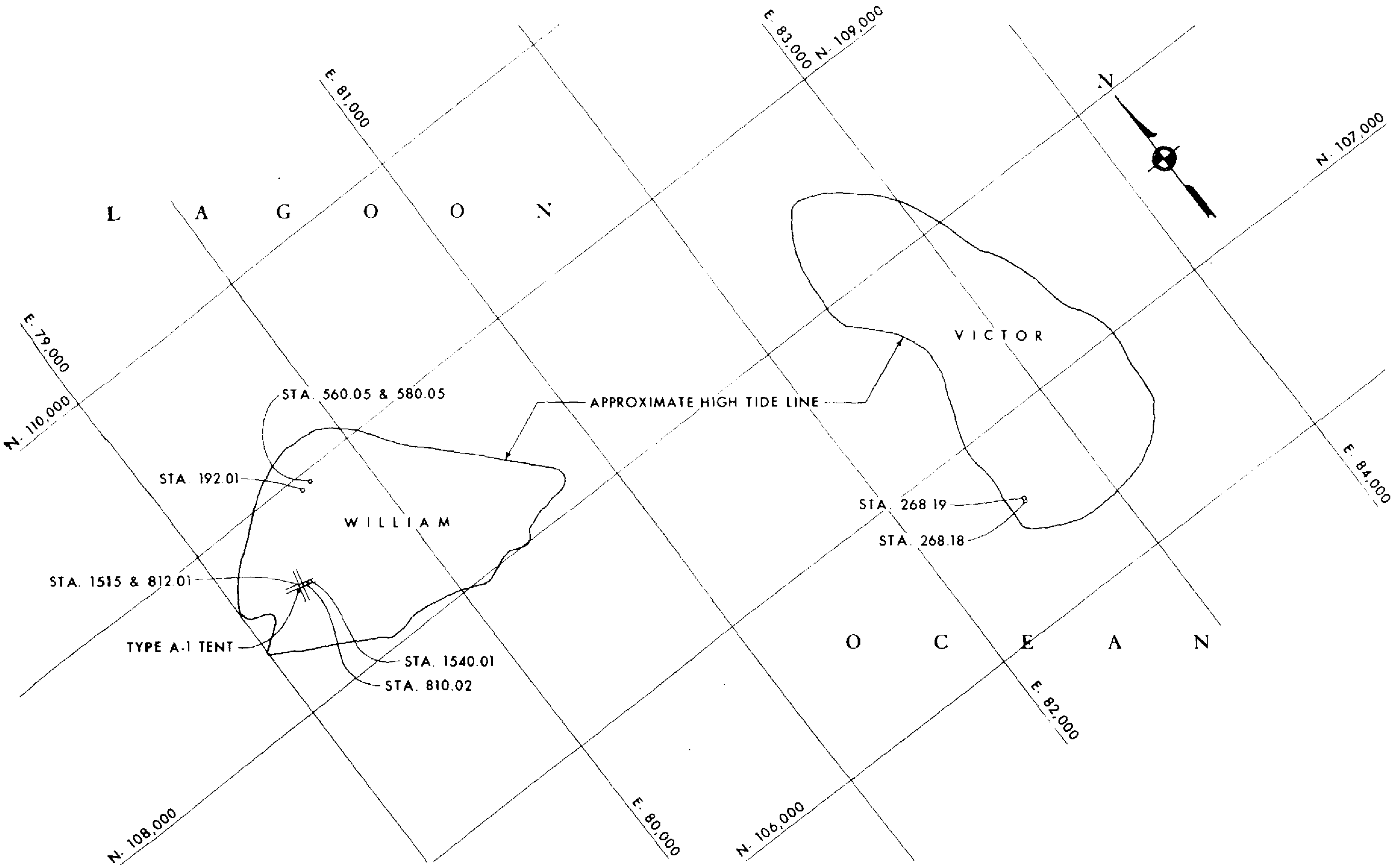


Figure 2-129. Scientific Plot Plan - William-Victor

SECTION 4
EXPENDABLE CONSTRUCTION

NAN CAMP.

Construction of the first increment of the NAN camp was authorized on 24 September 1954 and was completed on 7 March 1955; the second increment was started on 7 April 1955 and completed on 15 June 1955; and the third increment was started on 20 June 1955 and completed on 17 December 1955. The camp, as designed and built, is illustrated in the site plans, Figure 2-137, which also lists all the structures and facilities provided. This camp served as the port-of-entry and as the forward base camp for all activities in Bikini Atoll. It was provided with temporary shops and warehouses, an LST pier and ramp, POL facilities, a personnel decontamination facility, chapel, infirmary, recreation facilities, in addition to the usual messing, housing and other camp and utility services. The buildings, except for the chapel and housing tents were basically of the standard design prepared for all expendable buildings, viz, wooden frames, plywood siding, corrugated aluminum roofing, shutter windows and a concrete slab floor. Eight-man tents, consisting of canvas over a wooden frame on a concrete floor, were provided for housing and related uses. The chapel was a specially designed structure with a coral base floor, the frame, siding and roofing of which were wooden. All buildings except the interiors of the mess hall and infirmary and the entire chapel were left unpainted during the Operation. Upon completion of the Operation and as part of the roll-up, the buildings were covered with one coat of aluminum paint. The construction of this camp progressed gradually and without unusual incident all the way from the beachhead to the final stages.

Figure 2-130. Movie Theater - Nan

Figure 2-132. Typical Expendable Building

Figure 2-131. Typical 100-Man Latrine

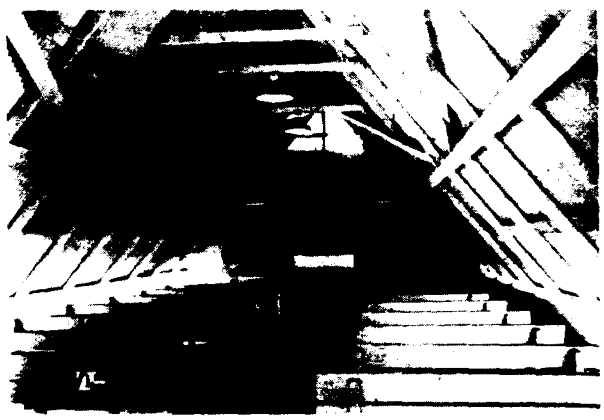


Figure 2-133. Interior Chapel - Nan

Figure 2-134. Second Increment Nan Camp

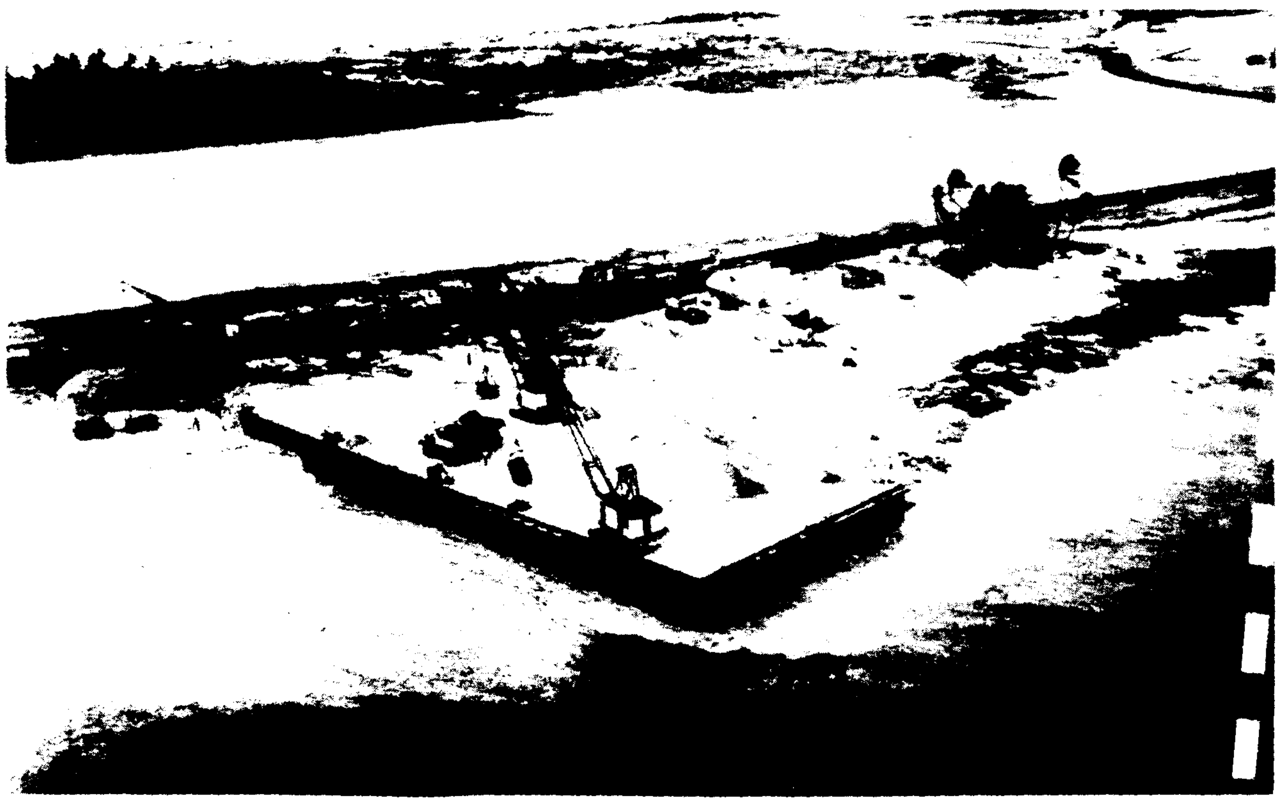


Figure 2-135. LST Mole - Nan - 79% Complete

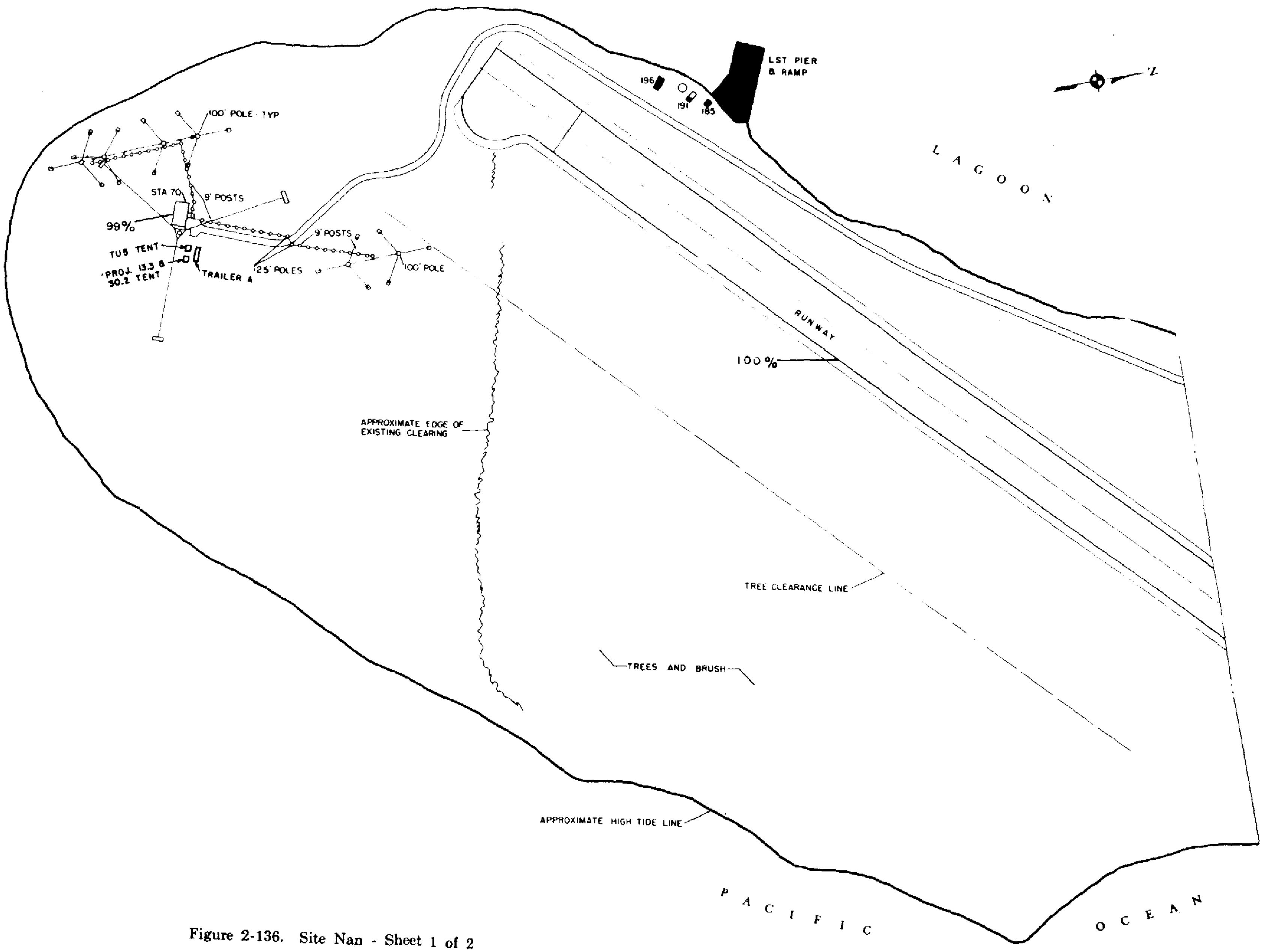
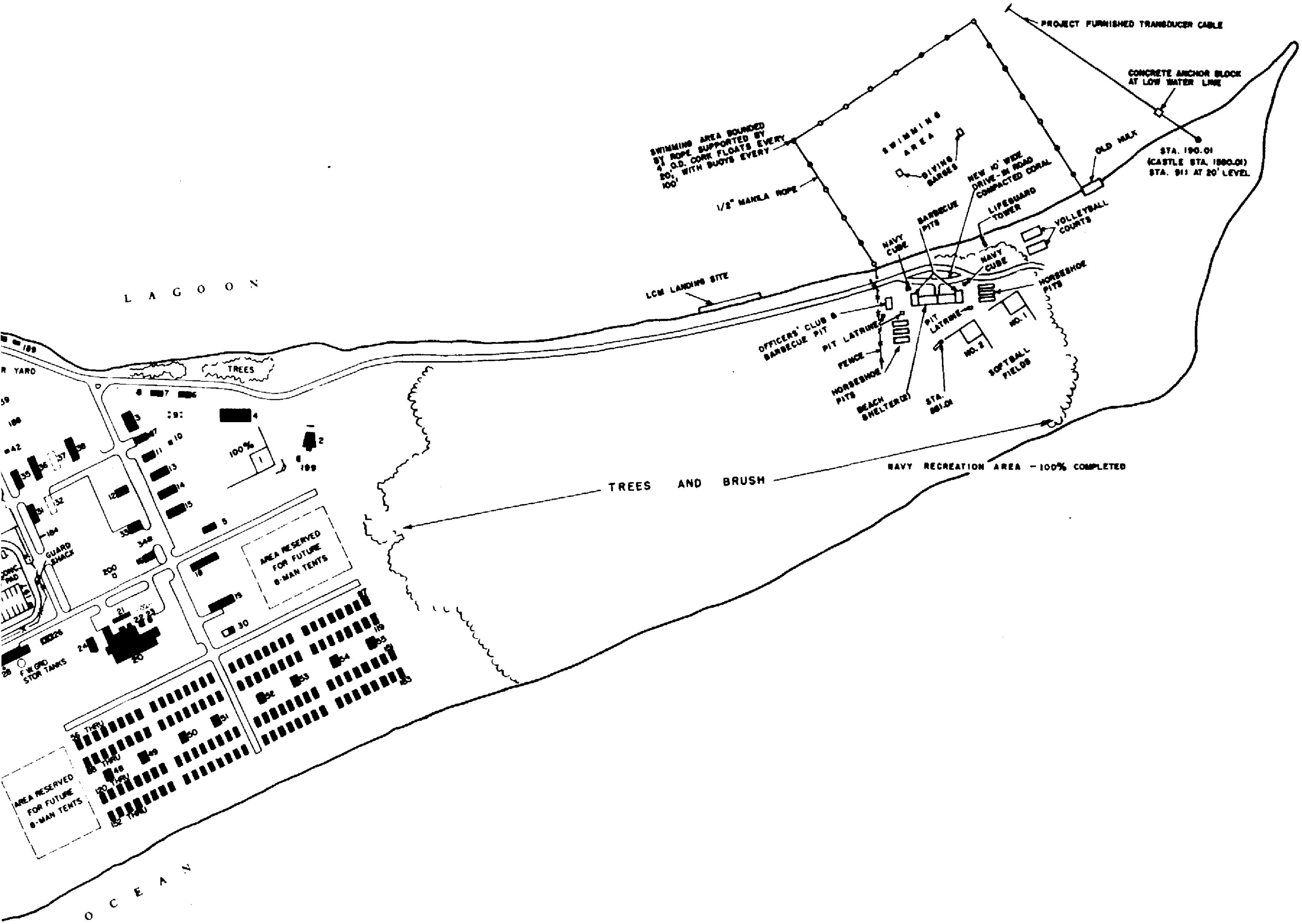


Figure 2-136. Site Nan - Sheet 1 of 2



BLDG NO	DESCRIPTION
1	BASEBALL FIELD
2	MOVIE
3	VOLLEYBALL COURT
4	BASKETBALL COURT
5	CHAPEL
6	RECREATION
7	REFRESHMENT BLDG.
8	STORES BLDG.
9	HORSESHOE PITS (2)
10	LATRINE
11	GUARD OFFICE
12	TEST LAB. & SURVEY
13	CONSTRUCTION OFFICE
14	ADMINISTRATION BLDG.
15	AEC BLDG.
16	TIME & FISCAL OFFICE
17	
18	PX, P.O., BARBER SHOP & PX STORAGE
19	INFIRMARY
20	MESSHALL
21	REEFERS
22	BOILER HOUSE
23	GARBAGE SHED
24	MESSHALL STORAGE
25	LAUNDRY & DISTILLATION PLANT
26	WATER TOWER
27	
28	WELL
29	
30	DAY ROOM & LIBRARY
31	HEAVY EQUIPMENT SHOP
32	
33	CAMP OFFICE
34	DISPATCHER'S OFFICE
35	AIR DISPATCHER
36	PLUMBING & SHEET METAL SHOP
37	
38	ELECTRIC & REFRIG. SHOP
39	CARPENTER SHOP & SAWMILL
40	
41	AEC WAREHOUSE
42	LATRINE
43	DRY STORES
44	BULK STORAGE
45	BIN STORAGE
46	CEMENT STORAGE
47	POWER HOUSE NA-500 (EXISTING)
48-55	LATRINES (25-MAN TYP.)
56-183	TENTS (8-MAN TYP.)
184	GREASE RACK
185	MARINE DISPATCHER SHED
186	RADSAFE BLDG
187	FIRE STATION
188	GENERAL STORAGE BLDG.
189	PAINT STORAGE
190	PAINT SHOP
191	MARINE POL FACILITIES
192	AIR OPERATIONS BLDG
193	FIRE & CRASH BLDG.
194	HANGAR
195	
196	MARINE REPAIR SHOP
197	LATRINE
198	PORTABLE PIER STORAGE BLDG.
199	FIELD LATRINE
200	MOTOR POOL DISPATCHER TENT
201	TENT

LEGEND

- FIRST INCREMENT - 250 MAN
- SECOND INCREMENT - 500 MAN
- THIRD INCREMENT - 1000 MAN
- POSSIBLE FUTURE BUILDINGS
- PER CENT COMPLETED

Sheet 2 of 2 Sheets

Figure 2-137. Applying Bare Course - Nan Airstrip

NAN AIRPORT:

The airport consisted of a 150′ x 4500′ runway with 25′ on each side for shoulders, a 500′ x 425′ plane parking and service apron, and a 500′ x 425′ helicopter mat. Three operational buildings were also provided. Work first started on 28 December 1954 with the clearing of a center line for the survey party; over-all site clearing followed. The east 1,000 feet of the proposed runway was found to be unsuitable for compaction. The surface was removed to a depth of 12 inches and replaced with borrow material prior to placing sub-base. Borrow pits were established alongside the proposed runway wherever suitable material was found.

The specified compaction of the sub-base was obtained by utilizing sheep's foot, grid, and wobbly-wheel rollers. The material used for the sub-base was clean, non-organic sand with the following gradation as typical:

Sieve Size	% Passing
⅜	100
# 4	90
# 8	87
# 16	77
# 30	29
# 50	6
# 100	1-5
# 200	0-4

Loose dry unit weight	71.5 lbs./cu. ft.
Rodded dry unit weight	80.5 lbs./cu. ft.

In order to prevent surface disturbance by truck tires while spreading the base course, sandy organic top soil, which acted as a sealer, was placed over the sub-base to an average depth of 0.2 feet. This material, which was also used under the 4-inch surface course of the airstrip shoulders, compacted well and had a CBR value of 30 per cent at optimum moisture. The average gradation of material was as follows:

Sieve Size	% Passing
⅜	100
# 4	80
# 8	77
# 16	69
# 30	38
# 50	16
# 100	10
# 200	7

Rock for the base and surface courses was obtained from the southern tip of the island. Crushing operations were started on 30 December 1954. The material was produced in a plant consisting of a primary and secondary crusher, in order to obtain the required 4-inch maximum size aggregate. Base and surface course aggregates were hard, durable mixtures of coral rock and sand, with a high bearing capacity either wet or dry. Placement of the 4-inch base course started on 1 February 1955; compaction was obtained by using sheep's foot, grid, wobbly-wheel rollers and a Jobsite-built 45-ton pneumatic roller. The runway strip was completed on 13 March 1955. Average gradations of the base and surface course aggregate were as follows:

A. Base course aggregate -

Sieve Size	% Passing
4 Inch	100
2 Inch	64
1 Inch	49
½ Inch	39
# 4	29
# 10	25
# 40	17
# 80	4
# 200	0-5

B. Surface course aggregate -

Sieve Size	% Passing	
1-½ Inch	100	Loose dry unit weight 90.5 lbs./cu. ft.
1 Inch	93	
½ Inch	63	
# 4	41	
# 10	33	Rodded dry unit weight 101.5 lbs./cu. ft.
# 40	11	
# 80	4	
# 200	1	

The parking apron, helicopter mat, and the end of the runway from Station 0 to Station 3 received a top coat of approximately 0.2 gallons of bitumuls per square yard. A seal coat, consisting of 0.6 gallons per square yard mixed into beach sand, was then applied to a thickness of ½ inch. This seal coat was rolled and sanded as necessary. A total of 38,346 gallons of bitumuls was used.

On 15 March 1955, an airplane landed on the airstrip for the first time. By 10 April 1955 the buildings were occupied, and on 28 May 1955 all work was completed. The job as completed required 500,000 square yards of site clearing and 53,414 cubic yards of borrow materials. The air operations building, of wood frame construction finished with plywood siding and aluminum roof, was 30′ x 60′ with a 9′-2″ x 12′-6″ lean-to for a latrine, and with a 10′-6″ x 10′-6″ control tower. The fire-crash station of similar construction was 24′ x 36′, with a vertical clearance of 15 feet. The hangar building, 50′ x 75′ with vertical clearance of 20 feet, was finished with corrugated aluminum siding and roofing.

The California Bearing Ratio Method was used on the airstrip to determine shear strength and bearing capacity. The test locations were uniformly spread throughout the area. A total of 36 tests was made for the base course with maximum readings of 100 obtained at three locations and with a minimum reading of 38 and the average of all tests being 69. A total of 49 tests was made for the surface course with maximum readings of 100 being obtained at many of the test locations, with a minimum reading of 75 and with the average of all tests being 93. The results of these tests indicated that uniformly high bearing values were obtained.

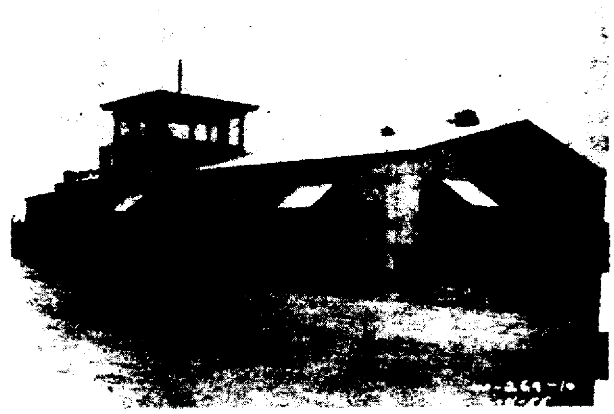


Figure 2-138. Operations Building - Nan Airport

SHOT-ISLAND CAMPS.

Temporary camps were required to house and sustain construction and operation forces at Yvonne, Ursula, and Gene in Eniwetok Atoll, and at Tare and Fox in Bikini Atoll. The designs of these camps were accomplished in the field, utilizing standard building drawings whenever possible. Field Engineers located the standard buildings on a plot plan with only minor revisions were able to conform to the requirements of each camp site. To expedite the planning of these camps, estimates and bills of material for typical buildings were prepared; a package-unit construction plan was formulated which included these estimates, bills of material, and drawings. This procedure proved effective in camp planning with a minimum of engineering, drafting, and estimating time.

The shot-island camps were established as shown in the following table:

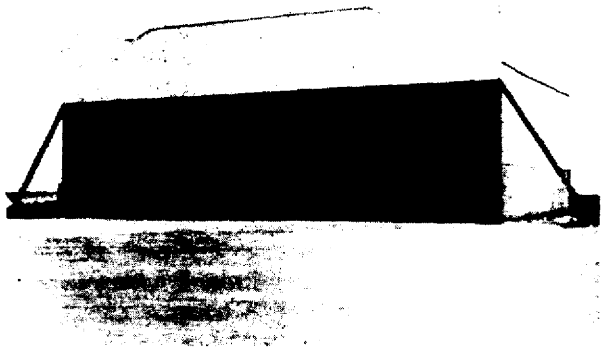


Figure 2-139. Hangar - Nan Airport

Site	Authorized	Beachhead Established	Camp Completed
Yvonne	4-18-55	5-8-55	9-15-55
Ursula	4-18-55	5-3-55	8-15-55
Fox	4-30-55	6-8-55	8-27-55
Tare	6-9-55	7-19-55	9-21-55
Gene*	6-9-55	7-6-55*	12-25-55

* Work stopped 8-3-55 and restarted 8-15-55

Figure 2-140. Tare Camp

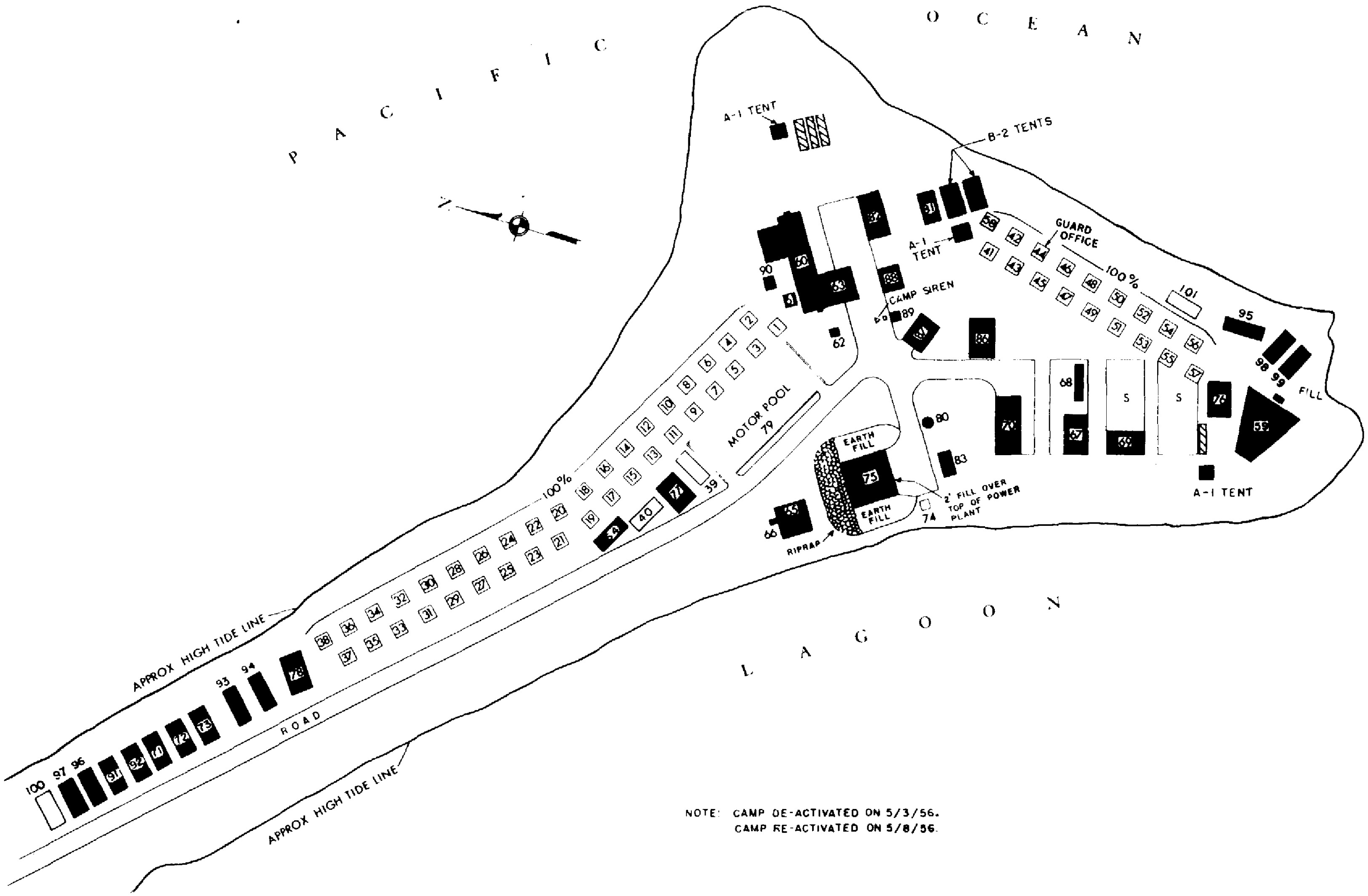
The buildings and other facilities provided at each of the above camps are listed in camp site plans which are shown as follows: Figure 2-144, Yvonne; Figure 2-145, Ursula; Figure 2-147, Fox; Figure 2-148, Tare; and Figure 2-146, Gene. Prefabrication at the established camps on Nan and Elmer was used extensively for trusses, wall panels, water towers, and like items. The camps at Yvonne, Ursula, and Fox were constructed on former camp sites and, where practicable, existing concrete slabs and utility pipelines were utilized. At Ursula, existing buildings and tent frames were repaired and reused. The camps, as designed and built, were adequate except for housing facilities at Fox and Yvonne. At these two sites, housing facilities were overcrowded and it became necessary to provide berths in the recreation and other buildings. Approval was later received in the field to construct additional 8-man tents on an "as needed" basis; thirteen tents were added at Yvonne and eight at Fox.

The work at Gene started on 9 July but was suspended on 3 August until the need for this camp could be more clearly defined. By 15 August, the need for the camp became definite and work was again undertaken. On 4 April 1956, the construction of an airstrip on this site was authorized. By 8 April 1956, the base course for the airstrip had been graded, rolled, and compacted; base course aggregate was supplied from Janet. On 10 April the airstrip was placed in operation. The entire Gene camp area was often flooded at high tide, therefore a 4-foot earth berm was built along the entire length of the north (ocean) side.

Figure 2-141. Interior Mess Hall - Nan

Figure 2-143. Typical Shot-Island Mess Hall

Figure 2- 142. Typical Power and Water Plant - Shot-Island Camp



NOTE: CAMP DE-ACTIVATED ON 5/3/56.
CAMP RE-ACTIVATED ON 5/8/56.

Figure 2-144. Yvonne Camp

BUILDING SCHEDULE

BLDG No	DESCRIPTION
*1 THRU 58	4 MAN TENTS
59	MOVIE
60	MESSHALL
61	BOILER HOUSE
62	GARBAGE SHED
63	REEFERS (3)
64	TENT
65	REFRESHMENT BUILDING
66	REEFER
67	HEAVY EQUIPMENT & VEHICLE REPAIR
68	GREASE PIT
69	CARPENTER SHOP
70	PLUMBING & ELECTRICAL SHOP
71	8 MAN TENT
72	8-MAN TENT
73	8-MAN TENT
74	ACID TANK
75	POWER & DISTILLATION PLANT
76 THRU 78	100 MAN LATRINES
79	MOTOR POOL
80	21,000 GAL. F. W. GROUND STORAGE TANK
81	P. X., P. O. & BARBER SHOP
82	ADMINISTRATION BUILDING
83	WATER TOWER
84	HORSESHOE PITS
85	VOLLEY BALL COURT
86	STORAGE WAREHOUSE
87	FIRE HOUSE & FIRST AID
88	CAMP OFFICE, SUPPLIES
89	TIME SHACK
90	LAUNDRY
91	RECREATION OFFICE
92	GYM
93-96	8-MAN TENTS
97	DAY ROOM
98-101	8-MAN TENTS
*39-40	8-MAN TENTS

LEGEND

PERCENTAGE OF COMPLETION

TRAILER SPACE

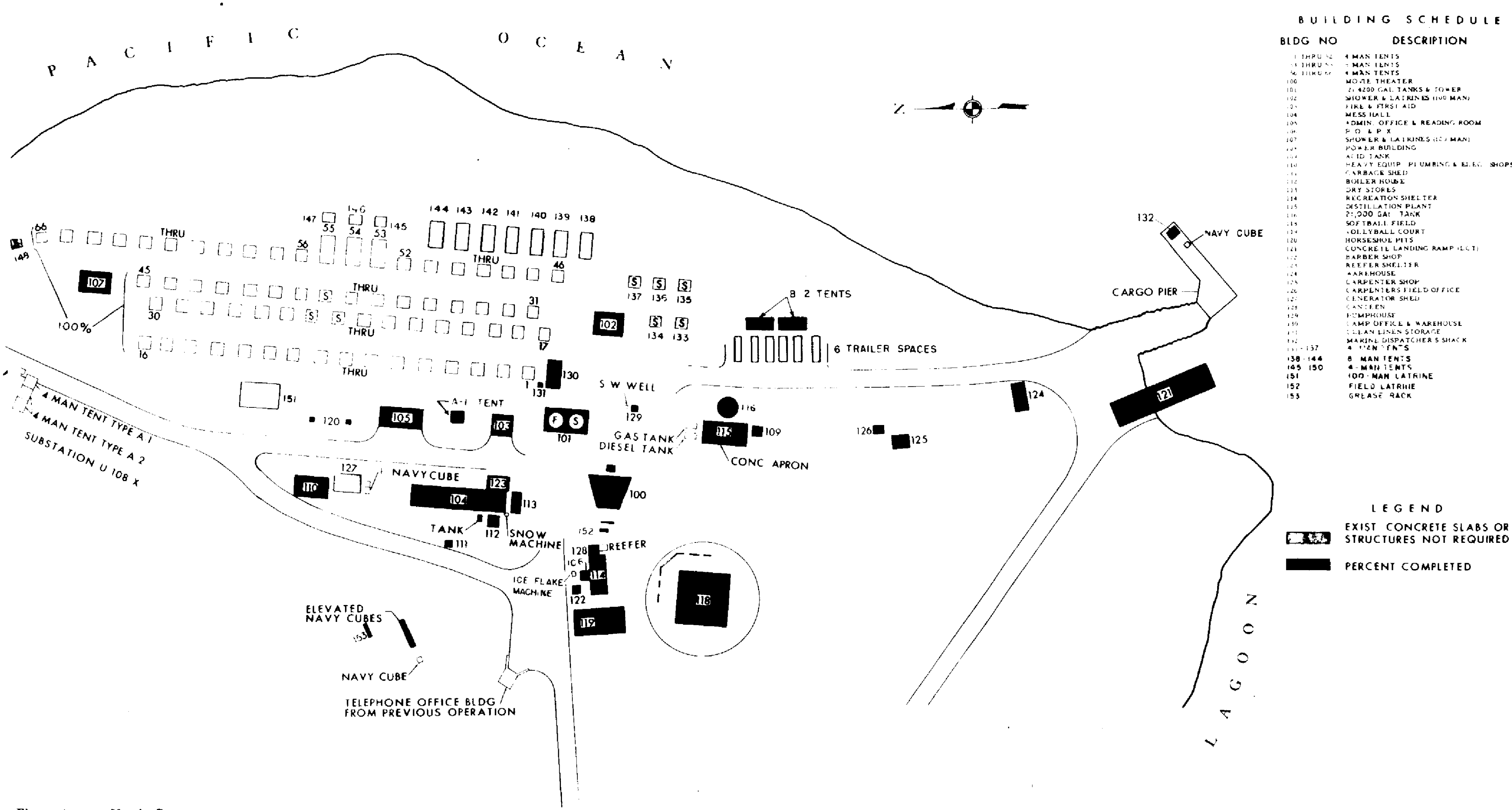


Figure 2-145. Ursula Camp

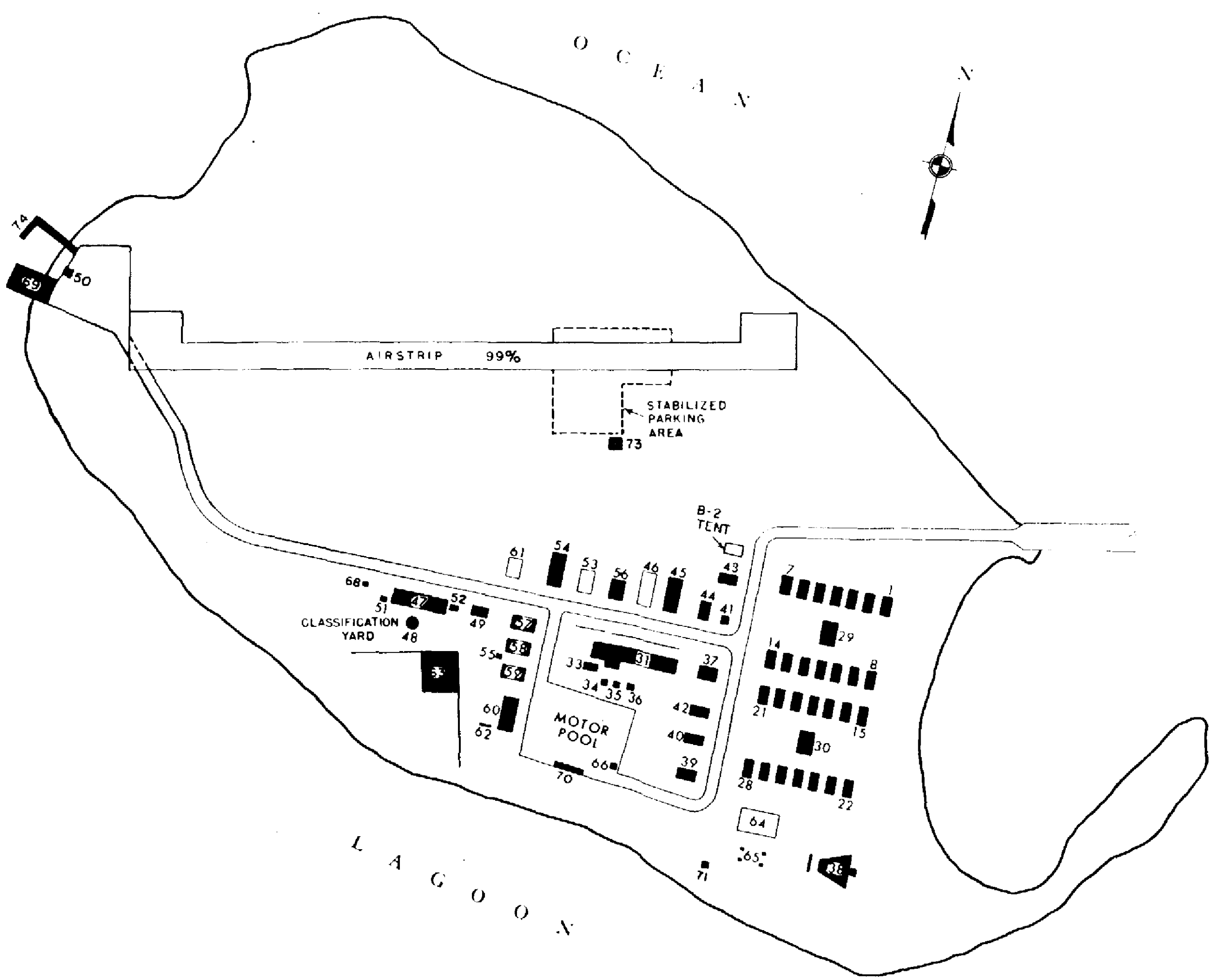


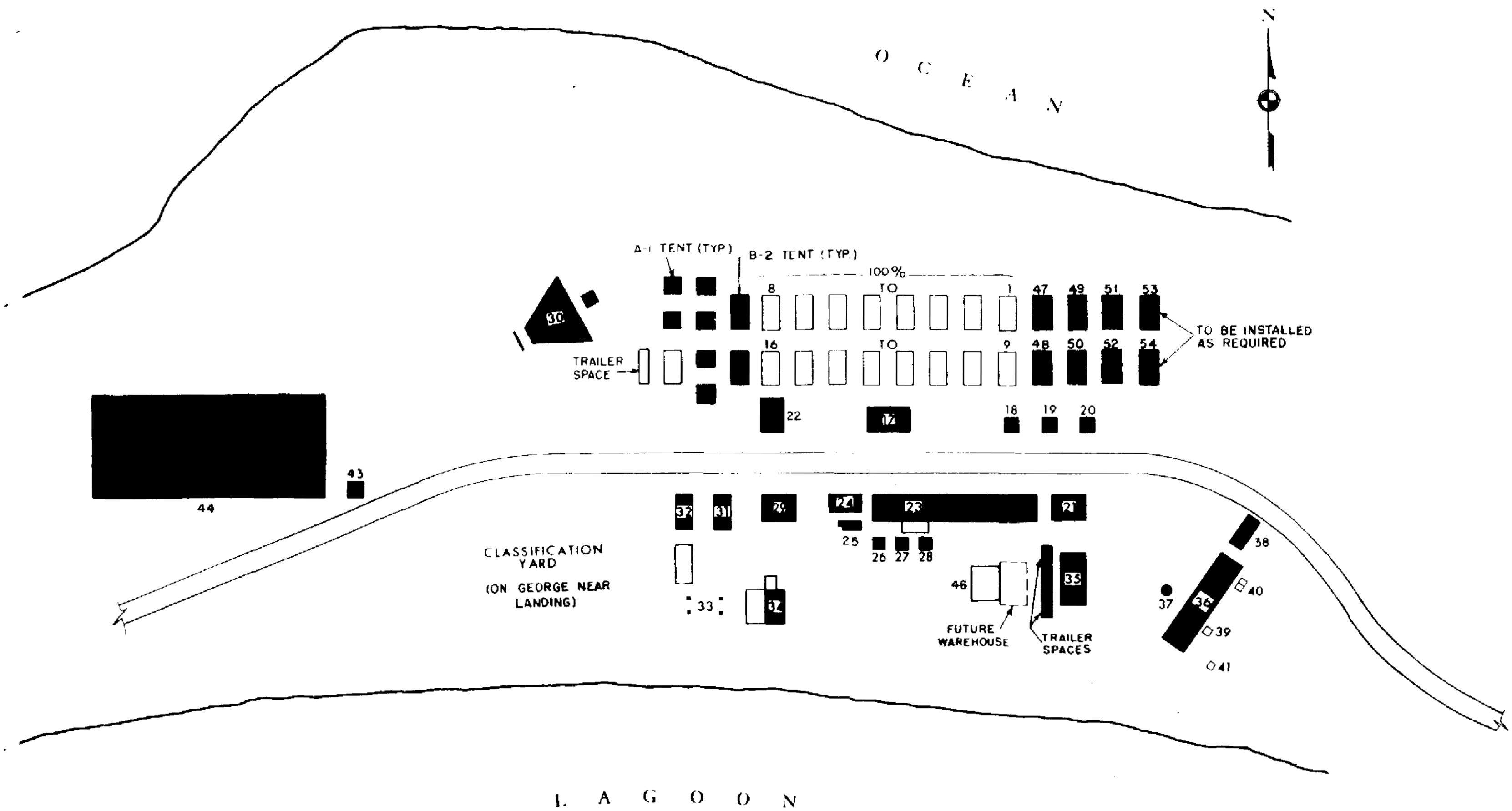
Figure 2-146. Gene Camp

BUILDING SCHEDULE

BLDG No	DESCRIPTION
1 THRU 28	8 MAN TENTS
29 THRU 30	125 MAN LATRINE
31	MESSHALL
33	REEFERS
34	GARBAGE SHED
35	BOILER HOUSE
36	LAUNDRY
37	P.X., P.O. & BARBER SHOP
38	MOVIE
39	REFRESHMENT BUILDING
40	GYM
41	TIME SHACK
42	RECREATION OFFICE
43	DAY ROOM & LIBRARY
44	CAMP OFFICE
45	CONSTRUCTION OFFICE
46	ADMIN. & A.E.C. BUILDING
47	POWER & DISTILLATION PLANT
48	[illegible],000 GAL. GRD. STORAGE TANK
49	30 FT. WATER TOWER & TANKS
50	MARINE DISPATCHER SHED
51	ACID PIT
52	FUEL OIL TANK
53	A.E.C. WAREHOUSE
54	GENERAL BULK WAREHOUSE
55	FIELD LATRINE
56	FIRE HOUSE & FIRST AID
57	ELECT. & REFRIG. SHOP
58	CARPENTER SHOP
59	PLUMBING & SHEET METAL SHOP
60	VEHICLE REPAIR, HVY. DUTY SHOP
61	CEMENT STORAGE
62	GREASE RACK
63	BASEBALL FIELD
64	VOLLEY BALL COURT
65	HORSE SHOE PITS
66	MOTOR POOL DISPATCHER SHACK
67	
68	GASOLINE TANK
69	LANDING RAMP
70	P.O.L. FACILITIES
71	PUMP HOUSE
72	
73	AIR DISPATCHER'S TENT
74	PERSONNEL PIER

LEGEND

PERCENT OF COMPLETION



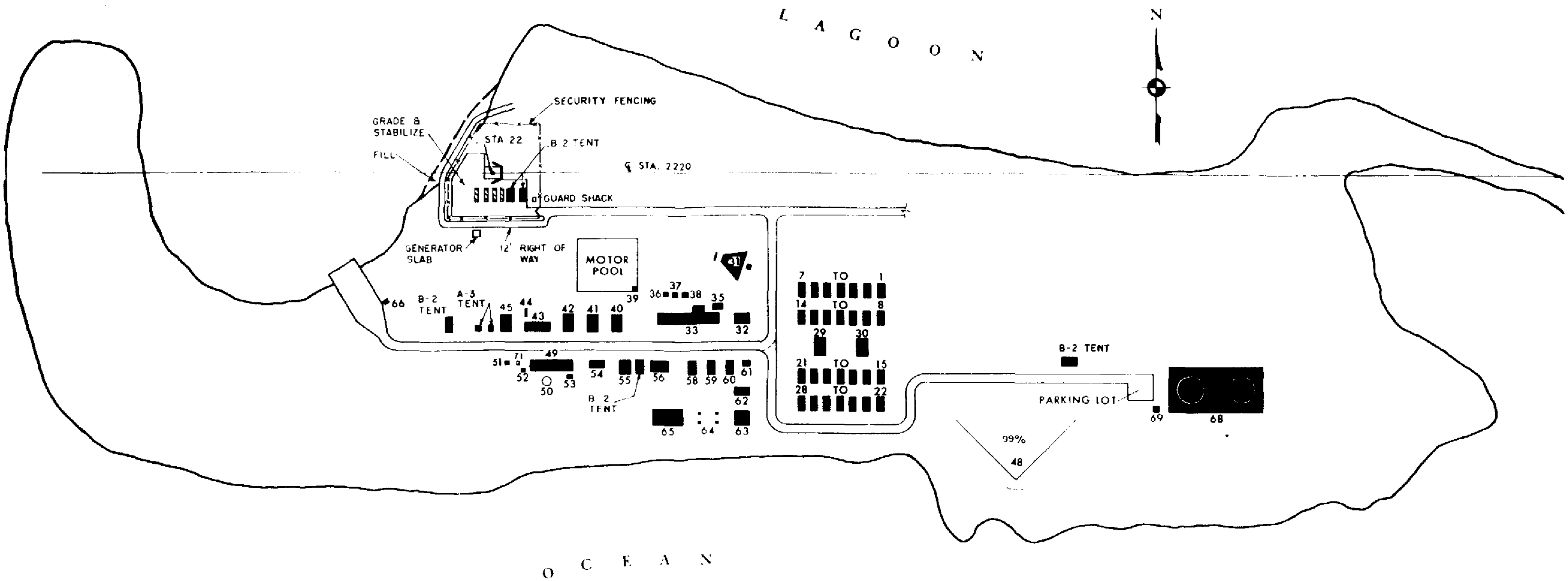
BUILDING SCHEDULE

BLDG NO	DESCRIPTION
1 THRU 16	8 MAN TENT
17	125 MAN LATRINE
18	TIME SHACK
19	CAMP OFFICE
20	GUARD OFFICE
21	ADMIN & CONST. OFFICE
22	FIRE HOUSE & FIRST AID
23	MESSHALL
24	MESSHALL STORAGE
25	REEFERS
26	GARBAGE SHED
27	BOILER SHED
28	LAUNDRY
29	P.X., P.O., & BARBER SHOP
30	MOVIE
31	GYM
32	DAY ROOM & LIBRARY
33	HORSE SHOE PITS
34	REFRESHMENT BUILDING
35	ELECT. & PLUMBING SHOP
36	POWER & DISTILLATION PLANT
37	4200 GAL. GRD. STORAGE TANK
38	30' WATER TOWER & TANKS
39	ACID PIT
40	FUEL OIL TANK
41	GASOLINE TANK
42	MARINE DISPATCHER'S SHED (PORTABLE)
43	AIR DISPATCHER'S TENT
44	HELICOPTER LANDING MAT
45	
46	CARPENTER SHOP
47 - 54	8-MAN TENTS

LEGEND

PERCENT COMPLETED

Figure 2-147. Fox Camp



NOTE:

ENTIRE ISLAND GRADED TO SUIT FIELD CONDITIONS AND RAD-SAFE REQUIREMENTS.

LEGEND

PERCENTAGE OF COMPLETION

TRAILER SPACE

BUILDING SCHEDULE

BLDG NO	DESCRIPTION	BLDG. NO.	DESCRIPTION
1 THRU 28	8-MAN TENTS	49	DISTILLATION & POWER PLANT
29 - 30	125 MAN LATRINES	50	21,000 GAL. GROUND STORAGE TANK
31	MOVIE	51	GASOLINE TANK
32	P.X., P.O. & BARBER SHOP	52	ACID PIT
33	MESSHALL	53	FUEL OIL TANK
34		54	30 ft. WATER TOWER & TANK
35	REEFERS	55	FIRE HOUSE & FIRST AID
36	GARBAGE SHED	56	ADMINISTRATION & CONSTRUCTION OFFICE
37	BOILER HOUSE	57	
38	LAUNDRY	58	DAY ROOM & LIBRARY
39	MOTOR POOL DISP. SHED	59	RECREATION OFFICE
40	ELECTRICAL & REFRIGERATION SHOP	60	CAMP OFFICE
41	CARPENTER SHOP	61	TIME SHACK
42	PLUMBING & SHEET METAL SHOP	62	GYM
43	VEHICLE REPAIR & HEAVY DUTY SHOP	63	REFRESHMENT BUILDING
44	GREASE RACK	64	HORSESHOE PITS
45	GENERAL BULK WAREHOUSE	65	VOLLEYBALL COURT
46		66	MARINE DISPATCHER SHED
47		67	
48	BASEBALL FIELD	68	HELICOPTER LANDING MAT
		69	AIR DISPATCHER TENT
		70	
		71	FIELD LATRINE

Figure 2-148. Tare Camp

MAN-MADE ISLANDS AND CAUSEWAYS

MAN-MADE ISLANDS I, II, & III. In order to locate certain DOD scientific stations at the proper distance from Station 18, the construction of three islands in the Dog-Charlie reef was required. Two of these islands were 220′ x 140′, one was 90′ x 140′, and all three were built to elevation 9.5 from approximate reef elevation of 1.0. Bulkheads were formed of 60-pound rail piles which were backed by 3-inch timbers. The area was then backfilled with available reef coral and sand. The rail piles, driven 8 feet into the coral on 5-foot centers, projected approximately 9 feet above the reef. These rails were interconnected on the outside by two horizontal rails which acted as walers. The walers were connected to the piles by U-bolts, while the horizontal 3-inch timbers were fastened to the inside of the rails by J-bolts. Opposite bulkheads were connected by 1-¼-inch tie rods for distribution of the load. The bulkheads which faced the shot site, being subjected to reflected pressures, had the tops curved back to prevent disturbance of the shock wave. This was accomplished by splicing curved 6-inch steel channels to the rails at a point about four feet from the top of the rails, and by fastening the timbers to the curved channels.

OFFSHORE YVONNE.

Construction of an island and two causeways at Yvonne was required in order to properly locate Stations 24 and 1819 in relation to other stations, to reduce the possibility of fall-out and damage to other structures from the LaCrosse event (Station 24), and to properly locate the Station 1524 pipeline. As finally built, the island was 110′ x 100′ with a T-shaped addition approximately 90 feet on one side, 40 feet on the other, and 40 feet wide. This island was connected to Yvonne by a causeway 470′ long and 24′ wide. The causeway that was provided for the Station 1524 pipe array was 1500′ long and 40′ wide. The islands and causeways were built to a plus 9.0-foot elevation. The design was standard for this type of work as discussed in this report under the sub-heading of Man-Made Islands I, II, and III. Rails at this site were driven into T-shaped holes which were drilled into the coral because of its hardness. A change in requirements after construction had started necessitated removing and redriving a number of piles in order to increase the size of the island.

Figure 2-149. Man-Made Island No. 1 - 10% Complete

Figure 2-150. Placing Planking for Bulkhead Man-Made Island No. 3

Figure 2-151. Recovering Fill Around Man-Made Island No. 3

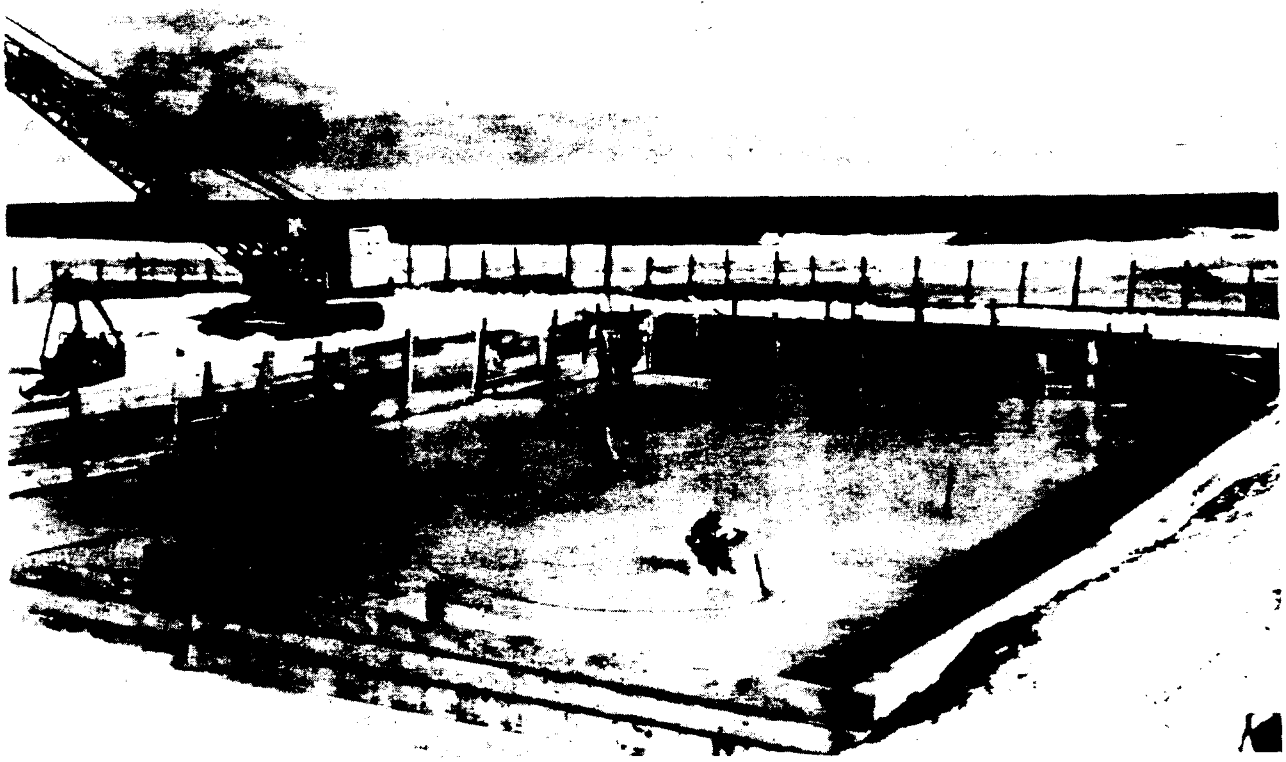


Figure 2-152. Drilling at Station Site - Man-Made Island No. 2

OFFSHORE SALLY.

In order to properly locate Station 1, a 110′ x 170′ man-made island was constructed that was connected to Sally by a 210′ x 70′ causeway, all of which was built to an elevation of plus 9.0 feet. The construction was similar to that of the other man-made islands.

ACCESS CAUSEWAYS.

Land access between the islands in the Gene-Irene, Peter-Tare, and Dog-George island complexes was provided through the reconstruction of existing causeways. In general, the causeways constructed during previous test Operations had been washed out as a result of high tides and storms. These were rebuilt, useing the most conveniently located bank and reef coral, which was compacted and stabilized with sea water. Riprap provided protection of the fill along the sides of the causeway where serious erosion was most likely to occur. This type of causeway construction, though subject to a larger degree of continuing maintenance, has proven to be the most effective and economical method of interisland connection.

The lengths, widths at the top elevation, and elevations of all man-made islands and causeways at the Proving Ground are summarized at the end of this discussion. This construction, and other projects undertaken on the reefs at the Proving Ground, were subject to frequent shutdowns because of tidal conditions or storms. The equipment used was frequently awash and therefore, required extra maintenance; crank cases and gear boxes were drained at the end of each working day. Maintenance of such equipment required close supervision to avoid delays due to breakdowns.

It was not unusual for men to work in waist-deep water for fairly long periods. At flood tides, the planks used in bulkhead construction had to be first loosely bolted to the rails above water and then submerged into place by a man standing on the plank until the J-bolts could be secured. Weather was always important. A storm in December 1955 caused a considerable setback in progress during construction of the man-made islands. Approximately 50 per cent of the George-Fox causeway, practically all of the Easy-Dog causeway, and about 15 per cent of the Sugar-Roger and Roger-Peter causeways were also washed away at that time. Additional men and equipment were diverted to these storm damaged areas in order to rectify the setback in progress.

A summary of man-made island and causeway construction follows:

ENIWETOK ATOLL

SITE	LENGTH	WIDTH AT TOP	ELEVATION OF TOP	COMMENTS
GENE - HELEN	1,200′	24′	+ 9.0′	Estimated 200′ riprap (lin.ft.) used on both sides (ocean and lagoon) Causeway constructed on site of existing "IVY" causeway.
HELEN - IRENE	1,750′	24′	+ 9.0′	Estimated 400′ riprap (lin.ft.) used on both sides (ocean and lagoon) Causeway constructed on site of existing "IVY" causeway.
RUBY - SALLY	1,200′	70′	+ 12.0′	Fill was required for minor repair of existing causeway. Some of the timber bulkhead was also replaced. Built originally for GREENHOUSE.
SALLY - TILDA	600′	35′	+ 12.0′	Existing sheet pile causeway. Built for GREENHOUSE (Earth filled) Minor repairs.
TILDA - URSULA	490′	20′	+ 12.0′	Existing timber causeway. Built for GREENHOUSE (Trestle type) Minor repairs.
SALLY - STATION 1	210′	70′	+ 9.0′	Timber and rail bulkhead, earth filled to site of Station 1.
STATION 1 M.M.I.	170′	110′	+ 9.0′	Timber and rail bulkhead, Earth filled.
YVONNE - STATION 24	470′	24′	+ 9.0′	Timber and rail bulkhead, earth filled.
STATION 24 M.M.I.	110′	100′	+ 9.0′	Timber and rail bulkhead, earth filled. Extension for Station 1819. Approximately 100′ long x 40′ wide, "T" shaped.
YVONNE - STATION 1524	1,500′	40′	+ 7.0′ To + 9.0′	Portion of causeway timber and rail (ocean side) with natural earth slope on lagoon side.

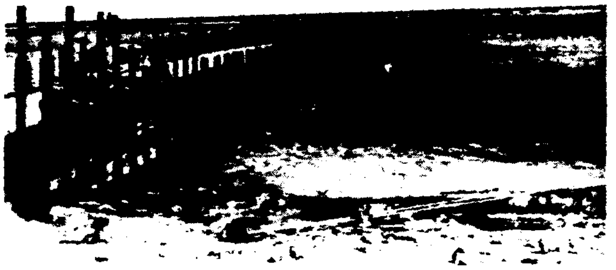


Figure 2-153. Constructing Station 1524 Causeway

Figure 2-154. Waves Breaking Over Station 1524 Causeway

Figure 2-155. Dog-Easy Causeway - 50% Complete

BIKINI ATOLL

SITE	LENGTH	WIDTH AT TOP	ELEVATION OF TOP	COMMENTS
M. M. I. 1	140′	90′	+ 9.5′	Timber and rail bulkhead, earth filled.
M. M. I. 2	220′	140′	+ 9.5′	" " "
M. M. I. 3	220′	140′	+ 9.5′	" " "
DOG - EASY	3,000′	20′	+ 10.0′	Riprap used along total length of causeway on ocean side and lagoon side. Reconstructed CASTLE causeway.
EASY - FOX	1,300′	20′	+ 10.0′	" " "
FOX - GEORGE	2,450′	20′	+ 9.5′	" " "
OBOE - PETER	CONNECTED BY EXISTING AIRSTRIP.			
PETER - ROGER	3,200′	15′	+ 8.5′	Estimated 6,000′ riprap (lin. ft.) used on ocean side and lagoon side. Constructed on site of CASTLE Causeway.
ROGER - SUGAR	1,200′	15′	+ 8.5′	Estimated 2,400′ riprap (lin. ft.) used on ocean side. Reconstructed CASTLE Causeway.
SUGAR - TARE	1,100′	15′	+ 8.5′	Estimated 550′ riprap (lin.ft.) used on ocean side of causeway. Reconstructed CASTLE Causeway.

Figure 2-156. Bulkhead Construction - Sally

Figure 2-157. Dog-Easy-Fox Causeway

AIRSTRIPS.

All existing airstrips were rehabilitated. A summary of the airstrips and helicopter pads that were available for the Operation is shown in the following table:

ENIWETOK ATOLL
AIRSTRIPS AND HELICOPTER LANDING SITES

SITE	LENGTH	WIDTH	SHOULDERS	COMMENTS
LEROY	100′	100′	-	Helicopter landing area. (new) Cleared area.
BRUCE	100′	100′	-	Helicopter landing area (new) Cleared area.
DAVID	100′	100′	-	Helicopter landing area (new) Cleared area.
YVONNE	990′	50′	-	Existing airstrip rehabilitated also new timber and rail bulkhead at east end of strip added for water erosion and protection.
GENE	1,200′	50′	-	New compacted coral airstrip 1-inch surface course 3-inch base course with helicopter landing area superimposed on airstrip. Plane parking area 110′ x 120′.
FRED	6,850′	150′	40′	Existing airstrip (permanent base).
ELMER	1,280′	75′	N.S. 45′ S.S. 10′	Existing airstrip rehabilitated with new asphalt surface. Helicopter landing area 183′ and 100′. Plane parking area approximately 250′ x 230′.
TILDA	1,400′	50′	25′	Existing airstrip rehabilitated with new asphalt surface. Helicopter landing area and plane parking apron 130′ x 100′.
JANET	4,100′	90′	-	Rehabilitated 1,550′ of existing airstrip from Station 12 00 to 27+50 with 3″ thick compacted coral. Rebladed and rolled remaining portions.

BIKINI ATOLL
AIRSTRIPS AND HELICOPTER LANDING SITES

SITE	LENGTH	WIDTH	SHOULDERS	COMMENTS
FOX	215′	100′	-	Helicopter landing area (new) cleared and stabilized.
HOW	100′	100′	-	Helicopter landing area (rehab. existing area) cleared and stabilized.
NAN	4,500′	150′	25′	8″ base course and 4″ surface course watered and rolled helicopter landing area 4″ base and 2″ surface asphalt treated. Plane parking & service apron 6″ base and 3″ surface asphalt treated.
PETER - OBOE	5,700′	150′	25′	Existing airstrip was usable with minor repairs.
TARE	215′	100′	-	Helicopter landing area (new) 4″ compacted coral treated with dust pallative.
UNCLE	100′	100′	-	Helicopter landing area (new) Cleared area.
BRAVO	100′	100′	-	Helicopter landing area (new) Cleared area.

Figure 2-158. Airstrip - Elmer

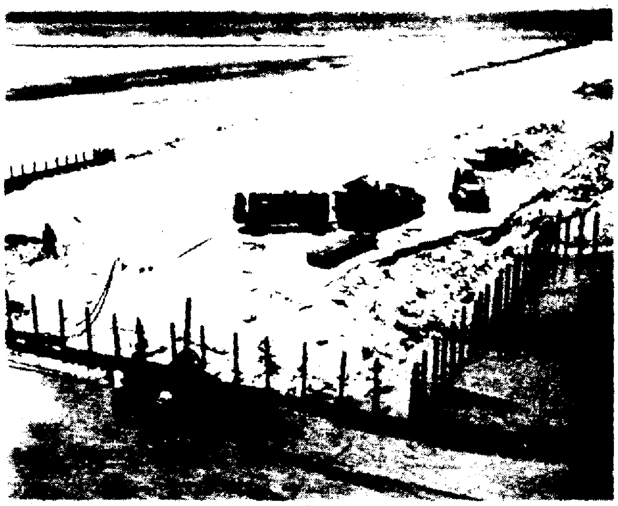


Figure 2-159. Extending Yvonne Airstrip

Figure 2-161. Runway Barrier - Peter-Oboe Airstrip

Figure 2-160. Airstrip - Janet

INTERATOLL COMMUNICATIONS.

At the close of Operation CASTLE, TG 7.1 transferred two high-frequency transmitters and two receivers to TG 7.5. This equipment was activated by the Contractor when the Nan Camp was first established and provided two HF circuits for phone and teletype communications between Nan and Elmer during the build-up stage of REDWING. These circuits, however, could not meet the demands of a full-scale test operation. Therefore, in conjunction with AEC communication personnel, a series of path-proving tests were conducted over a period of approximately one year, which determined the feasibility of VHF transmission. For the primary radio link between Eniwetok and Bikini Atolls, a multipule channel VHF system was designed. This system is illustrated in Figure 2-164.

The Contractor drew up specifications for three KW amplifiers and high gain antennas, which were purchased. The AN/TRC-24 multichannel radio equipment was obtained from military sources on a loan basis. Sigtot with Samson units were used to provide on-line crypto operation of teletype messages, and AFSAY 806 voice cyphony equipment was used to provide security of the voice channels. These devices were installed and later serviced by military personnel because of security reasons.

Two antennas each were required at Elmer and Nan—one for transmitting and one for receiving. The antenna system consisted of four dipoles fed in phase and mounted one-half wave length from the vertex of a 60-degree corner reflector. The corner reflectors at Elmer were mounted on top of individual 130-foot steel towers. The corner reflectors at Nan were mounted between two members of type 2400 (X-braced) towers located at the 235′-9″ and the 264′-3″ levels of the 300-foot tower at Station 70.

Figure 2-162. Equipment for VHF System

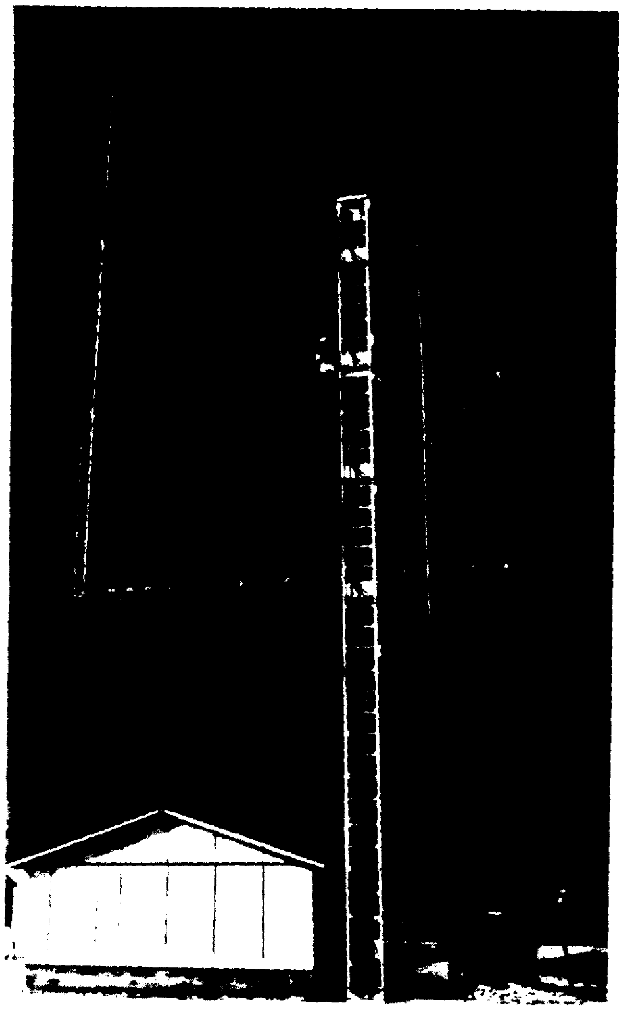


Figure 2-163. Antennas Used in VHF Propogation Tests

A ground repeater station, which operated unattended, was installed at Station 70 to act as a relay to the USS Curtiss and as the primary radio link during evacuation of Bikini Atoll. An airborne (in a C-54) repeater station was provided to permit operation between the USS Curtiss and Elmer in the event of station failure at Nan or when the Curtiss was out of station range. This airborne repeater was also provided for service between Elmer and the USS Curtiss in case of transmission path disruption between Nan and Elmer caused by ionized areas resulting from test operations. Before the test operations, there was some concern as to the effect of thermonuclear detonation on the propagated signal of the tropospheric scatter system. However, no difficulties were encountered in this respect and after the Zuni event the use of the aircraft repeater was discontinued.

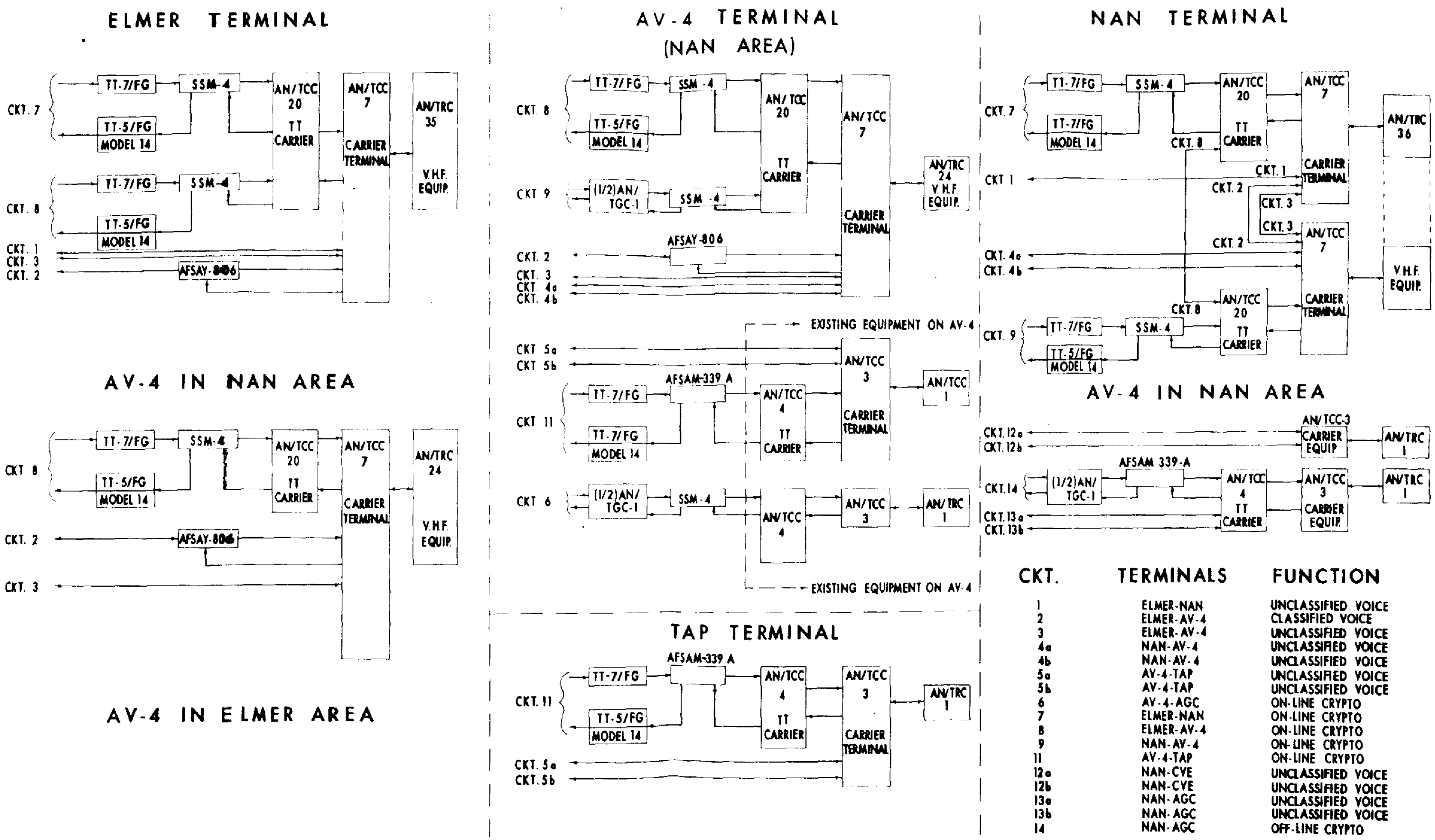
A serious delay in activating the VHF system was caused by a late change in frequency assignments. This change necessitated redesigning two of the antennas under manufacture and resulted in a three-week delivery delay. The system was activated on 28 April 1956 and was very effective in meeting demands.

TELEPHONE.

The telephone system existing after the CASTLE roll-up consisted of the 400-line dial switchboard on Fred and the 280-line manually-operated switchboard on Elmer; interconnection was through the existing submarine cable system. For the REDWING Operation, this system was expanded as shown in the telephone layout diagrams, Figures 2-172 and 2-173. In addition, local systems were provided at various other island complexes primarily for use in instrumentation of the various stations. These local networks were connected to the general telephone system thru the nearest switchboard. A typical local system is shown in Figure 2-174. Interconnections between phones of Bikini and Eniwetok Atolls were made through a radio link between sites Nan or the AV 4 and Elmer, and phone connection to Honolulu or the Continental US could be made through the Fred switchboard then over the ACAN radio network.

A summary of telephone instruments is shown in the following table:

	COMMON BATTERY DESK	COMMON BATTERY WALL	MAGNETO DESK	MAGNETO WALL	ARMY FIELD	SWITCHING KEYS
ELMER	356	216	12	17	23	42
GENE	18	12	1	2	9	1
URSULA	12	14	1	2	8	1
YVONNE	24	12	0	3	26	1
NAN	142	36	1	5	21	4
FOX	22	6	0	0	14	1
TARE	30	8	0	0	11	1
TOTAL	604	304	15	29	112	51



CKT.	TERMINALS	FUNCTION
1	ELMER-NAN	UNCLASSIFIED VOICE
2	ELMER-AV-4	CLASSIFIED VOICE
3	ELMER-AV-4	UNCLASSIFIED VOICE
4a	NAN-AV-4	UNCLASSIFIED VOICE
4b	NAN-AV-4	UNCLASSIFIED VOICE
5a	AV-4-TAP	UNCLASSIFIED VOICE
5b	AV-4-TAP	UNCLASSIFIED VOICE
6	AV-4-AGC	ON-LINE CRYPTO
7	ELMER-NAN	ON-LINE CRYPTO
8	ELMER-AV-4	ON-LINE CRYPTO
9	NAN-AV-4	ON-LINE CRYPTO
11	AV-4-TAP	ON-LINE CRYPTO
12a	NAN-CVE	UNCLASSIFIED VOICE
12b	NAN-CVE	UNCLASSIFIED VOICE
13a	NAN-AGC	UNCLASSIFIED VOICE
13b	NAN-AGC	UNCLASSIFIED VOICE
14	NAN-AGC	OFF-LINE CRYPTO

Figure 2-164. Interatoll Radio Circuit

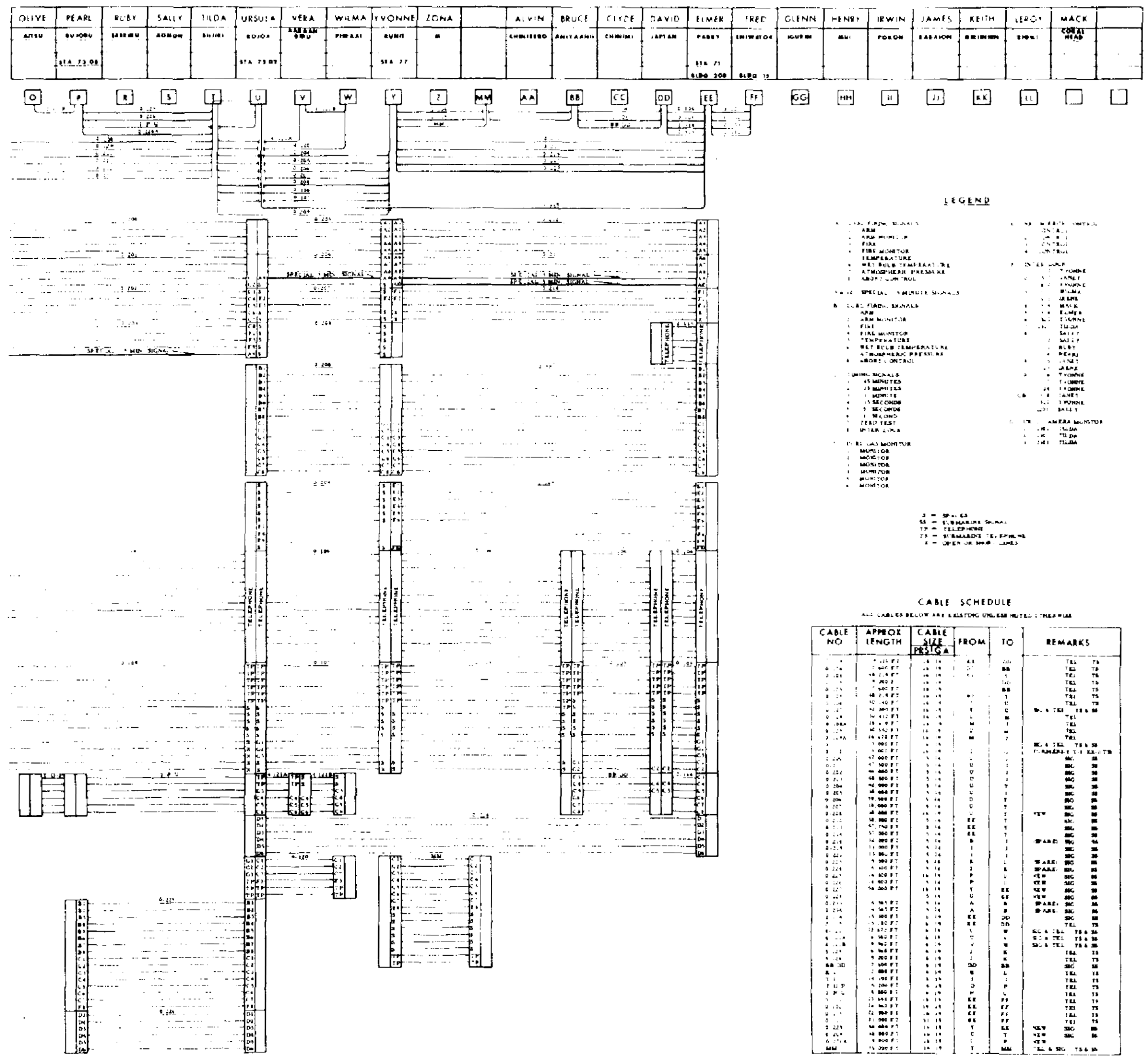


Figure 2-168. Submarine Cable Block Diagram - Eniwetok Atoll - Sheet 2 of 2

SUBMARINE CABLES.

In planning the submarine cable system for Operation REDWING, a complete survey of existing cables was made early in the program. Preliminary estimates of requirements were made, which included replacing all damaged and faulty cables and providing cable for additional circuits. Approximately one-half million feet of cable and necessary splice boxes were initially ordered for shipment to Jobsite. An engineering study established that sixteen-pair No. 19 plastic wire-armored submarine cable had physical and electrical characteristics which were generally adaptable to the requirements of the Proving Ground.

For the cable pairs allocated to the inter-island telephone system, medium loading was required to provide minimum attenuation of voice frequencies to a cutoff point of approximately three kilocycles. This was accomplished by 88 millihenry loading coils, assembled in cylinders which were located in splice boxes at approximate 6000-foot intervals.

As the signal and telephone requirements were firmed by the Using Agencies, they were consolidated and furnished to the Contractor in the form of cable allocation charts. Layout drawings and block diagrams, Figures 2-168 thru 2-171 were prepared, adapting the information for Jobsite installation.

The existing submarine cable terminal at Yvonne was located in an area in which destruction was probable as a result of test events. This terminal station was therefore replaced by new Timing Station Seventy Seven, which was located near the camp area and was considered to be out of the possible destruction area of the Yvonne events.

In planning for cable installation at Bikini Atoll, it was considered that the barge events would require a major portion of new cable. The barges were to be expended in succession at approximately the same location off site George. Two 16-pair No. 19 submarine cables were required for signals and communication for each barge. The land terminal point for these cables was the submarine cable terminal (Building No. 3.3) on George. A total of approximately 225,000 feet of cable was allocated for the barge installations.

Due to difficult trenching conditions, erosion, and anticipated inundation from several events, 6500 feet of 16-pair No. 19 telephone cable, which under normal circumstances would be buried underground from the terminal building on George to the camp switchboard on Fox, was supplied as a submarine cable and installed in the lagoon. Similar conditions existing in the Tare complex and the necessity of protecting the island distribution network from the Zuni event required the installation of 16-pair No. 19 cable from Station 2300 to Station 2200, and one 16-pair No. 19 cable from Station 2300 to Station 22, as submarine cable to be installed in the lagoon. The total cable needed for these two runs was 25,800 feet.

Original requirements for the Eniwetok Atoll were estimated to be 359,600 feet, and at Bikini 328,650 feet. As the Operation developed, additional quantities were required because several sections of submarine cable developed faults and had to be replaced. A total of 449,000 lineal feet was installed at Eniwetok Atoll and 365,000 feet at Bikini Atoll. This cable was laid from specially-equipped M-boats. Approximately six 6,000-foot reels could be handled in one day, not including the splicing time.

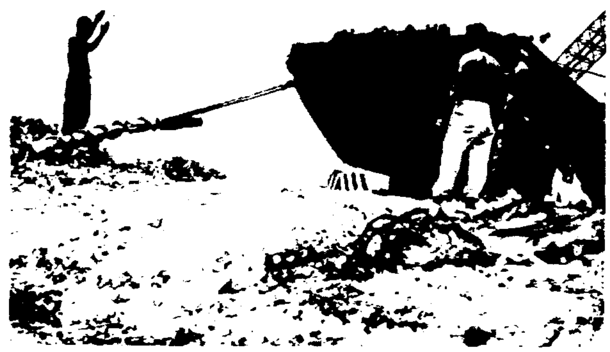


Figure 2-165. Submarine Cable - Temporarily Anchored

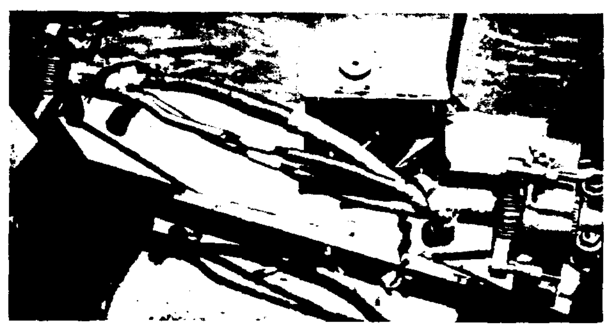


Figure 2-166. Cable Being Spliced

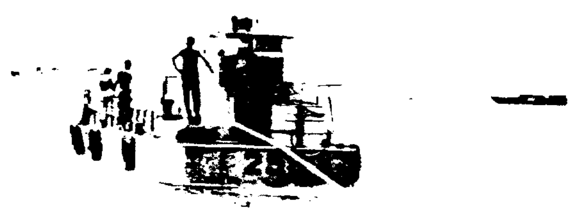


Figure 2-167. Laying Submarine Cable

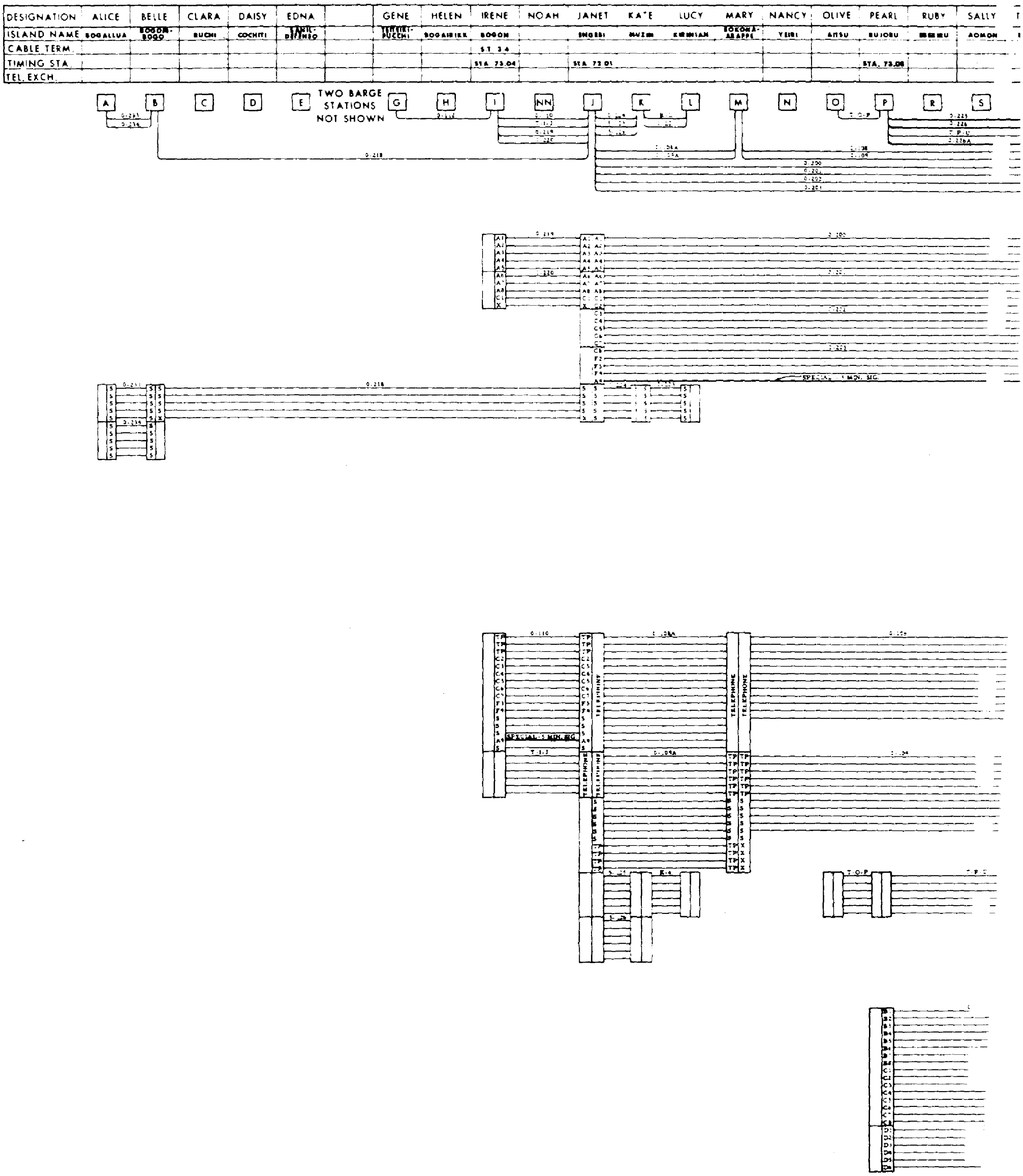
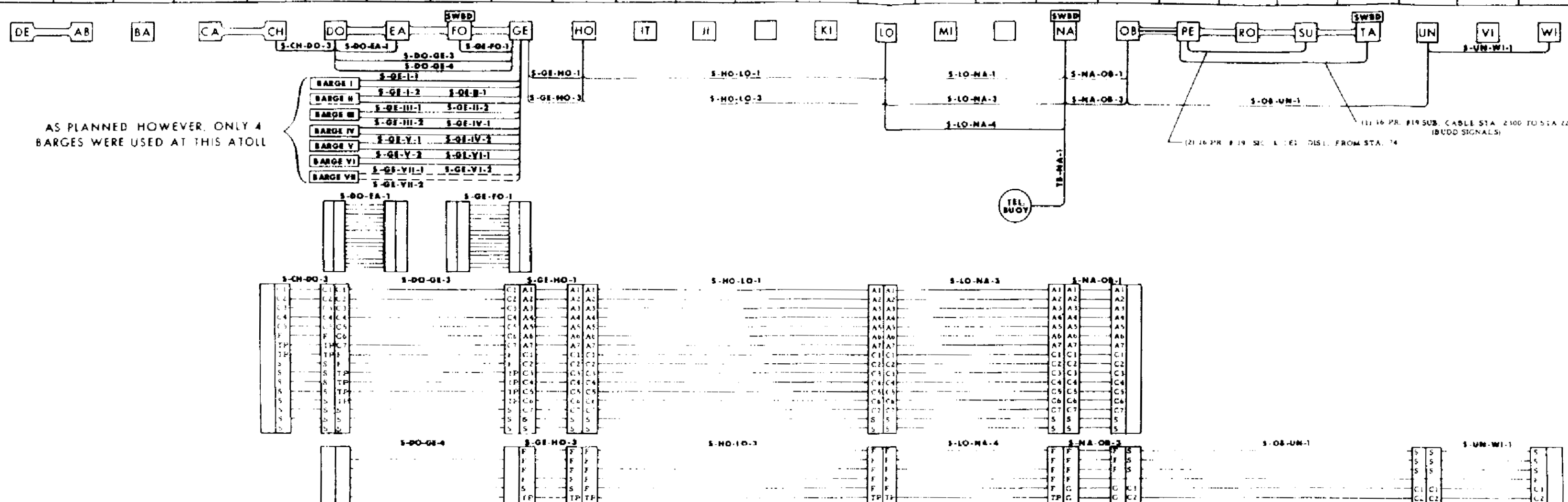
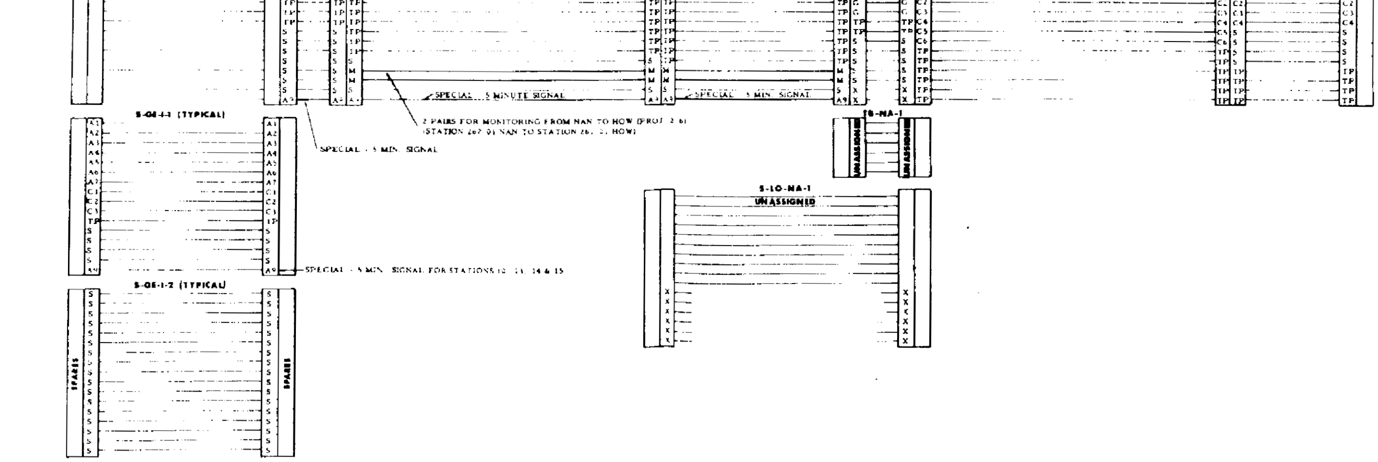


Figure 2-168. Submarine Cable Block Diagram - Eniwetok Atoll - Sheet 1 of 2

SIGNATION	DELTA	ABLE	BAKER	CAUSEWAY CHARLIE	CHARLIE	DOG	EASY	FOX	GEORGE	HOW	ITEM	JIG		KING
LAND NAME		BOKORY-AADAA	BOKON-EJIEN	NAMU	NAMU	YUROCHI	UORIKKU	BOMURIKKU	AOMOEN	BIKINI	BOKON-FUAAKU	YOMYARON		ENIAIRO
ABLE TERM.					ST 31	S.T. 3.2			ST 33	ST 12				
ING STA.					STA. 73.01	STA. 75.01			STA. 76	STA. 75.02				
EXCH.														

SIGNATION	LOVE	MIKE		NAN	OBOE	PETER	ROGER	SUGAR	TARE	UNCLE	VICTOR	WILLIAM	YOKE	ZEBRA	ALFA	BRAVO
LAND NAME	ROCHI-KARAI	IONCHEBI		ENYU	AIRUKIIJI	AIRU-KIRARU	BIGIREN	BEERE	ENINMAN	ENIIRIKKU	RUKOJI	CHIEERETE	ARRIIKAN	OURUKAEN	BOKOAITO-KUTOKU	BOKORYURU
ABLE TERM.	ST 13			S.T. 11	ST 21			S.T. 22	—							
ING STA.				STA. 70	STA. 74			STA. 73.06		STA. 73.07		STA. 73.05				
EXCH.						STA. 2300			STA. 22							





CABLE NO.	APPROX. LENGTH	CABLE SIZE PRS	CABLE SIZE GA	FROM	TO	REMARKS
S-CH-DO-3	45,450 FT	16	19	CH	DO	NEW TS & SS
S-DO-GE-3	16,150 FT	16	19	DO	GE	TS & SS
S-DO-GE-4	16,150 FT	16	19	DO	GE	
S-GE-I-1	15,500 FT	16	19	GE	I	TS & SS
S-GE-I-2	15,500 FT	16	19	GE	I	SPARES
S-GE-II-1	15,500 FT	16	19	GE	II	TS & SS
S-GE-II-2	15,500 FT	16	19	GE	II	SPARES
S-GE-III-1	15,500 FT	16	19	GE	III	TS & SS
S-GE-III-2	15,500 FT	16	19	GE	III	SPARES
S-GE-IV-1	15,500 FT	16	19	GE	IV	TS & SS
S-GE-IV-2	15,500 FT	16	19	GE	IV	SPARES
S-GE-V-1	15,500 FT	16	19	GE	V	TS & SS
S-GE-V-2	15,500 FT	16	19	GE	V	SPARES
S-GE-VI-1	15,500 FT	16	19	GE	VI	TS & SS
S-GE-VI-2	15,500 FT	16	19	GE	VI	SPARES
S-GE-HO-1	63,494 FT	16	19	GE	HO	EXISTING SS
S-GE-HO-3	63,494 FT	16	19	GE	HO	NEW TS & SS
S-HO-LO-1	25,158 FT	16	19	HO	LO	EXISTING SS
S-HO-LO-3	25,158 FT	16	19	HO	LO	NEW TS & SS
S-LO-NA-1	22,931 FT	16	19	LO	NA	EXISTING
S-LO-NA-3	22,931 FT	16	19	LO	NA	NEW SS
S-NA-OB-1	65,874 FT	16	19	NA	OB	EXISTING SS
S-NA-OB-3	65,874 FT	16	19	NA	OB	NEW TS & SS
S-LO-NA-4	22,931 FT	16	19	LO	NA	TS & SS
S-OB-UN-1	25,000 FT	16	19	OB	UN	TS & SS
S-UN-WI-1	27,300 FT	16	19	UN	WI	TS & SS
S-TB-NA-1	2,000 FT	16	19	TB	NA	UNASSIGNED
S-DO-EA-1	5,000 FT	16	19	DO	EA	NEW
S-GE-FO-1	6,500 FT	16	19	GE	FO	NEW
S-GE-VII-1	15,500 FT	16	19	GE	VII	NEW TS & SS
S-GE-VII-2	15,500 FT	16	19	GE	VII	NEW SPARES

LEGEND

A. FIRING SIGNALS
1 ARM
2 ARM MONITOR
3 FIRE
4 FIRE MONITOR
5 TEMPERATURE
6 WET BULB TEMPERATURE
7 ATMOSPHERIC PRESSURE
9 SPECIAL - 5 MINUTE SIGNAL (LASL)

B. NONE

C. TIMING SIGNALS
1 45 MINUTES
2 15 MINUTES
3 1 MINUTE
4 15 SECONDS
5 5 SECONDS
6 1 SECOND
7 ZERO TEST

D. NONE

E. NONE

F. INTERLOCK OR MONITOR
1 1315 CHARLIE
2 1320 DOG
3 1512 GEORGE
4 1521 GEORGE
5 1515 HOW
6 2300 PETER
7 2200 SUGAR
8 22 TARE
9 1515 WILLIAM

G. CAMERA CONTROL
1 CONTROL PAIR
2 CONTROL PAIR
3 CONTROL PAIR

S SPARE
TP TELEPHONE
X OPEN OR SHORT LINE
M MONITORING

EXISTING CABLE
NEW OR REPLACED CABLE

TS - SUBMARINE TELEPHONE CABLE
SS - SUBMARINE SIGNAL CABLE

TS & SS - COMBINED TEL. & SIG. CABLE

Figure 2-169. Submarine Cable Block Diagram - Bikini Atoll

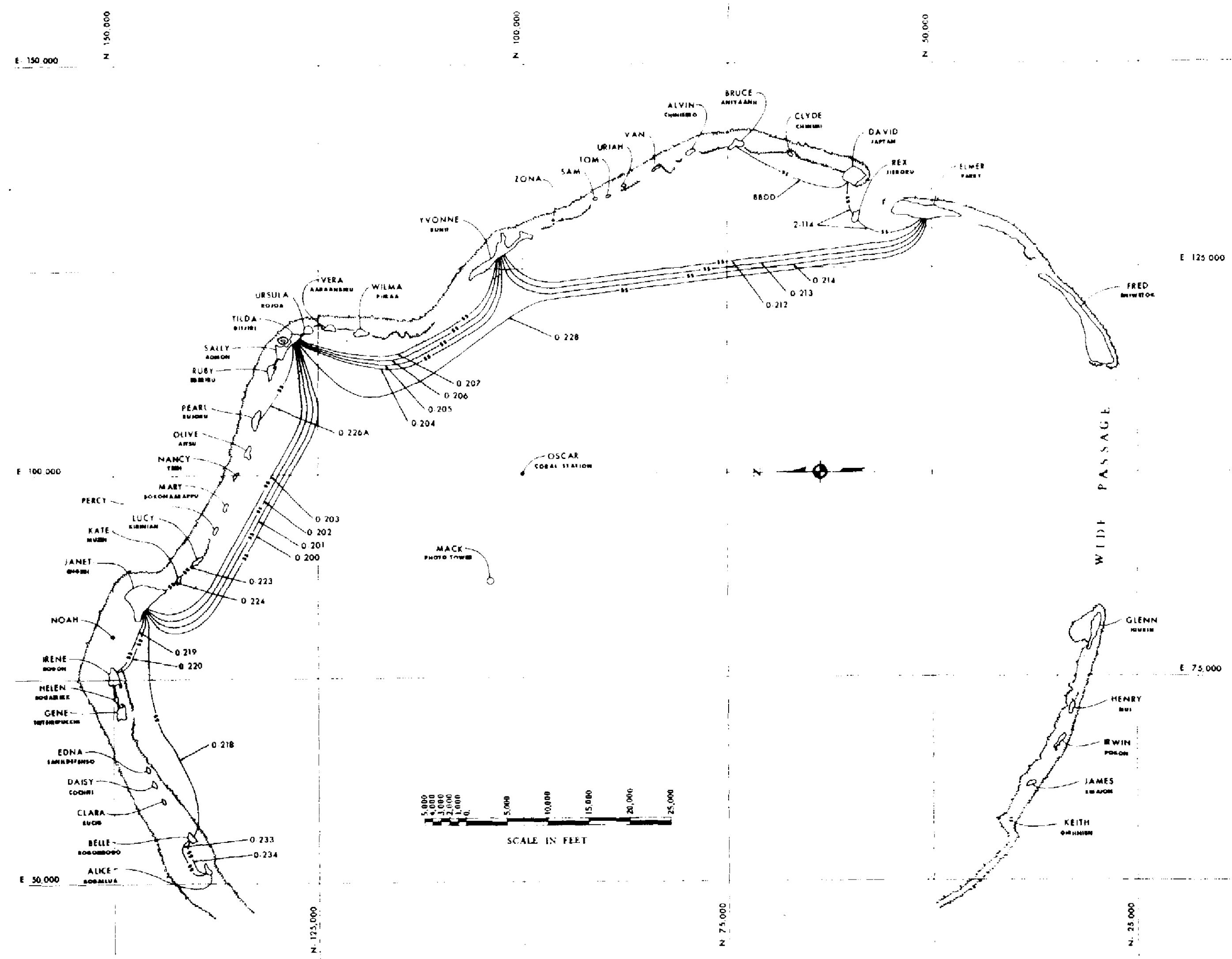


Figure 2-170. Submarine Cable Layout - Eniwetok Atoll

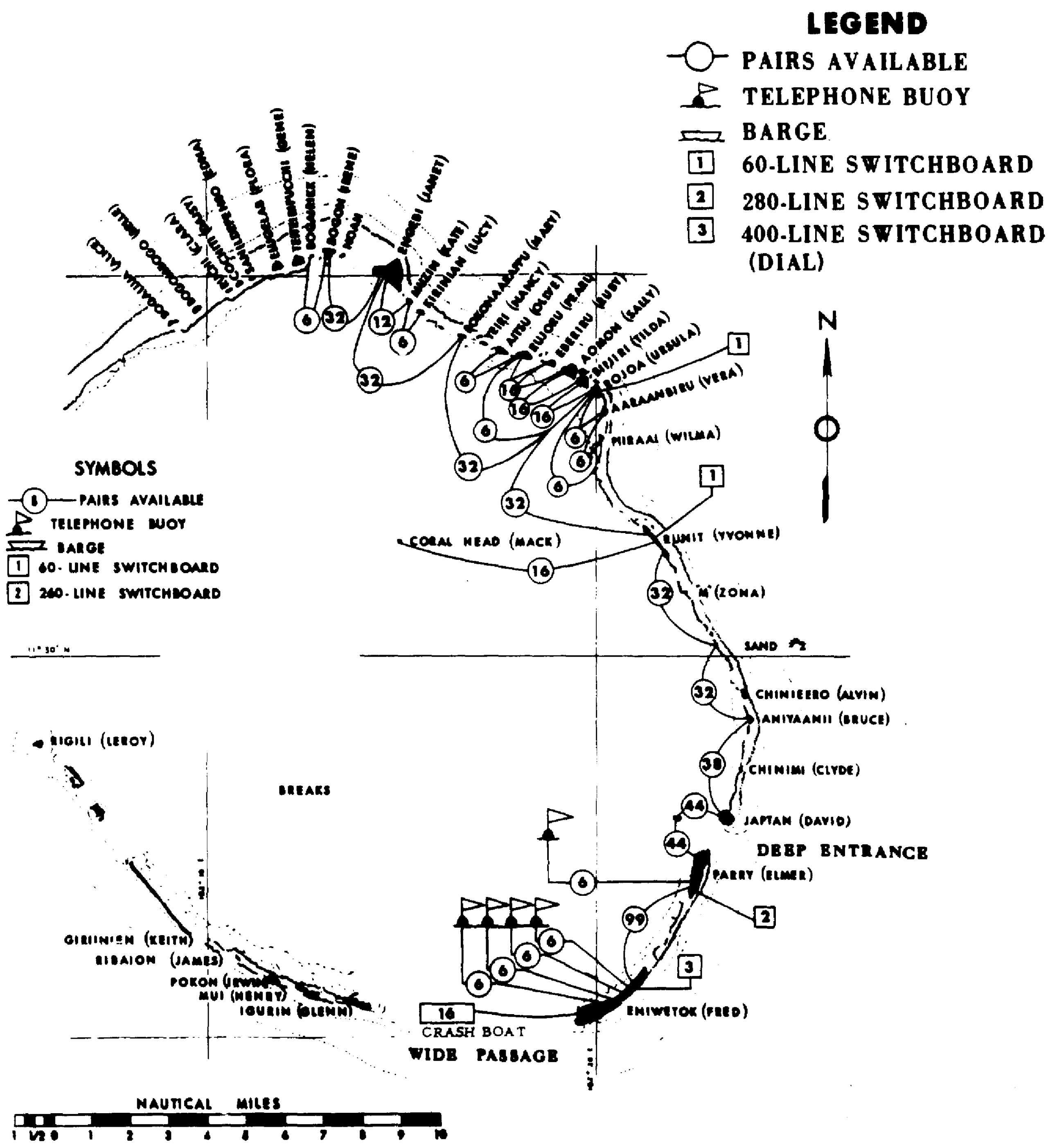


Figure 2-172. Telephone Communications - Eniwetok Atoll

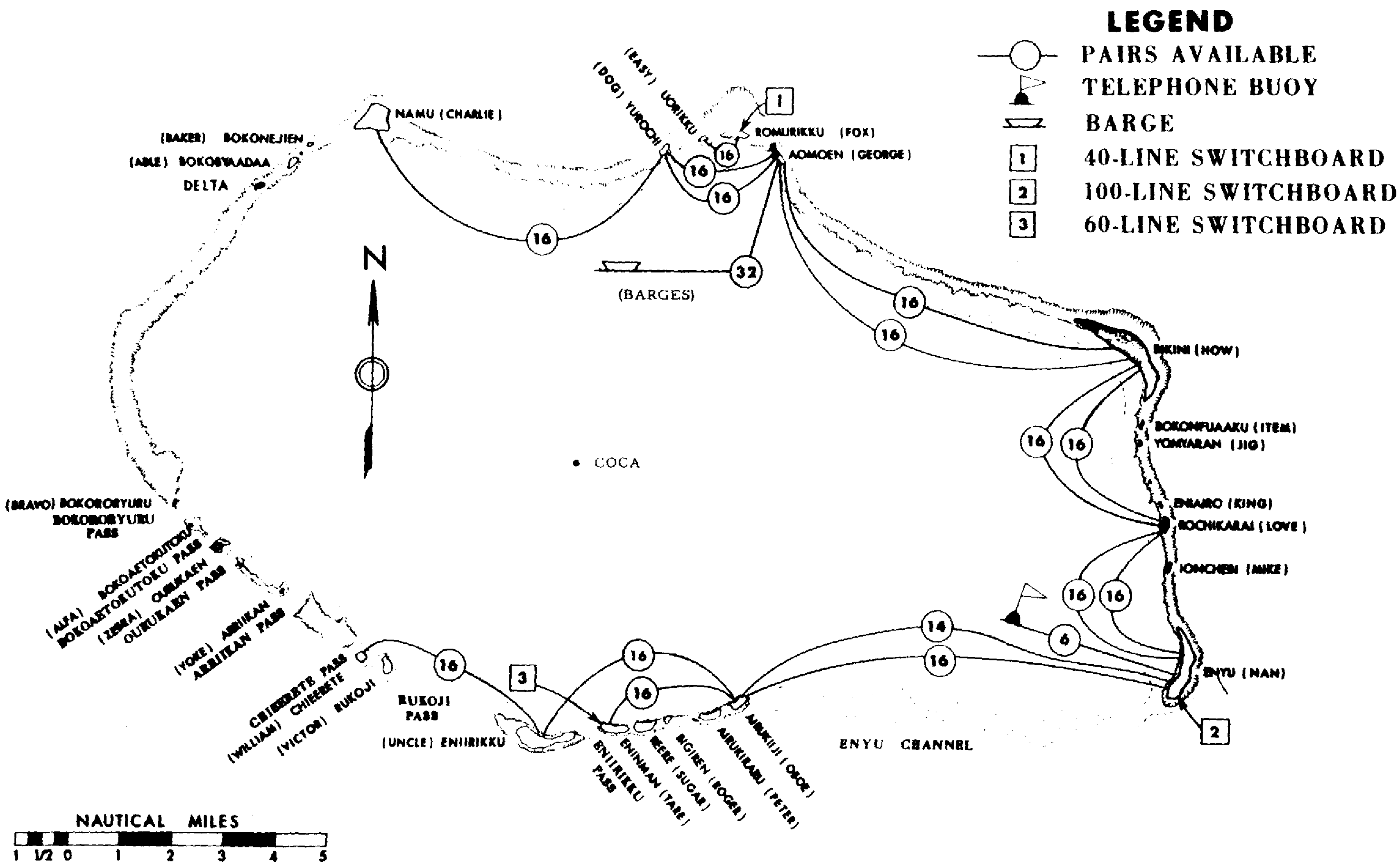


Figure 2-173. Telephone Communications - Bikini Atoll

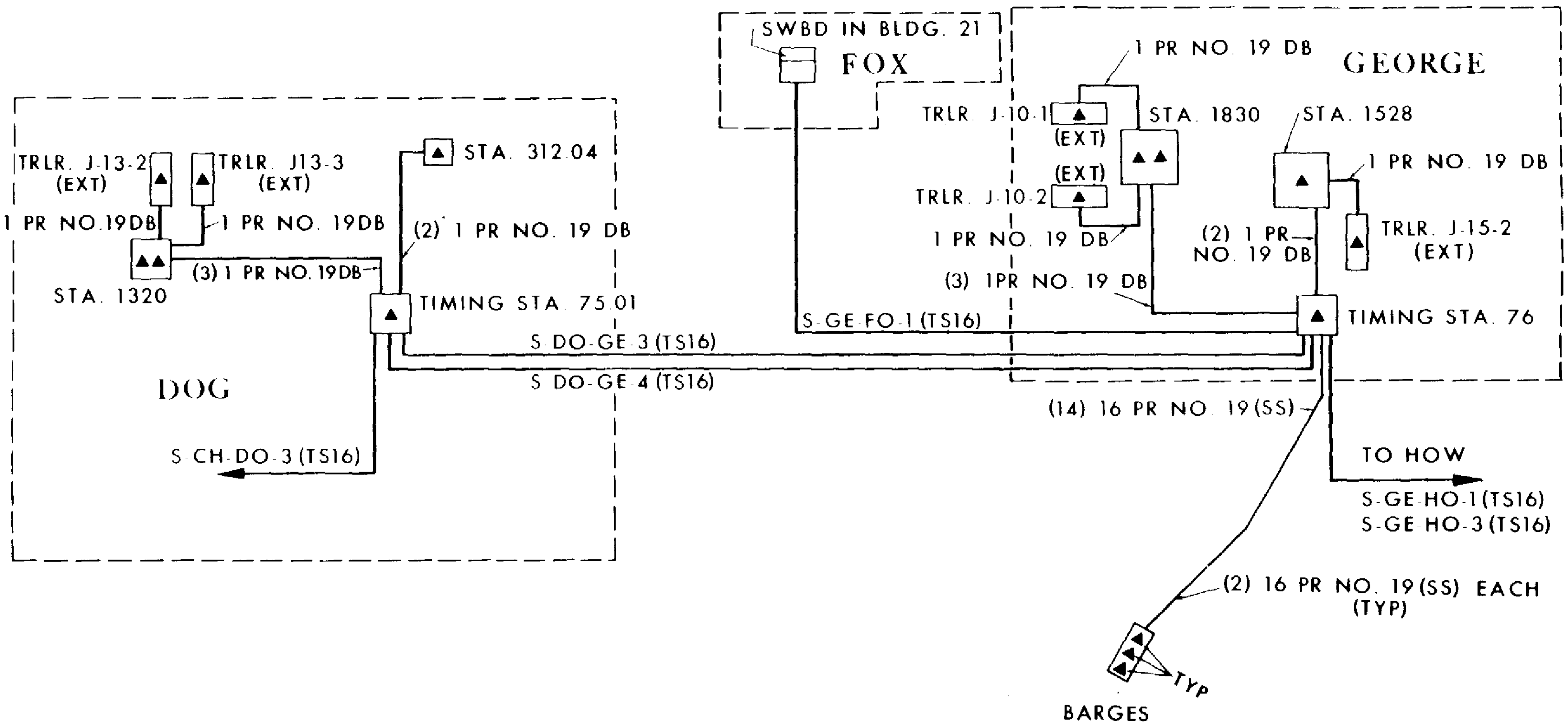


Figure 2-174. Typical Telephone Circuits for Island Complexes

MISCELLANEOUS CONSTRUCTION.

To support the REDWING Operation adequately, numerous miscellaneous jobs were accomplished under the Expendable Test Facilities Program. Progress of these items was reported as shown in Chart No. 2-3 under the following three categories: User's Test Facilities; Miscellaneous Test Construction Other Than Scientific Stations; and Miscellaneous Expendable Construction-Including Reimbursable.

The "User's Test Facilities" construction projects were accomplished on many islands of Eniwetok and Bikini Atolls. These facilities were required by scientific personnel for instrumentation and operational purposes. Included in this catagory were the grading and stabilizing of areas for parking of User's vans, the provision of water, power, and other services to these areas, the construction of numerous tents for use in connection with User's vans, the installation of security fencing and lighting for designated restricted areas, the construction of a number of MP guard shacks, the construction of an animal shelter and exercise building on David, clearing and grading for additional roads, the construction of helicopter mats near critical stations, and other like items.

Illustrative of the extent and type of work required under the category of "Miscellaneous Test Construction Other Than Scientific Stations" are the following:

Establish Station 1612 mock-up at trailer lot on Elmer, including grading, a concrete pad, and a framed rain shed over an instrument mount.

Construct a float 14′ long with 5′ beam of ⅜″ plywood decked and fitted with a 3′ x 3′ hatch.

Rehabilitate Janet airstrip and grade 150′ x 300′ along one side of runway.

Construct LST landing ramp adjacent to deep water pier, Elmer.

Provide pit latrines at Stations 5, 6, 7, 23 and 24.

Rehabilitate Building 341. Repair and test air conditioning and public address system.

Construct 72 8-man tents, for temporary housing, Elmer.

Construct 15-tent slabs on Fred (tents erected by military personnel).

Construct a 96-man decontamination station, sites Elmer and Nan.

Demolish Sandstone Gamma Baker Station, IVY Station 202, CASTLE Station 1211, and GREENHOUSE Station 20E.

Provide earth berms around Nan power house (NA-500) and Station 70.

Install four poles and one power outlet for User-furnished Rhombic antenna.

Construct new Coca triangulation station.

Support Eniwetok Marine Biological Laboratory.

Under the category "Miscellaneous Expendable Construction" were numerous small jobs of modifications to existing facilities, such as replacements or additions of electrical fixtures which normally could not be classified as maintenance. For the control of expenditures for such work at Fred, an "Atcom Advance Fund" was established, against which the Atoll Commander could obligate funds for the betterment of established facilities. Included under this category in support of REDWING were the following items:

VHF propagation tests to determine the feasibility of VHF circuits for inter-atoll communications.

Transfer of one generator from the Fred to the Nan powerhouse. (Similar generator in Nan powerhouse damaged beyond economical repair during CASTLE.)

Construction of decontamination barge for use in case operations at Bikini were shifted to bases afloat as in CASTLE.

Construction of helicopter pads at sites Leroy, How, Uncle, Bruce and David. (Helicopter landings not provided in temporary camp construction.)

Construction of approximately 75 additional (wooden) clothes lockers. (Shortage of clothes lockers was due to increase in participating personnel beyond that anticipated.)

Installation of navigation ranges for small craft approaching Nan, Gene and Yvonne. (Required to facilitate entry of marine craft by night to meet needs of scientific personnel.)

Under the category "Miscellaneous Expendable Construction-Reimbursable" were those projects of a more or less permanent base character accomplished by the Contractor for AEC but funded by other agencies. Constructed under this category were the following:

Weather stations at Tarawa, Kapingamaringi, Kusaie and Rongerik.

Modification to Building 15, Fred.

Annex to Rad-Safe, Building 221, Elmer.

Tie-down anchors and static grid, Fred.

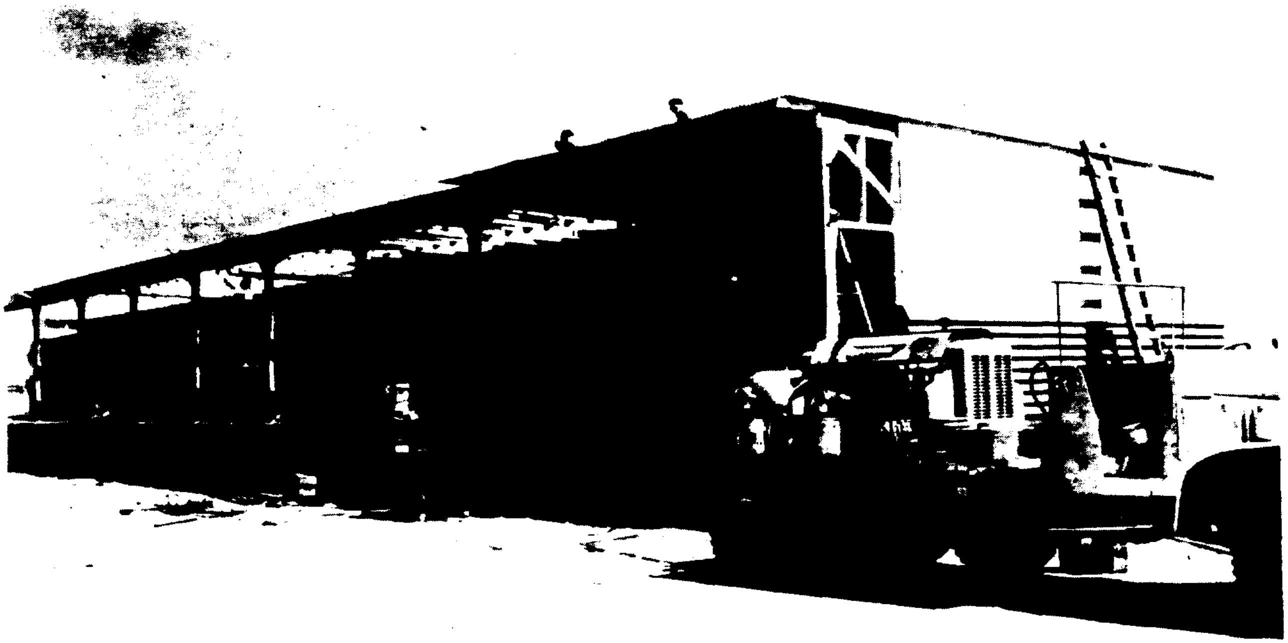


Figure 2-175. Refrigeration Project - Fred - 38% Complete

Figure 2-176. TG 7.3 Recreation Facilities - 80% Complete

Additional parking apron, Fred.

Modification of Building 90, Fred.

Sleeve antennas, transmitting station, Fred.

Antenna joint transmitting station, Fred.

Laboratory and administration spaces for TG 7.1, Fred.

Communication facilities, Buildings 164 and 221, Elmer.

Ice Block tanks, Elmer.

Remodel Building 120, Elmer.

Refrigeration project, Fred.

Comunication facilities, Buildings 89, 638 and 90, Fred.

Recreation facilities for TG 7.3, David.

Of particular interest in the foregoing work was the planning and implementation of Projects for TG 7.1 administration - laboratory spaces and for the weather stations.

In eary October 1955, criteria were first received for space requirements of TG 7.1 on Fred. The proposal then submitted to the Contractor called for the construction of three buildings with a total of 10,500 square feet and the rehabilitation of Buildings 633, 634, 635, 636, and 640 with an additional power supply from portable generators in view of the critical power situation at Fred. Completion of this project was requested by 1 March 1956. To meet this date the design was based on materials that could be procured on acceptable dates. Final authorization for the construction of Buildings 686 and 687, and the rehabilitation of Buildings 633, 634, 635, 636, and 640 was received on 26 January, at which time a completion date of 15 March was requested. At that time, the Contractor was informed that in lieu of Contractor-furnished generators, four 60 KW Government-furnished generators would be forthcoming to provide power for Buildings 633, 634, and 635 and that power for the other buildings would be provided from the island system. Completion could not be met by the requested date of 15 March because of the late receipt of electrical items and some of the dehumidifying equipment resulting primarily from the late firming of requirements for this project. About 22 March the project was only 57 per cent complete; approximately one-third of the space was made available to the users. Through a concentrated effort, this project was, for all practical purposes, completed on 21 April 1956, with progress reported at 97 per cent.

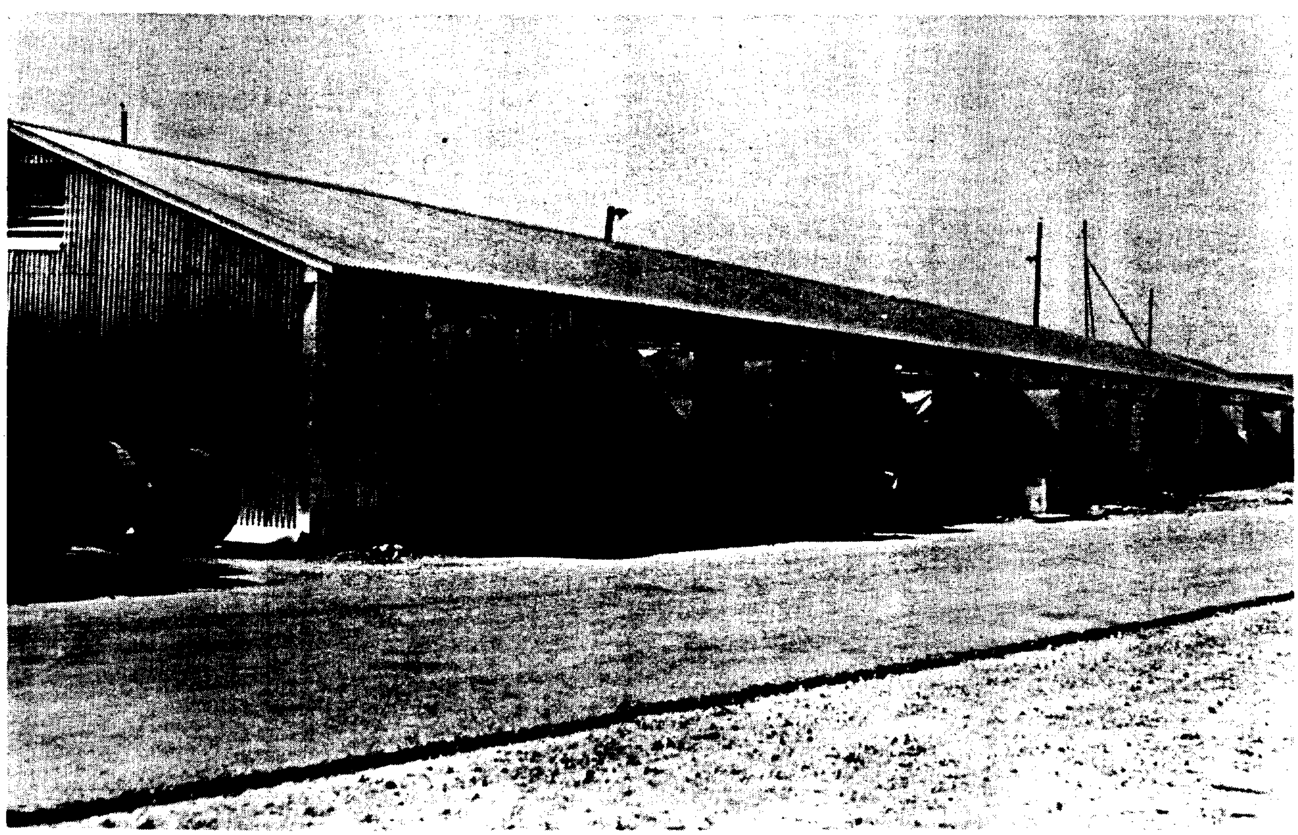


Figure 2-177. TG 7.1 Laboratory and Administration Building - Fred

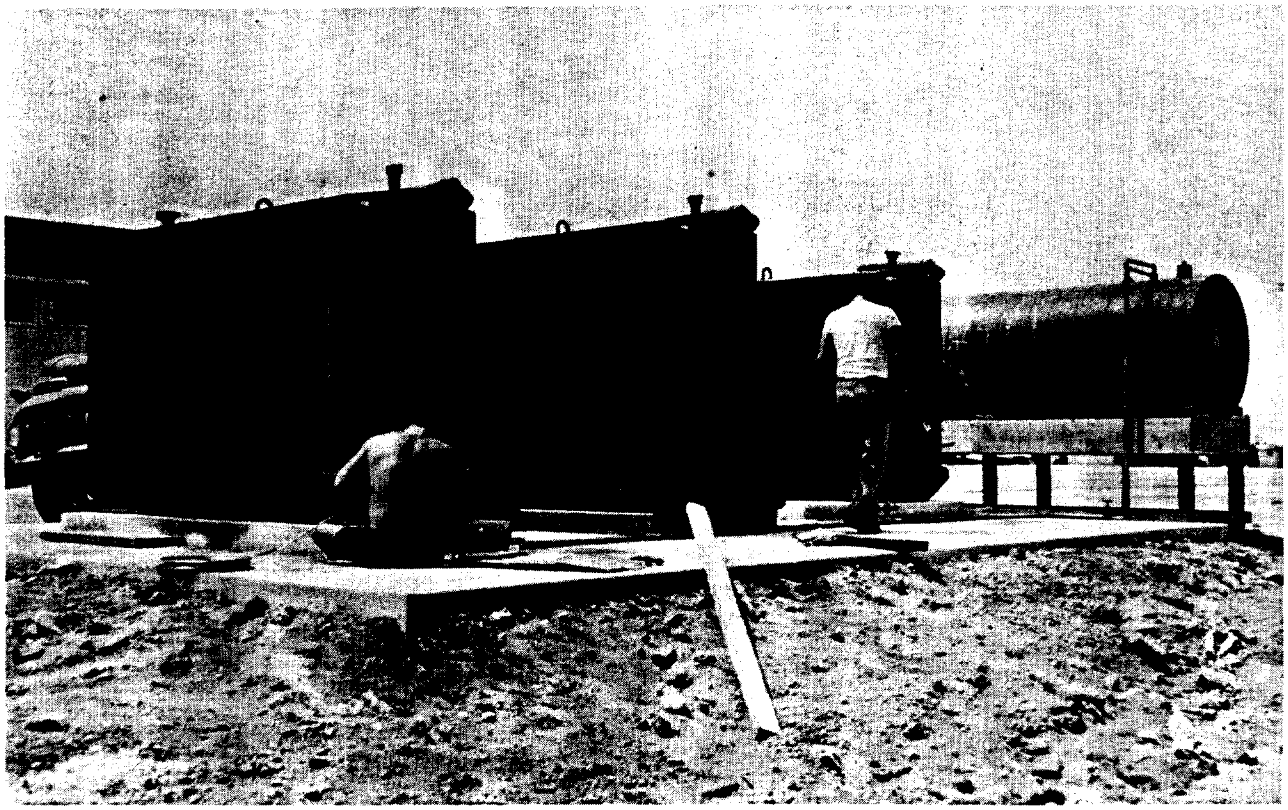


Figure 2-178. Generator for Buildings 633, 634, and 635 - Fred

OFF-ATOLL PROJECTS.

On 21 May 1955, representatives of the Contractor accompanied personnel of Advance Headquarters JTF-SEVEN, AEC and the U. S. Air Force on a reconnaissance of certain islands in the Western Pacific Ocean area to determine the suitability of locations, to select specific sites, to develop information upon which estimates for the construction of weather stations could be made, and to conduct a study of the logistics support problems involved. A PBM plane was made available for this reconnaissance; the sites visited were Kusaie, Tarawa, Kapingamarangi, Rongerik and Taongi. After an aerial sweep of each proposed site to determine breaks in the reefs, (which would permit entry by supporting vessels) a landing was made. A survey was then made to determine the availability of aggregate for concrete, the approximate number and height of trees that would have to be removed, the condition of the beaches for use by landing craft, the ground height above high tide, the slope of the ground and other relevant items as were necessary for planning purposes. A sketch and detailed report were prepared and forwarded to the Home Office, for use in making preliminary plans and estimates. The Taongi site was eliminated due to its inaccessibility to surface vessels. The plans that evolved as a result of this reconnaissance called for simple wooden-frame structures on concrete floors, using double aluminum roofs and plywood for siding; this type of structure was planned for an operational and supply building, and for the camp buildings and facilities needed for approximately 25 operating personnel. Five existing buildings on Rongerik were to be rehabilitated for this use. Construction of these projects was scheduled in two phases: in the first phase the various structures and service facilities were to be provided and in the second phase the weather station equipment would be installed. To provide the logistic support for this construction, CJTF-SEVEN arranged a schedule of supporting vessels so that the first phase at each site could be completed by 1 February 1956, and the second phase by 1 April 1956. The reconnaissance had established that the Kapingamarangi project could best be supported by the use of an LSD with an LCU outfitted as a houseboat; the other projects could be supported by an LST. Firm approval of the construction and confirmation of site acquisition were delayed until two days prior to the departure of the first scheduled vessel on the Kapingamarangi mission. The rigid time schedule of this vessel required a readiness which compelled the prefabrication of building assemblies, a water tower, and other preliminary work in advance of drawing and estimate approvals by CJTF-SEVEN.

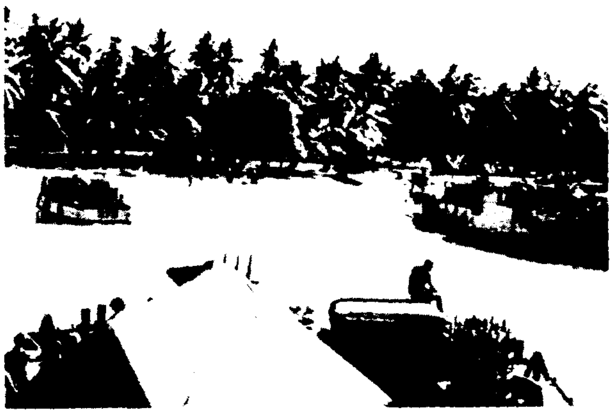


Figure 2-179. Arriving Wotho

Figure 2-181. Existing Road - Wotho

Figure 2-180. Pier Facilities - Betio Island, Tarawa

The first phases of the Kapingamarangi and Kusaie projects were completed and that of Tarawa was nearing completion when the off-atoll scientific requirements were made known. Criteria and priorities in the construction of these projects were not firmly established until 26 January 1956 when a conference was held in the Contractor's Home Office between representatives of the AEC, JTF-SEVEN and other interested parties, at which time all off-atoll work was covered. The off-atoll scientific projects were to be located on Ujelang, Wotho, Uterik, Rongerik and Kusaie. A rescheduling of supporting vessels was then effected so that the scientific projects could be undertaken along with the work remaining on weather station projects.

The major problems with off-atoll construction were those connected with logistics. Planning of each mission had to be detailed with respect to men, materials, and equipment since resupply for each construction mission was limited to that which could be carried on a PB-M-type plane. One of the PBM's was lost in landing at Kusaie. A large seaplane landing area was thereafter wire dragged to 9 feet and marked with appropriate buoys. The beaching of the LST at Tarawa was delayed from 11 December to 16 December because of existing unfavorable conditions. When the vessel finally beached, it was approximately 500 feet from the shore with three to six feet of water at the bow ramp. Vehicles could be taken over the bow ramp only during a three hour period. A DUKW was used to transfer packaged cargo from the LST to the beach. Other cargo was landed through the use of a barge and tug which were furnished free of charge by the Tarawa local government. This latter cargo had to be landed at the pier located on this island which was about one mile from the construction site.

Each weather station was provided with an operation-supply, mess hall, day room, two barrack-buildings each 48′ x 20′, and a pump house 16′ x 16′. The buildings were wooden-

Figure 2-182. Aerial View of Tarawa

Figure 2-183. Clearing Beach for LCU Landing

Figure 2-185. LCU at Uterik during Low Tide

Figure 2-184. LCU at Kapingamarangi

Figure 2-186. Operations Building - Rongerik

framed, on concrete slabs, and covered with plywood or aluminum (whichever was available.) Power and fresh and salt water services were provided. Navy cubes on a prefabricated wood tower were used for elevated water storage; Navy cubes were also used for fuel-storage and septic tanks. Each weather station required concrete anchor blocks for guying each of three 90-foot antennas, and a concrete rawinsonde pad. Limited camp facilities at Wotho, Uterik, and Ujelang were provided by the erection of tents or sheds for shelters. A standard Jobsite portable galley was used at Wotho, and at the other two sites a galley was set up around army field ranges.

The off-atoll scientific projects were as follows:

Wotho — Stations 562.01 and 562.02 for Raydist receiving-transmitting: These stations consisted of two antenna farms approximately 3,200 feet apart in cleared ground with antenna poles at each farm guyed to three concrete guy anchor blocks. Power at each station was supplied from two portable generators. Telephone service between stations was provided through a six pair conductor; one pair also led to a camp tent.

Project 31.1 Microbaragraph Station: This recorder station was set up in an eight-man tent, which was provided with a work bench and electric outlets.

Ujelang — Project 31.1: Construction requirements were similar to those on Wotho.

Uterik — A Rad-Safe monitor station in an eight-man tent was provided with power and water service.

Rongerik — Project 2.65: Contractor cleared ground for a station set up b Users.

Project 6.3: Area was cleared, four posts, station equipment, and portable generators were set up, an fuel and water service provided.

Project 31.1: Same as for Wotho.

Kusaie — Project 6.3: Same as for Rongeri

The building schedule for off-atoll construction as finally accomplished was as follows:

SITE	PROJECT	1st PHASE	2nd PHASE
Kapingamarangi	Weather Station	9-10-55/10-2-55	2-22-56/3-5-56
Kusaie	Weather Station	11-12-55/12-8-55	2-15-56/3-21-56
	Project 6.3		Ditto
Tarawa	Weather Station	12-11-55/1-13-56	3-22-56/3-28-56
Rongerik	Weather Station		1-29-56/2-14-56
	Project 2.65		Ditto
	Project 5.6		Ditto
	Project 6.3		Ditto
	Project 31.1		Ditto
Ujelang	Project 31.1		3-29-56/4-6-56
	Project 5.6		Ditto
Uterik	Rad-Safe Monitor Station		2-28-56/3-13-56
Wotho	Projects 5.6 and 31.1		2-7-56/2-20-56

Figure 2-187. Camp Area - Wotho

SECTION 5
PERMANENT CONSTRUCTION

A long range plan* for improvements of the PPG facilities and utilities was initially prepared in October 1952, then revised in 1954 after CASTLE, and again in June 1956 as REDWING neared completion. The conclusions and recommendations contained in these reports were predicated on sound and reliable information resulting from the experience with all phases of engineering, construction, operation and maintenance. Each plan covered those items considered necessary and desirable for each succeeding test operation. This Completion Report covers the items undertaken from 1 July 1954 through 30 July 1956. When the Long Range Plan of 1954 was formulated, all eventualities of the next operation could not possibly have been foreseen. Therefore, in addition to items recommended in this plan, a number of items had to be undertaken due to increases in operational requirements and participating personnel for Operation REDWING beyond that anticipated when the plan was first prepared.

Shortly after the completion of Operation CASTLE, extensive improvements of the Fred airfield were undertaken. This eventually involved the asphalt paving of approximately 300,000 square yards of the airfield parking aprons and seal coating approximately 114,000 square yards of runway.

The parking aprons were, for the most part, composed only of a thick dust pallative which, under repeated use during CASTLE, had become broken and unsuitable for airplane operations. Using a survey grid system, the entire existing apron area was tested by the CBR method. These tests indicated that the aprons were substandard and would be particularly unsuitable for jet plane operations. The dust pallative of approximately two inches thick was removed and the base course thus exposed was tested again. The base course was removed in all areas that were found unstable, and after recompacting the sub-base, a new base course of graded aggregate was placed. The base course was compacted with a minimum CBR requirement of 80 per cent, but in 90 per cent of the tests the CBR's rose to 98 per cent. This assured adequate support for wheel loads up to 100,000 pounds. In areas where the CBR's indicated satisfactory stability, the surface was watered and rolled to grade preparatory to the application of asphaltic concrete.

* Proposed Long Range Improvement Programs dated October 1952, June 1954, and June 1956.

During REDWING, the parking area was increased by the addition of a southeast apron to provide for an increase in plane operations. The total apron area of approximately 300,000 square yards was paved with a 60-40 emulsion of bitumuls mixed with graded aggregate. The asphaltic concrete was deposited in windrows and spread with a blade. This operation was followed by rolling with steel rollers and finally with wobbly-wheel and compaction rollers. A 40-ton compaction roller was constructed in the field, largely from surveyed parts of other equipment. This roller consisted principally of eight large rubber-tired wheels and a frame on which a steel box, loaded with limonite concrete to provide the 40-ton load, was carried. The results obtained were good. One sub-base failure occurred which was found to be due to a rotting coconut log deeply embedded. This area was firm at the time of the CBR tests. There were no failures of the parking apron base course or paving during Operation REDWING.

After the completion of Operation CASTLE, the Fred runway showed signs of cracking at the surface. The runway was periodically shut down, the surface thoroughly cleaned, and a sand-seal coat of approximately one-quarter of a gallon of asphalt per square yard was applied. This operation was followed by rolling and later by sweeping to remove the excess sand. The new parking aprons were similarly treated for protection of the surface from jet plane blasts. This seal coating was effective in that patching was necessary only during the latter half of Operation REDWING.

Figure 2-188. Jobsite Fabricated Roller

Figure 2-189. Fred Airfield - Looking West

Figure 2-191. Excavating for Conduit from Runway

Figure 2-190. Southwest Apron - Fred Airfield

Figure 2-192. 24-Man Barrack - David

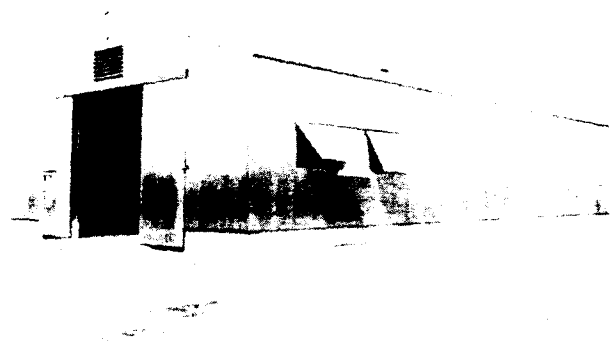


Figure 2-194. Camp Issue Building - Elmer

Figure 2-193. Chapel - Fred

The permanent construction requirements are listed under Budget Projects 5026, 6001 and 6011, and the items undertaken are indicated in Figures 2-5, 2-7, and 2-9. They are also shown graphically in the camp site plans of Elmer, Fred and David, Figures 2-199, 2-200, and 2-201. The cutoff date for reporting permanent construction is dependent upon the date the project is completed and does not necessarily coincide with the completion of a test operation.

To engineer the structures added to the permanent base, maximum use was made of prefabricated buildings. The all-aluminum building (Pacific Iron and Steel type) has practically become standard for such base structures as barracks, mess halls, offices, and other camp buildings. These buildings have double roofs for weather protection, and their most notable advantage is that they virtually do not require maintenance. The steel frame building with aluminum siding and roofing (Butler type) has become standard for warehousing and shops; this type of building lends itself well for these services. Exceptions to the standard designs were those for special-use buildings such as the chapels and the guest house on Fred, which were wooden-frame structures, and for the explosive storage facilities on Rex, which were Navy standard igloo-type steel magazines.

Due to the relatively low elevation of the islands and flat gradient of the normal ground surface, the drainage problem in certain areas was given special attention to ensure that warehousing facilities would be accessible and useable during all weather conditions. With respect to the construction of all buildings, there were no unusual problems except for those arising from a compressed construction schedule for those items included in Budget Project 6011. It was recognized early in the program that to have the facilities most urgently required for REDWING completed on time, it would be necessary to initiate procurement of construction materials as early as possible after the start of the Fiscal Year, 1 July 1955, when funds could be made available. Therefore, in May 1955, the Deputy Director, Test Division, authorized advanced planning and design so that necessary approvals from Using agencies could be obtained and purchase orders awarded without delay. Though unavoidable under the established funding and design approval process, the funds could not be made available until 11 August 1955, and final approval of drawings could not be given until late September and early October 1955. However, authority was received to proceed with preliminary work in advance of final approval of drawings. This preliminary work consisted of demolishing existing buildings, site grading, and pouring concrete foundations. By expediting the procurement of steel and aluminum components of buildings and by careful surveillance of transportation conditions to ensure adequate cargo space, the flow of materials started in September and was completed in December. As building materials began to arrive, men and equipment were concentrated on these projects and the work was well under way by December 1955. At this time, as previously noted, it was necessary to defer construction of certain nonvital projects in order to complete vital scientific test facilities on scheduled dates.

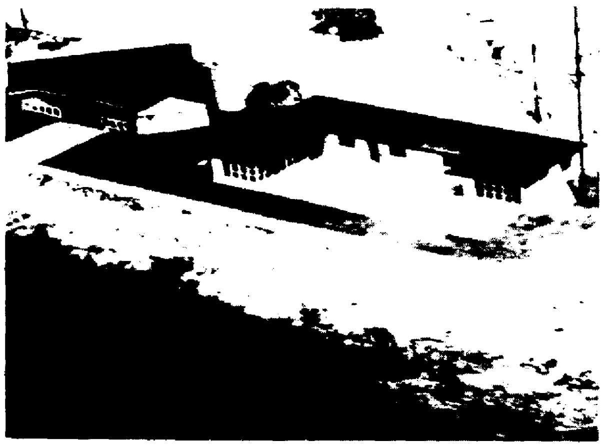


Figure 2-195. Guest House - Fred

A critical situation developed with respect to adequate storage and distribution of jet fuel because of delays in expanding the Fred POL system. A major contributing factor to the difficulties experienced with this project was the delays in the development of criteria by the U. S. Air Force. Several major revisions to criteria were received during the preparation of design in the Home Office. Also, a number of field conditions were not adequately provided for and a number of field revisions to the

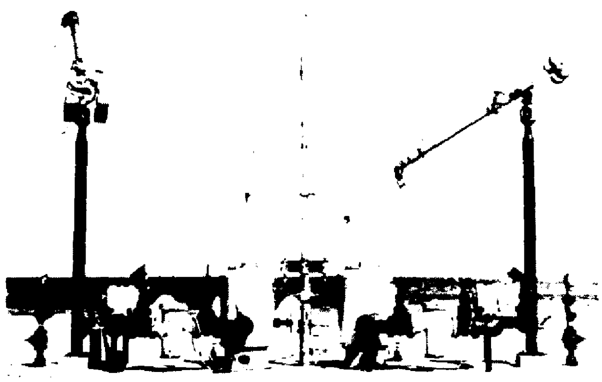


Figure 2-196. Jet Fuel Stand - Fred

design were found necessary. The additions to the jet fuel facilities system were not completed by the time the first jet planes arrived. Therefore, with the concurrence of the U. S. Air Force Command, certain changes to existing facilities were effected which permitted jet plane operations during the period when the jet fuel facilities were under construction. As finally designed and built, the POL additions consisted of two 5,000-barrel and two 10,000-barrel steel storage tanks (15,000-barrels Avgas and 15,000-barrels jet fuel); three new 6-inch steel filling lines (approximately 800 feet long) laid on the bottom of the lagoon from 0.0-foot elevation to minus 99 feet, each connected at the seaward end, by a 200-foot flexible submarine hose; a complete foamite system for new tanks; miscellaneous piping and appurtenances; one fill stand for Avgas and one for jet fuel; a 16′ x 25′ addition to existing pump house; an 8-foot-high aluminum chain link fence; and earth dikes for each tank.

The major permanent base construction (P&E Projects) is summarized in the following pages:

PROJECT 5026

BUILDING NUMBER	DESCRIPTION	SIZE SQ. FEET	TYPE
	FRED		
663 thru 673	11 - 48-man barracks	39,259	PI&S
	M. P. headquarters	1,950	PI&S
	Guest house	2,018	Wood - Composition Roof
	DAVID		
103	Mess hall	1,668	PI&S
106	24-man barrack	1,936	PI&S
101	Power and water	1,716	PI&S
102	Receiver building	1,356	PI&S
	ELMER		

Deep Water Pier - Elmer. A V-shaped pier of steel H-piling and wooden deck. The seaward leg for deep draft vessels was 351′ x 45′ with catwalk extensions to dolphins at each end; the northern catwalk was 165′ x 3′ and the southern catwalk 70′ x 3′. The elevation of the lagoon bottom at the face of the pier was minus 30 feet and the elevation of the pier was plus 12 feet. The other leg of the V was 416′ x 45′. This provided a dock for an LST and access to the deep water leg of the pier.

Fire Protection-Elmer. Additional fire protection for POL facilities, including Foamite generator for new 5,000-barrel tank and extension of salt water service and foam lines and existing tanks; an electric fire-alarm system, hose racks and additional water supply systems for existing warehouses at Elmer; and installation of four risers and plugs at the deep water pier.

Second Submarine Power Cable. Installation between Elmer and Fred of 3/C-250MCM armored 5KV cable, 17,500 feet in length with switching gear at Elmer and Fred and voltage regulator station at Fred.

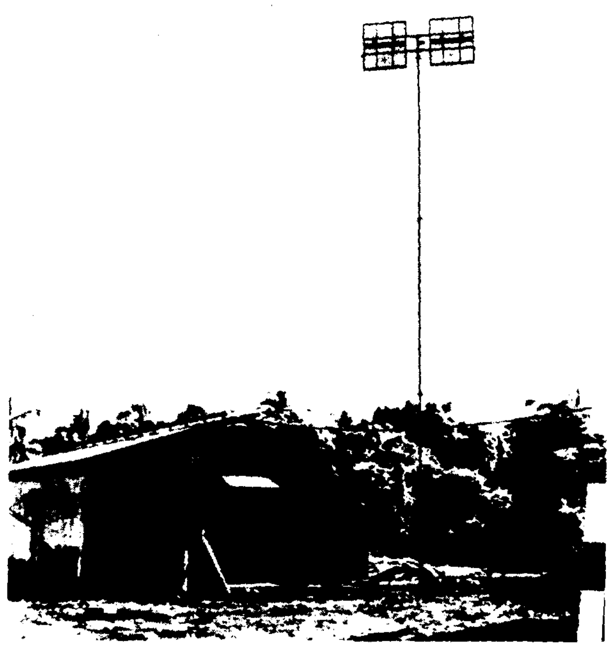


Figure 2-197. Joint Receiver Station - David

PROJECT 6001

BUILDING NUMBER	DESCRIPTION	SIZE SQ. FT.	TYPE
	ELMER		
209	Addition to Building 209	2,400	PI&S
242	Chapel	1,685	Wood - Asbestos Roof
205	Guard office and quarters	760	PI&S
117	Hospital addition	736	PI&S
223	Laboratory addition	3,840	PI&S
135-136	Barracks (2)	8,064	PI&S
680-1,-2,-3,-4	Latrines (5)	2,965	PI&S
513	Distillation plant addition	1,440	PI&S
515	Receiving and Classification	4,000	Butler
420	Convert Building 420, cement storage, to Marine repair Bldg.		
	FRED		
31	Laundry addition	3,650	PI&S
685	Crash fire station	4,950	PI&S
	DAVID		
180	Emergency Generator Shed	120	Wood - Shed Roof
	REX		
	Dynamite storage	2,680	Quonsets - Earth Cover - Navy Standard igloo type

PROJECT 6011

BUILDING NUMBER	DESCRIPTION	SIZE SQ. FT.	TYPE
	ELMER		
427	Cabinet shop	4,075	Butler
424	Paint shop	4,744	Butler
425	Paint storage	2,400	Butler
	POL facilities and fire protection		
	FRED		
679	Operations and administration building	16,196	Butler
678	Chapel	3,767	Wood - Asbestos Roof
683-4	Construction Maintenance shops	8,080	Butler
681	Electronics building	1,102	Butler
682	Construction maintenance shop	1,841	Butler

642	Warehouse	9,653	Butler
643	Warehouse	9,447	Butler
644	Warehouse	4,824	Butler
641	Warehouse	14,580	Butler
648	Warehouse	9,653	Butler
649	Warehouse	9,653	Butler
650	Warehouse	4,863	Butler
646	Warehouse	4,063	Butler
651	Warehouse	4,063	Butler
	POL facilities	2 - 5,000-bbl steel tanks 2 - 10,000-bbl steel tanks plus appurtenances	

Figure 2-198. New Housing Area - Elmer - 85% Complete

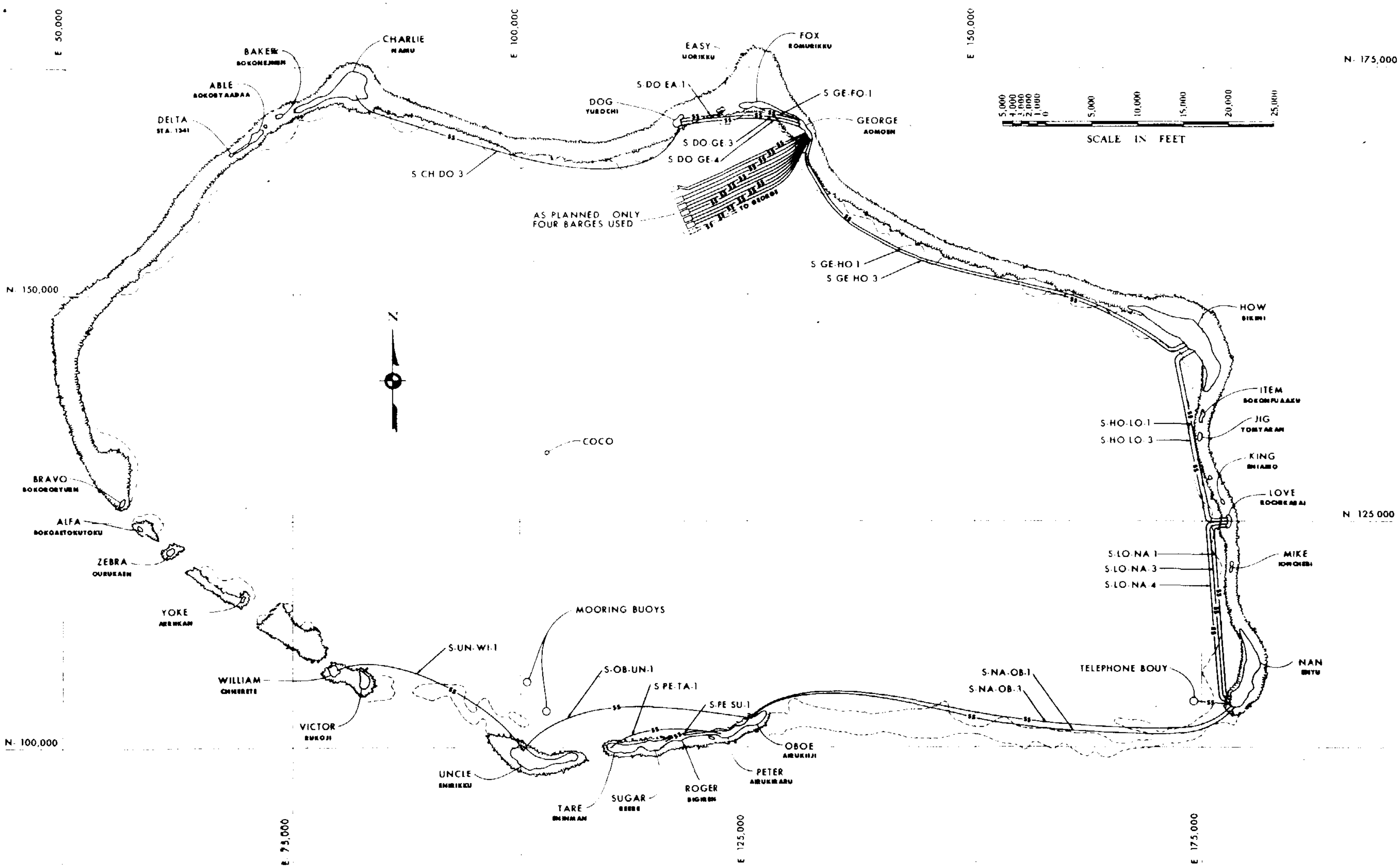


Figure 2-171. Submarine Cable Layout - Bikini Atoll

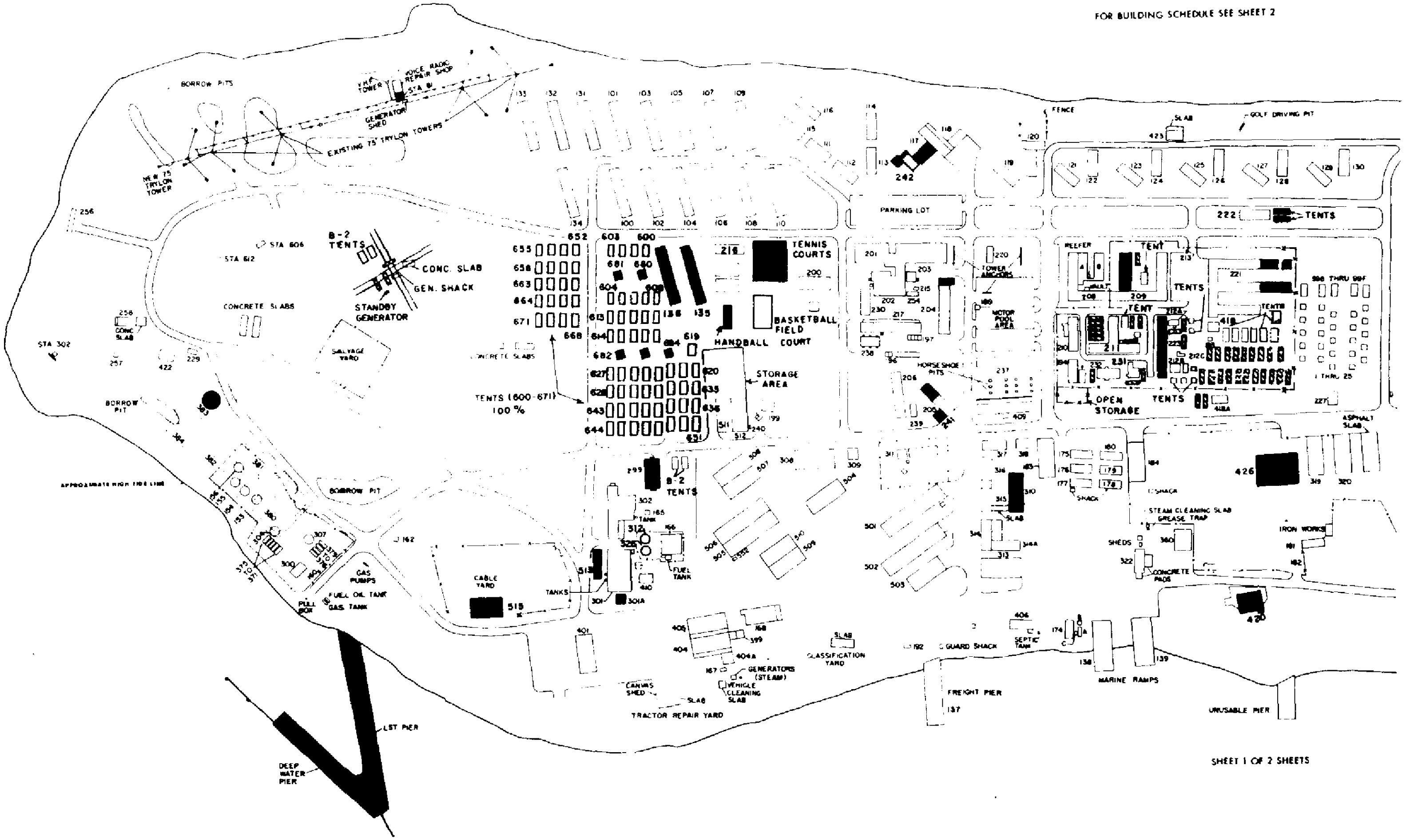


Figure 2-199. Elmer - Eniwetok Atoll - Sheet 1 of 2

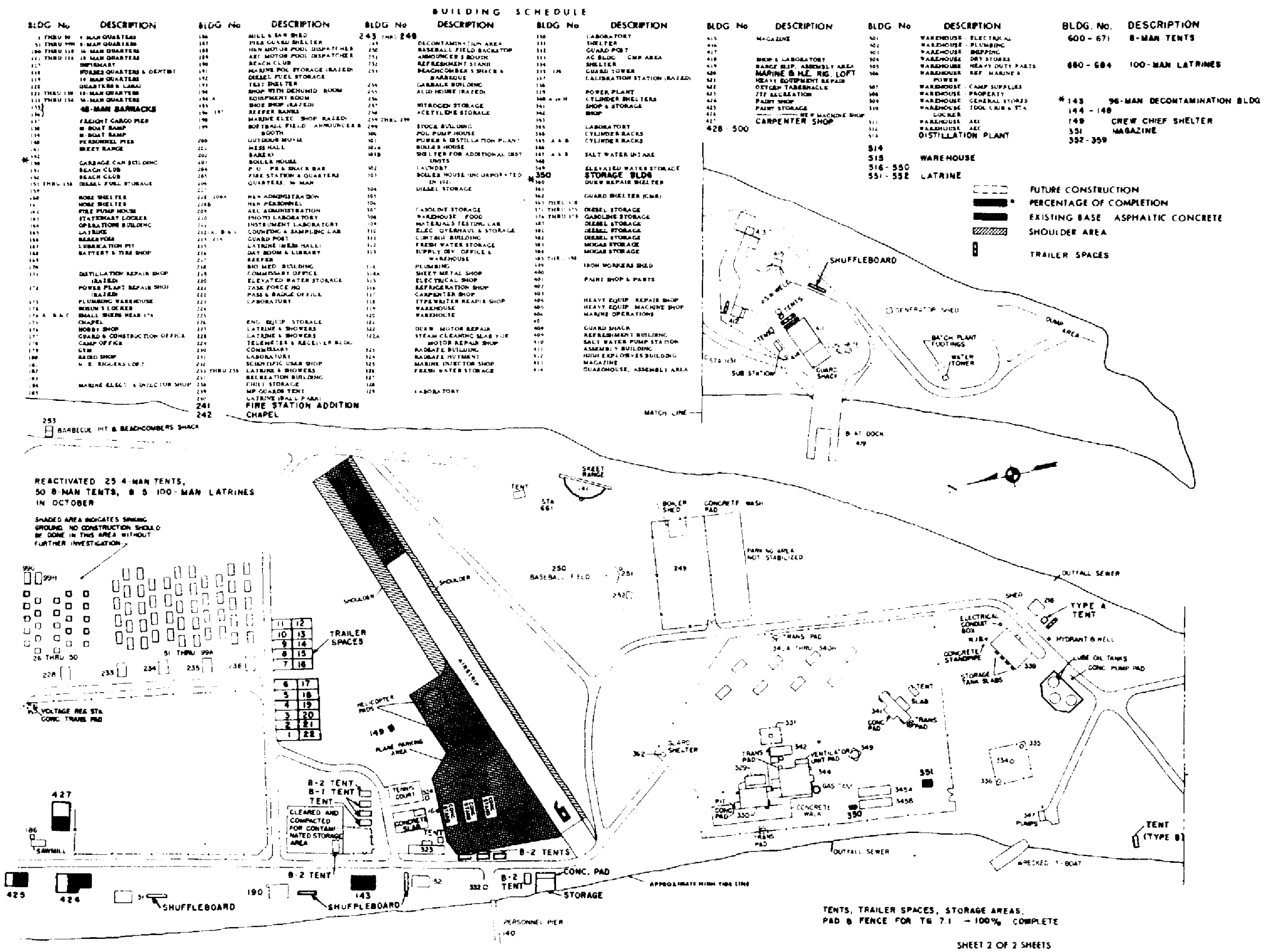
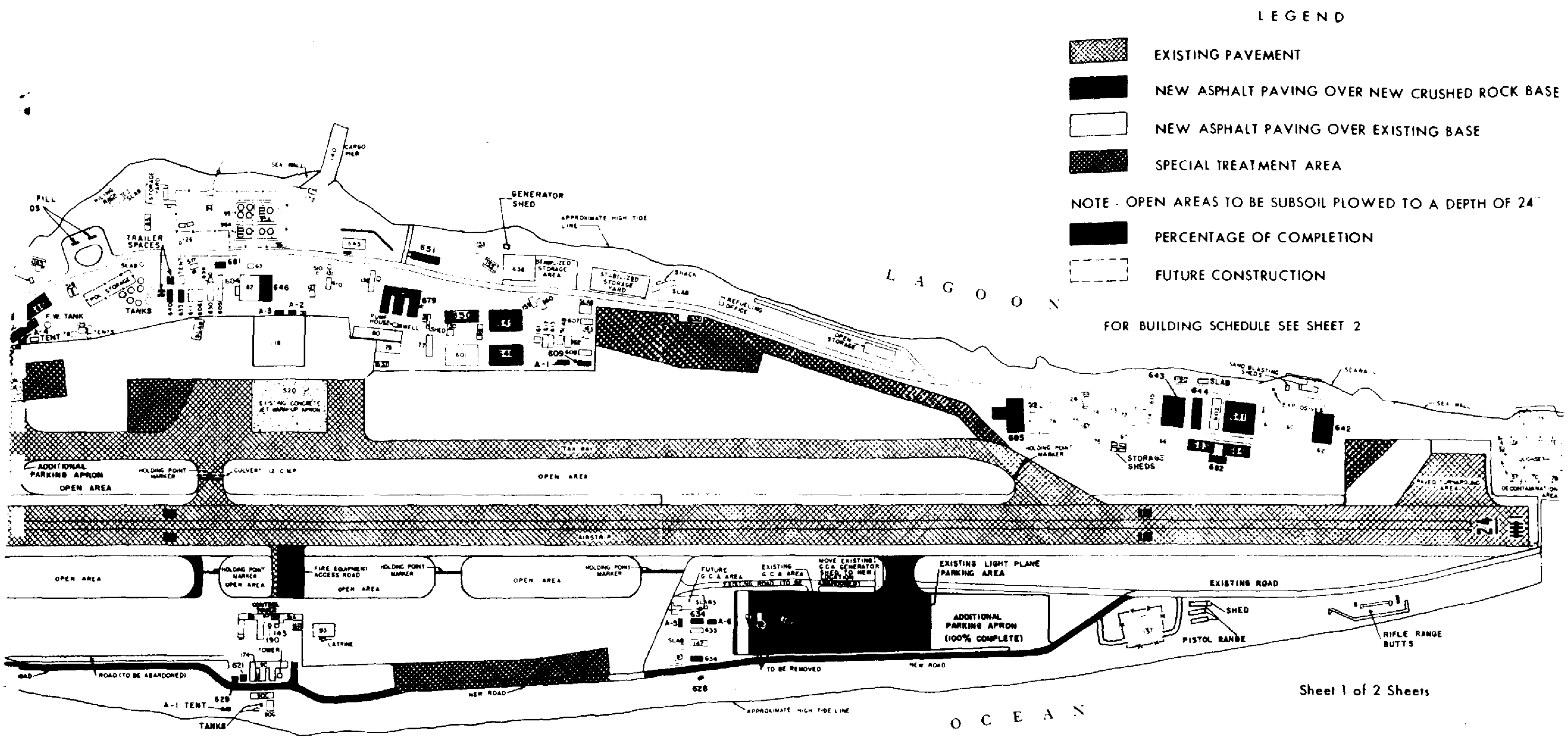


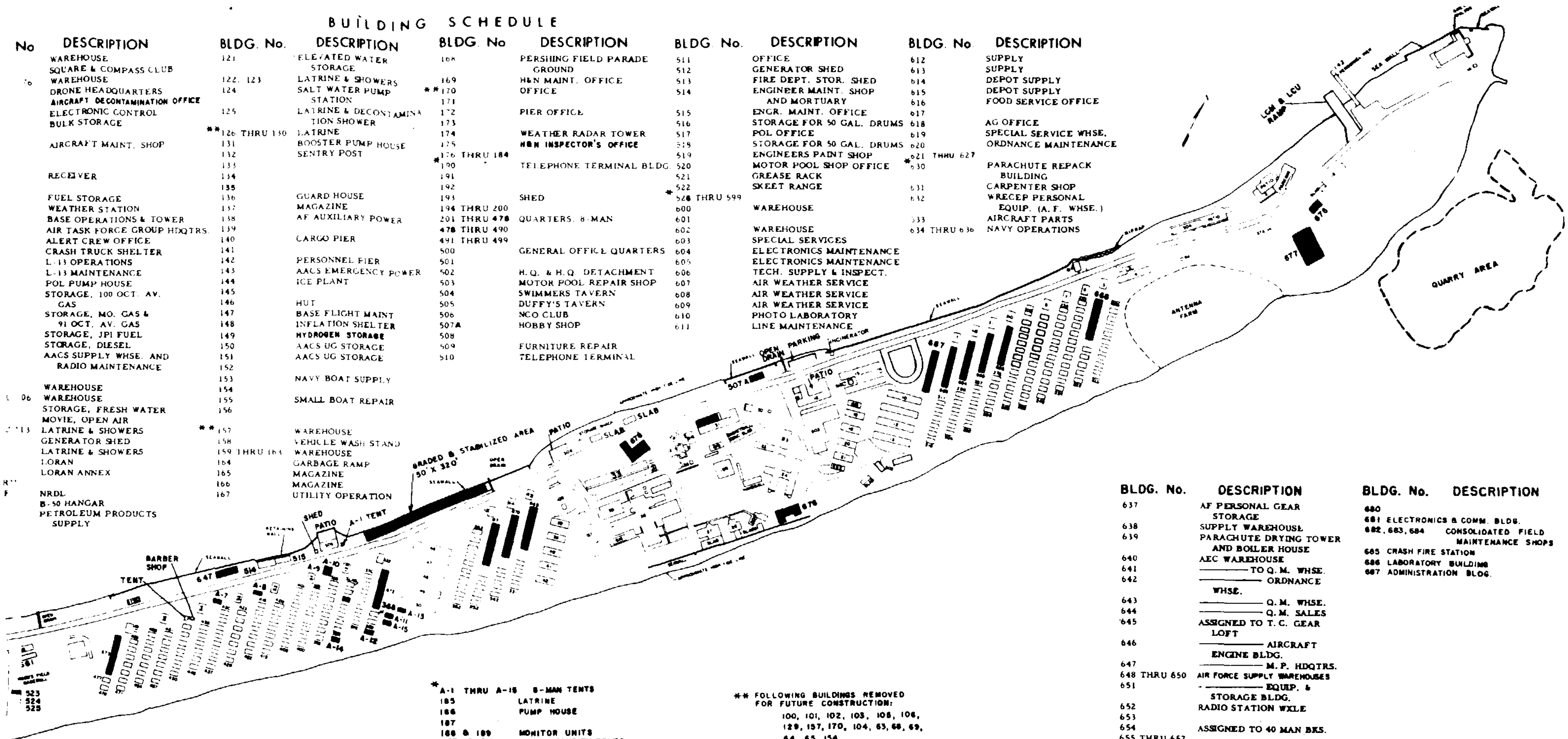
Figure 2-199. Elmer - Eniwetok Atoll - Sheet 2 of 2



' Atoll - Sheet 1 of 2

BUILDING SCHEDULE

No	DESCRIPTION	BLDG. No.	DESCRIPTION	BLDG. No	DESCRIPTION	BLDG. No.	DESCRIPTION	BLDG. No	DESCRIPTION
	WAREHOUSE	121	ELEVATED WATER	168	PERSHING FIELD PARADE	511	OFFICE	612	SUPPLY
	SQUARE & COMPASS CLUB		STORAGE		GROUND	512	GENERATOR SHED	613	SUPPLY
'o	WAREHOUSE	122, 123	LATRINE & SHOWERS	169	H&N MAINT. OFFICE	513	FIRE DEPT. STOR. SHED	614	DEPOT SUPPLY
	DRONE HEADQUARTERS	124	SALT WATER PUMP	**170	OFFICE	514	ENGINEER MAINT. SHOP	615	DEPOT SUPPLY
	AIRCRAFT DECONTAMINATION OFFICE		STATION	171			AND MORTUARY	616	FOOD SERVICE OFFICE
	ELECTRONIC CONTROL	125	LATRINE & DECONTAMINA	172	PIER OFFICE	515	ENGR. MAINT. OFFICE	617	
	BULK STORAGE		TION SHOWER	173		516	STORAGE FOR 50 GAL. DRUMS	618	AG OFFICE
		**126 THRU 130	LATRINE	174	WEATHER RADAR TOWER	517	POL OFFICE	619	SPECIAL SERVICE WHSE.
	AIRCRAFT MAINT. SHOP	131	BOOSTER PUMP HOUSE	175	H&N INSPECTOR'S OFFICE	518	STORAGE FOR 50 GAL. DRUMS	620	ORDNANCE MAINTENANCE
		132	SENTRY POST	176 THRU 184		519	ENGINEERS PAINT SHOP	621 THRU 627	
		133		*190	TELEPHONE TERMINAL BLDG.	520	MOTOR POOL SHOP OFFICE	*630	PARACHUTE REPACK
	RECEIVER	134		191		521	GREASE RACK		BUILDING
		135		192		522	SKEET RANGE	631	CARPENTER SHOP
	FUEL STORAGE	136	GUARD HOUSE	193	SHED	*528 THRU 599		632	WRECEP PERSONAL
	WEATHER STATION	137	MAGAZINE	194 THRU 200		600	WAREHOUSE		EQUIP. (A. F. WHSE.)
	BASE OPERATIONS & TOWER	138	AF AUXILIARY POWER	201 THRU 478	QUARTERS, 8-MAN	601		633	AIRCRAFT PARTS
	AIR TASK FORCE GROUP HDQTRS.	139		478 THRU 490		602	WAREHOUSE	634 THRU 636	NAVY OPERATIONS
	ALERT CREW OFFICE	140	CARGO PIER	491 THRU 499		603	SPECIAL SERVICES		
	CRASH TRUCK SHELTER	141		500	GENERAL OFFICE QUARTERS	604	ELECTRONICS MAINTENANCE		
	L-13 OPERATIONS	142	PERSONNEL PIER	501		605	ELECTRONICS MAINTENANCE		
	L-13 MAINTENANCE	143	AACS EMERGENCY POWER	502	H.Q. & H.Q. DETACHMENT	606	TECH. SUPPLY & INSPECT.		
	POL PUMP HOUSE	144	ICE PLANT	503	MOTOR POOL REPAIR SHOP	607	AIR WEATHER SERVICE		
	STORAGE, 100 OCT. AV.	145		504	SWIMMERS TAVERN	608	AIR WEATHER SERVICE		
	GAS	146	HUT	505	DUFFY'S TAVERN	609	AIR WEATHER SERVICE		
	STORAGE, MO. GAS &	147	BASE FLIGHT MAINT	506	NCO CLUB	610	PHOTO LABORATORY		
	91 OCT. AV. GAS	148	INFLATION SHELTER	507A	HOBBY SHOP	611	LINE MAINTENANCE		
	STORAGE, JP1 FUEL	149	HYDROGEN STORAGE	508					
	STORAGE, DIESEL	150	AACS UG STORAGE	509	FURNITURE REPAIR				
	AACS SUPPLY WHSE. AND	151	AACS UG STORAGE	510	TELEPHONE TERMINAL				
	RADIO MAINTENANCE	152							
		153	NAVY BOAT SUPPLY						
	WAREHOUSE	154							
06	WAREHOUSE	155	SMALL BOAT REPAIR						
	STORAGE, FRESH WATER	156							
	MOVIE, OPEN AIR								
13	LATRINE & SHOWERS	**157	WAREHOUSE						
	GENERATOR SHED	158	VEHICLE WASH STAND						
	LATRINE & SHOWERS	159 THRU 163	WAREHOUSE						
	LORAN	164	GARBAGE RAMP						
	LORAN ANNEX	165	MAGAZINE						
		166	MAGAZINE						
	NRDL	167	UTILITY OPERATION						
	B-50 HANGAR								
	PETROLEUM PRODUCTS								
	SUPPLY								



BLDG. No.	DESCRIPTION
637	AF PERSONAL GEAR STORAGE
638	SUPPLY WAREHOUSE
639	PARACHUTE DRYING TOWER AND BOILER HOUSE
640	AEC WAREHOUSE
641	——— TO Q. M. WHSE.
642	——— ORDNANCE WHSE.
643	——— Q. M. WHSE.
644	——— Q. M. SALES
645	ASSIGNED TO T. C. GEAR LOFT
646	——— AIRCRAFT ENGINE BLDG.
647	——— M. P. HDQTRS.
648 THRU 650	AIR FORCE SUPPLY WAREHOUSES
651	——— EQUIP. & STORAGE BLDG.
652	RADIO STATION WXLE
653	
654	ASSIGNED TO 40 MAN BKS.
655 THRU 657	
658 THRU 659	ASSIGNED TO 40 MAN BKS.
660	RAWINSONDE
661	ENG. EQUIP. BLDG.
662 THRU 673	48 MAN BARRACKS
674	WELDING SHED
675	C. O. QUARTERS
676	GUEST HOUSE
677	SWIMMING POOL
678	CHAPEL
679	OPERATIONS & ADMN. BLDG.

BLDG. No.	DESCRIPTION
680	
681	ELECTRONICS & COMM. BLDG.
682, 683, 684	CONSOLIDATED FIELD MAINTENANCE SHOPS
685	CRASH FIRE STATION
686	LABORATORY BUILDING
687	ADMINISTRATION BLDG.

*A-1 THRU A-15	8-MAN TENTS
185	LATRINE
186	PUMP HOUSE
187	
188 & 189	MONITOR UNITS
523 - 528	ARMY SECURITY TENTS
629	STORM DETECTION RADAR
628	25-MAN LATRINE

** FOLLOWING BUILDINGS REMOVED FOR FUTURE CONSTRUCTION:
100, 101, 102, 103, 105, 106, 129, 157, 170, 104, 63, 66, 69, 64, 65, 154

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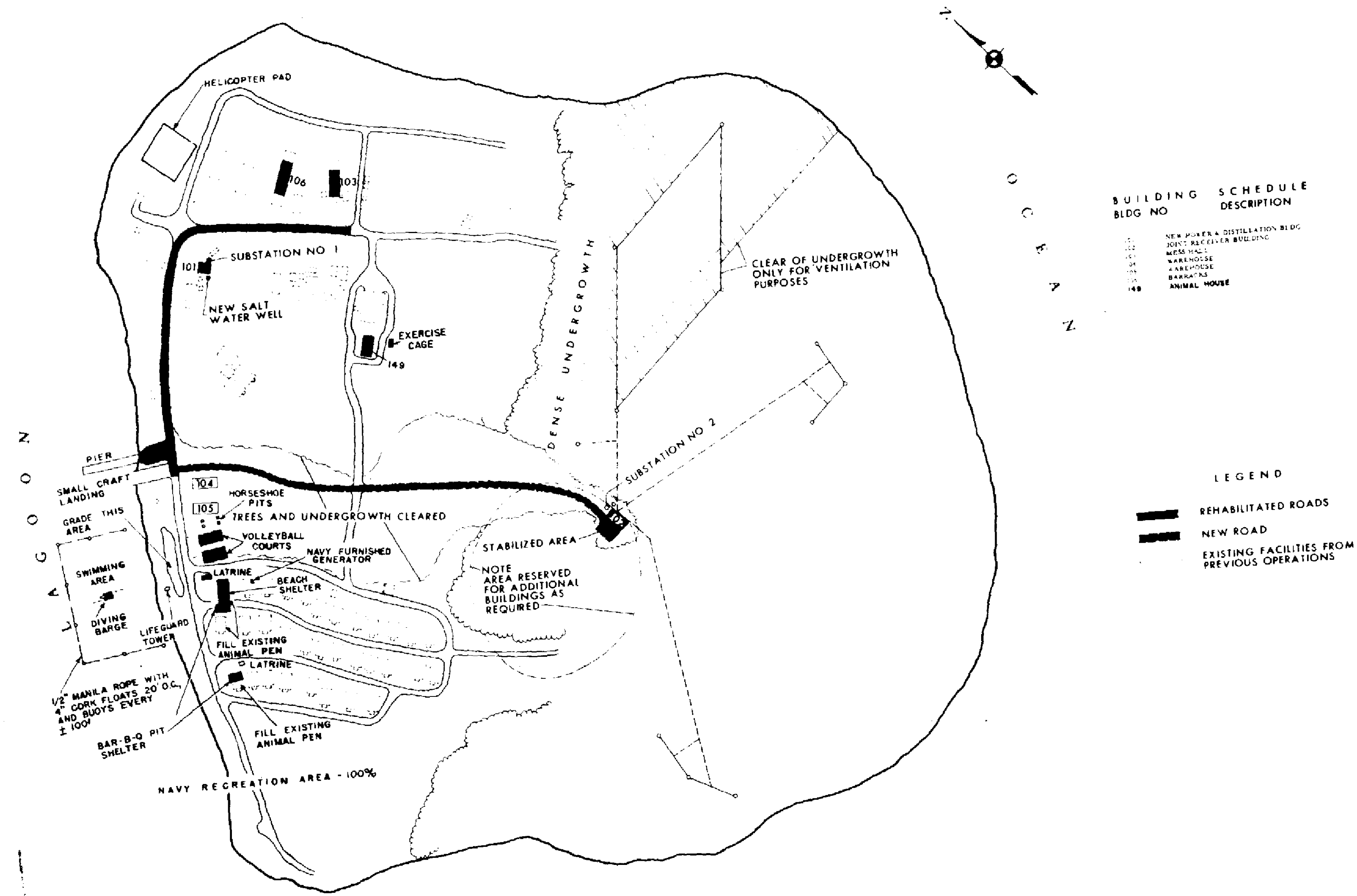


Figure 2-201. David - Eniwetok Atoll

CHAPTER III
ADMINISTRATION

SECTION I
MANAGEMENT

Contract AT-(29-2)-20 between the Atomic Energy Commission (AEC) and Holmes & Narver (H&N), the Contractor, is a Fixed-Fee Architect-Engineer-Construction - Management contract administered by the Manager, Albuquerque Operations Office of the AEC through the Deputy Director, Test Division. Within the framework of this Contract, the AEC has wide latitude to change the scope of work or services to be performed by Holmes & Narver and at the same time protect all the rights and interests of the Government insofar as the control and expenditure of funds is concerned. This Contract superceded Contract AT-(29-1)-507, under which the work and services for Operation GREENHOUSE were performed, and was executed to provide for Operation IVY. It was first modified and extended to cover Operation CASTLE and then altered again for REDWING. In general, the modifications and extensions provided for a continuation of H&N responsibility for the engineering, construction, operation, and maintenance of the Pacific Proving Ground. The centralization of authority and responsibility for all features of the project under one contract permitted simultaneous action on architect-engineer services, procurement of construction equipment and materials, recruitment of manpower, and the various other elements required for planning a complex Operation against a rigid end-date.

The organizational structures illustrated in Figures 3-1 and 3-2 provided for the executive and administrative control of the related functions assigned under this Contract. The administrative relationships of organizational units were further clarified by a standard system of Home Office and Jobsite procedures and bulletins which outlined methods, delegated authority, and fixed responsibilities. Of particular importance in this respect, in view of the fact that the responsibility of both engineering and construction resided in one organization, was the necessity of ensuring that engineering services, including inspection of construction, progress reporting, and related functions, were effective.

In any operation of this magnitude, a large part of the work is experimental, and when the sites of operation are isolated from the normal supply of both personnel and material, certain 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 representatives of the Commission, and the various participants, including Military, Scientific, and Transportation Agencies. The effectiveness of this planning is borne out by the manner in which difficulties, arising as a result of additions to the scope of work and the short time allocated for their completion, were overcome.

Over-all responsibility for policy direction affecting contractual obligations rested with the Executive Vice President of Holmes & Narver, Inc. He delegated to the Manager of the Construction Division the authority to coordinate all activities affecting the engineering, construction, and operation of the entire Pacific Proving Ground project. To assist the Manager of the Construction Division in fulfilling these responsibilities there was established within the H&N organization under the Project Manager, a self-contained administrative unit comprising all the elements necessary to completely service the requirements of this overseas project and also to facilitate Home Office participation. The plan of this unit was devised so that, upon inception of the project, the following phases could be coordinated.

1. Complete design of the project, including all engineering incidental thereto.
2. Preparation of cost estimates.
3. Accounting and control of costs.
4. Scheduling of operations, and the follow-up necessary for maintaining these schedules.
5. Purchase and inspection of materials and equipment and their transportation to the project sites.
6. Mobilization of manpower, including recruiting, security clearing, and transportation.
7. Furnishing a field staff for engineering supervision of construction.
8. Construction of the project.
9. Inspection of construction.

10. Provision for and management of service and supply facilities needed to make the project and its personnel self-sustaining.

11. Maintenance of improvements already in existence at the Proving Ground.

The Chief of Operations represented the Project Manager in correlating various Home Office activities with the field operations to ensure that Jobsite operations were geared to Home Office planning. Of particular importance in this respect was the supervision of activities directly affecting schedules. He was, therefore, responsible for the preparation of advance material estimates and bills of material, issuance of all requisitions, and checking inventories for the possible use of materials in long supply. All requisitions were screened to ensure that the materials or equipment ordered were justifiable and were being purchased in accordance with Commission and Contractor policies. An inspection force directly under the Chief of Operations ensured that materials, supplies and equipment being supplied were in accordance with purchase order specifications or that deviations from design specifications were acceptable to Engineering or Operating personnel as applicable. For the effective follow-up of schedules, all key information was funneled to the Home Office Operations Department (under the Chief of Operations) where it was assembled and recorded. The essential data regarding scheduled and actual progress of design, procurement, and construction were watched closely and, when necessary, priorities were established and expediting action taken. This included priority in overseas water transportation and the use of airlift for critical cargo.

The Chief of Operations kept the Project Manager informed of the developments in the field so that on-continent services could be coordinated to meet field requirements. This coordination included the need for revisions in schedules and necessary liaison with the AEC when the desired completion dates could not be met. During the planning and build-up stages, the Chief of Operations remained in the Home Office, but as plans matured and field operational activities increased in tempo, he transferred to Jobsite for the period of peak activity.

The Chief of Operations supervised operations in the field through the Resident Manager. Due to the magnitude of Operation REDWING, three Assistant Resident Managers were assigned during the peak of activity. The Resident Manager controlled field activities through Division Heads as shown in Jobsite Organization Chart Figure 3 - 2.

The solution of problems encountered during previous test operations led the AEC to assign the Contractor additional functional responsibilities in connection with Proving Ground operations. These additional responsibilities involved photography, pass and badge control, stevedoring, radiological safety and communications. To administer these added responsibilities properly, a regrouping and reassignment of divisional duties within the Jobsite organization was effected and a new Administration Division was established. The details with respect to implementing the Jobsite organization for the assumption of these added responsibilities are discussed in appropriate succeeding sections of this chapter.

The Chief Project Engineer was in charge of all engineering phases of the project, such as funneling engineering requirements into proper channels within the H&N organization and acting as a final source of technical information for both AEC and H&N management personnel. The procedural technique involved in the engineering phase has been previously discussed in Section I of Chapter II.

A detailed description of the mechanics of administrative control covering Accounting, Estimating, Industrial Relations, Safety, Procurement and Security is related in succeeding sections of this chapter.

SECTION 2
ACCOUNTING

For accounting purposes, Operation CASTLE ended 30 June 1954; REDWING was initiated on 1 July 1954 and ended on 30 August 1956.

Supplemental Agreement to Contract AT (29-2)-20, Modification No. 38, dated 23 September 1954, effective 1 July 1954, was received by the Contractor on 6 October 1954. The terms and conditions of Modification No. 38, Article No. X, briefly set forth the Commission's position as to the Accounting Department's requirements and responsibilities. Accounting records, books of account, systems of accounting, internal control, auditing, etc., were to conform to generally accepted accounting principles satisfactory to the Commission. Accounting records under the Contract were to be maintained as a separate and distinct set of accounts showing

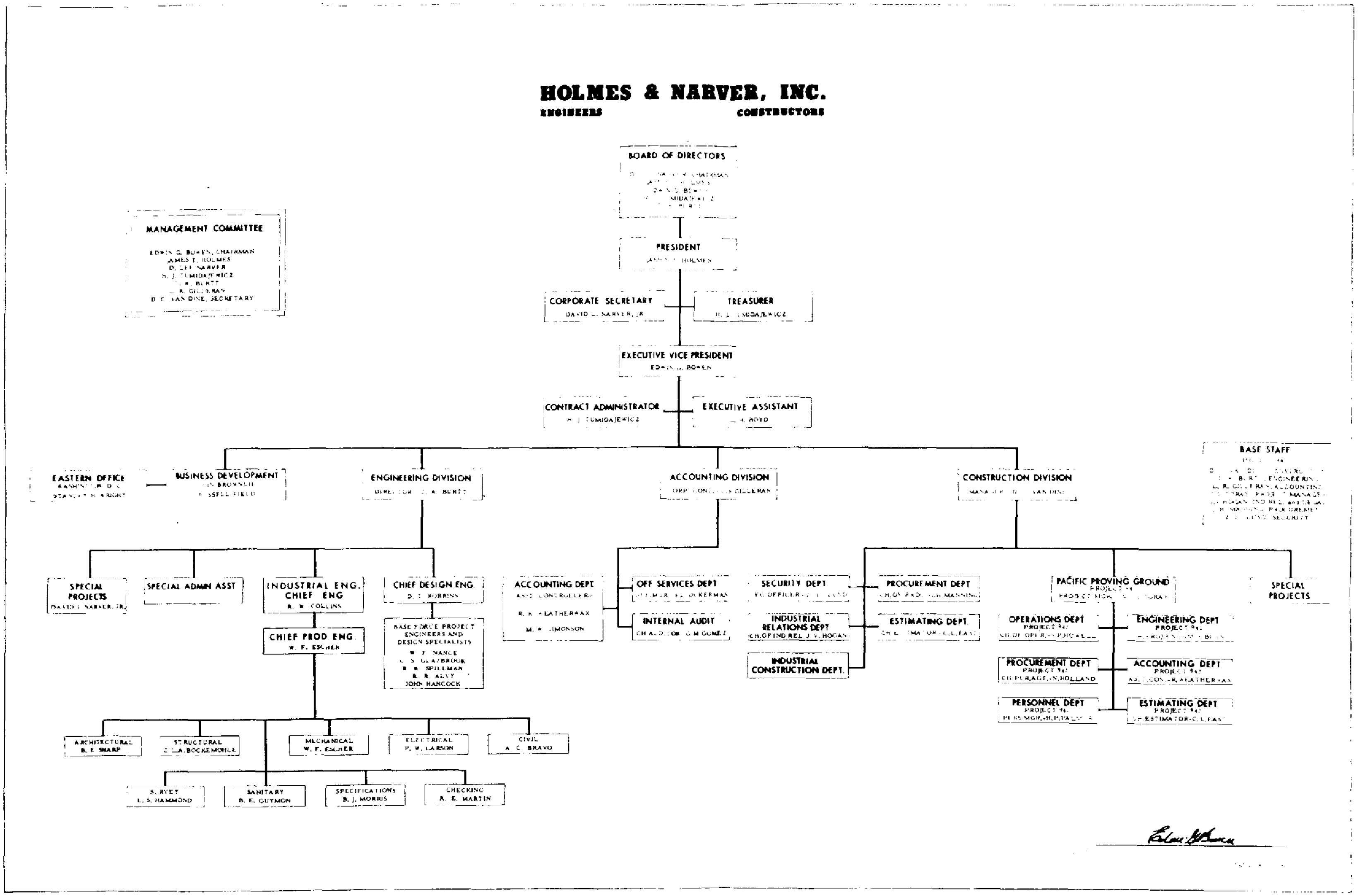
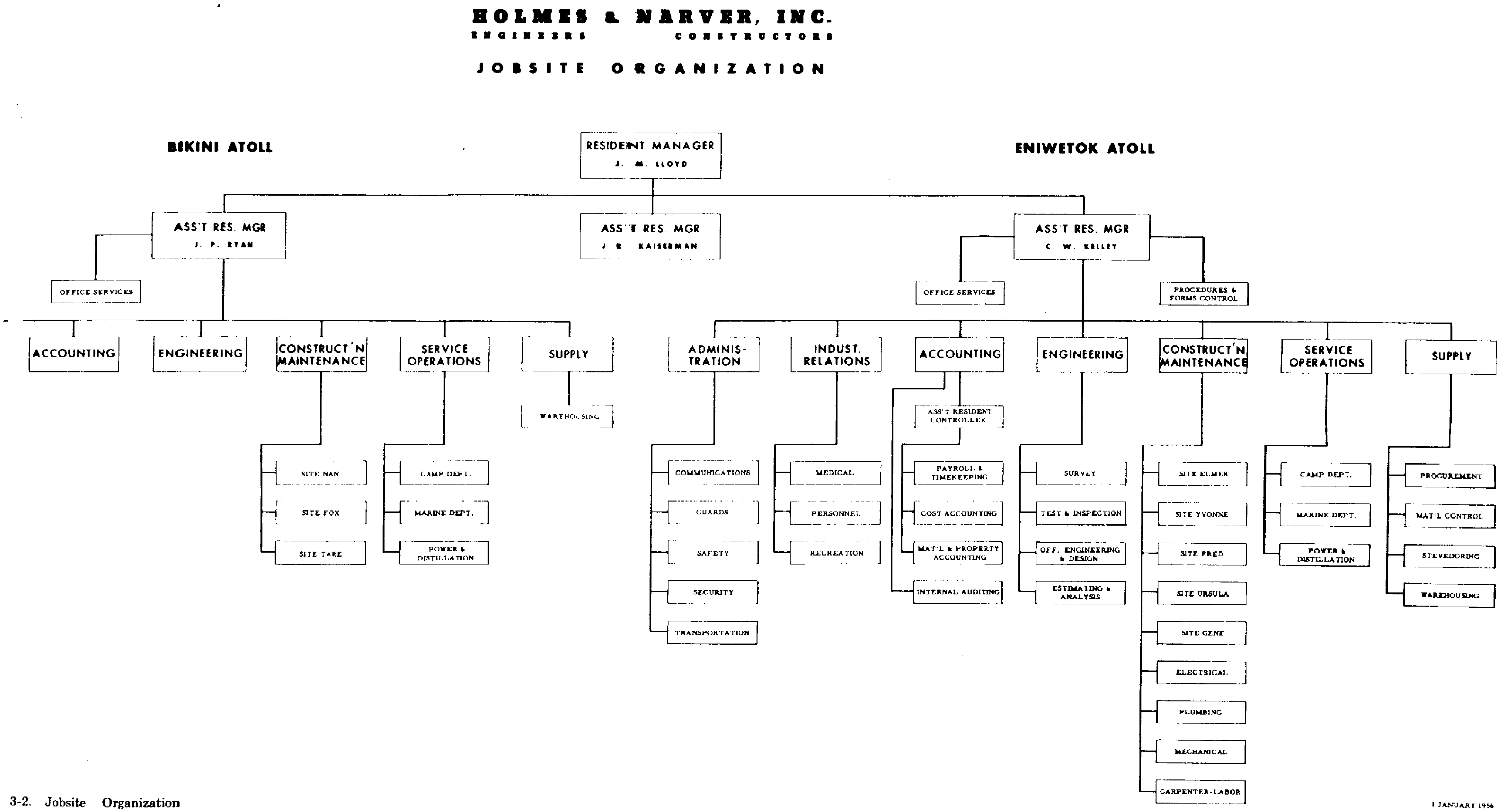


Chart 3-1. Holmes & Narver - Organization



3-2. Jobsite Organization

and supporting all costs incurred, revenues earned, fixed-fee accruals, and the receipt, use, and disposition of all Government-owned property coming into the possession of the Contractor under this Contract. The Contractor would also furnish to the Commission financial, cost, and other reports with respect to activities under the Contract, as prescribed.

Due to the geographic location of the site of work, it was necessary that the Accounting Department be divided into two groups - Home Office and Jobsite. The Jobsite Controller, reporting to the Resident Manager as a staff officer, administered and controlled the various accounting operations in accordance with the standard operating procedures and basic accounting policies established and issued through the office of the Home Office Controller. The field office prepared and audited all basic timekeeping records, cost accounting data, material accounts, token payments, travel advances, cashier records, inventory records, etc., for transmittal to the Home Office.

Except for revisions and additional reports required by the Commission, accounting statements and reports were submitted and records were maintained throughout Operation REDWING in accordance with the applicable requirements of the USAEC Controller's Manual, now incorporated into the AEC Manual. Functional accounting activities in the Home Office were segregated as indicated under the following headings:

BUDGETS, FINANCIAL PLAN, MID-YEAR REVIEW.

Budgeting for a fiscal year's operation commences approximately sixteen months prior to the beginning of the actual fiscal year; at the same time, a general scope of operations and estimated costs are prepared. During the month of April 1953, pursuant to instructions and information received from the Commission, a revised Budget reflecting changes in scope of work for fiscal years 1953 and 1954 and including estimated operating costs for Operation REDWING during fiscal year 1955 was completed and submitted. Refinement of plans, based on decisions of the Commission, were forwarded to the Budget Section for recording and coordination. Experience accumulated during prior Operations led to close approximation of funds required for construction and other phases of Jobsite operations. Using the Budget, anticipated cost schedules were established for Operation REDWING and costs were recorded in the same pattern, permitting proper comparisons of budgets to actual costs.

Approximately three months prior to the beginning of each fiscal year, a request is received from the Commission for detailed explanations of the intended application of funds estimated for each operational phase. At this time, the needs and requests of H&N Divisions responsible for Contract performance are correlated and interpolated into the respective monetary requirements of the AEC budget format. After review by the Commission, the H&N budget presentation became an approved financial plan. This plan constituted the monetary framework within which operational costs had to be contained, and the Budget Section periodically reviewed costs to ascertain that budgeted amounts were not being exceeded. In the event costs approached budgeted maximums, H&N Management was notified by the Controller; if additional amounts were required, the Commission was notified. Due to the nature of contractual operations during REDWING, requirements frequently changed as work progressed, and these changes had to be recognized and reflected within the budget. Semi-annually, a thorough reappraisal was made of forecast requirements. Necessary adjustments were reflected and the budget was resubmitted in a formalized "Mid-Year Review." After review by the Commission, the H&N Mid-Year budget presentation became a revised financial plan for that fiscal year.

GENERAL COST ACCOUNTING.

This Section is responsible for the maintenance of complete accounting records required by the Commission and H&N Management. Cost accounting procedures were established to cover cost distribution of contractual expenditures for preparation of AEC cost-budget reports and Management cost reports. During the month of August 1954, a new format, Schedule A, Organizational Cost-Budget Report, replaced the prior Cost-Budget Report as part of the monthly Financial Statement. The new Financial Statement format, Schedule B, Analysis of Organizational Costs, was initiated at the same time.

New schedules were prepared for Fiscal Year 1954, and direct comparisons were made between actual costs and the Financial Plan by category level and/or account number. Comparisons were also prepared on Job 1 by item number between estimated labor and material and actual labor and material. These new schedules provided H&N Management with pertinent information for maintenance of continuous cost controls. For the month of March 1955, certain Cost Report Schedules were revised toward simplification. Schedules E-12, E-13, and E-17 were revised to facilitate comparison between actual costs and current estimates. Schedules E-2 and E-3 covering labor and material comparisons were discontinued. Format for Schedules E-4 and E-5 were revised to appear on the same format as Schedule E-17. Format for Schedule E-10 was revised to eliminate the overseas accounts not applicable to the on-continent operation and the on-continent accounts not applicable to the overseas operation.

During the first part of 1955, a proposal to adopt standard labor rates for work performed under Jobs I, II and III of the next overseas test operation was forwarded to the Commission. Approval was received, and the use of standard labor rates for purposes of cost distribution was placed in effect on 27 June 1955. During the continuance of Operation REDWING, this method has been used to advantage; periodic reviews are made and necessary adjustments effected.

On 15 September 1955, Revision No. 7 to the Chart of Accounts was issued. This issue included all additions and changes in accordance with the latest policies and requirements under the Contract and completely replaced the prior Chart of Accounts.

Pursuant to the request of the Commission to submit suggestions for a new format for Schedule B, Analysis of Organizational Costs, that applied to H&N's particular accounting system, a new format was formalized and approved. Commencing with the month of October 1955, distribution of indirect costs was deleted and only direct costs were reflected. Costs were segregated as to Expendable Construction and Maintenance, with Maintenance costs indicated in the eight prime accounts. Plant and Equipment costs were broken down by Project Budget numbers.

The Scientific Program - Job I (Contract Identification Number 30,000 series and 50,000 series) Work in Process Subsidiary Accounts included a detailed account for each Scientific Station and/or Structure together with the appropriate Joint Task Force Seven Cost Code.

The Incidental Support Construction, Job I, (Contract Identification Number 56,000 series) Subsidiary Accounts included a detailed account for support services rendered the Task Groups and Units.

PAYROLLS AND TIMEKEEPING.

Employee payrolls were prepared and distributed on a weekly basis. As under other accounting functions, payroll activities were divided into two groups - Home Office and Jobsite. The Home Office payroll, prepared from individual employee time cards, was distributed on the second day after close of each work-week. As under prior Operations, the policy of processing off-continent payrolls and forwarding checks to the employee-designated allottee within five days after close of a work-week was continued, and the wage for the regularly scheduled work-week was paid currently. Upon receipt of the time cards in the Home Office (approximately ten days later) actual hours of work were compared to hours previously paid for the period, and adjustments for irregular hours worked were effected on the current pay check.

In order to eliminate the necessity of continuously checking the hours worked against hours paid, and effecting adjustment, a proposal was submitted to the Commission and approval was granted to advance each employee two successive weekly checks for the amount stated in the Employment Agreement. This method permitted the Payroll Section to complete final irregular hour adjustments and to process subsequent payrolls and pay checks in accordance with actual hours worked as reflected on the weekly summary card received from Jobsite. At time of termination, advance checks were deducted from the amount due for the last two work weeks.

In accordance with Appendix "B" of the Supplemental Agreement to the Contract, Modification 38, deductions were made from overseas employees' earnings to cover the cost of return transportation in case of incompleted contracts due to discharge for cause or voluntary termination. These monies were placed in a "Trustee For Travel Fund" account and returned to employees upon satisfactory completion of Contract. In order to eliminate certain controversies and to comply with legal requirements, Appendix B was revised by Modification No. 41, whereby the Contractor could advance the employee's cost of transportation to the Jobsite; deductions from the employee's earnings were made until the advance amount was repaid. This method of handling costs of transportation permitted H&N to close the "Trustee For Travel Fund."

Use of new methods and procedures installed during this Operation enabled the Payroll Section to efficiently process weekly payrolls for a number of personnel far in excess of the number possible under prior procedures and methods. For the period from July 1954 through May 1956, a total of 143,287 checks, in the approximate amount of $24,600,000 was processed for Jobsite employees. As of April 1956, the payroll operation served a peak of 2,852 overseas personnel.

ACCOUNTS PAYABLE.

The Accounts Payable Section processed and was responsible for payment of all accounts, including travel expense statements, with the exception of travel expenses covering employees journeying to the Jobsite under Employment Agreements. Although policies and procedures were predicated upon experience gained under prior Operations and compiled with the requirements of the Commission's General Accounting Office in the post-audit of expenditure of Government funds, review of methods used resulted in eliminating a considerable duplication of records and files. Under prior Operations, account payments were incorporated into a separate file by month for later review by AEC and GAO audit staff as well as by vendor for accounting purposes. By mutual consent, effective 1 January 1955, the separate AEC-GAO file was eliminated, resulting in a considerable saving of time and supplies.

Most material purchased was shipped by vendors to Oakland, California, for packaging and reshipment to the Jobsite. As material arrived in Oakland, the packer immediately prepared and transmitted receiving reports to the Accounts Payable Section for processing and prompt payment of vendor's invoices in order to avoid losing cash discounts. From 1 July 1954 through 31 May 1956, this Section processed and paid vendor invoices totaling approximately $17,802,000.00, (after deductions of cash discounts in excess of $87,500.00).

As under prior Operations, 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 REDWING (1 July 1954) through the month of May 1956, a total of 4,183 Travel Orders were processed covering single and multiple movement of personnel. Travel expenses in the approximate amount of $312,300.00 were processed and paid through both the Home and Jobsite Offices. Approximately 55,000 checks were processed during this period for payment of travel expenses, vendor's invoices, and other miscellaneous accounts payable.

PROPERTY.

Inasmuch as the functions of Property and Materials must be synchronized with Receiving and Warehousing, accountability procedures were developed in conjunction with Jobsite and on-continent warehousing operations. Jobsite Receiving and Warehouse Procedures were drafted concurrently with Jobsite Property and Material Accounting Procedures in order that controls would be maintained at all times without hampering or overlapping functions of the warehouse.

Accounting controls for material in transit to Jobsite were maintained through the "Inventory in Transit" accounts. Procedures provided that, upon receipt at Jobsite, the items be cleared from the "Inventory in Transit" accounts by charging the applicable warehouse inventory account; control of materials to the applicable job feature was maintained through the use of stores issues. All equipment was classified at time of purchase as one of the following categories:

1. Equipment not Related to Construction
2. Construction Equipment
3. Installed Equipment.

Control of equipment was maintained by use of an identification numbering system. Purchase Orders for equipment reflected identification numbers applicable to one of the above categories as well as the end use and/or the particular job feature.

At time of forwarding copies of invoices covering equipment purchases to the Jobsite, equipment cards reflecting pertinent information were completed and placed in the applicable Home Office file. Periodically, complete inventory equipment listings at Jobsite were reconciled with Home Office records. Copies of the monthly listings of retirements from equipment inventories, the periodic perpetual inventory, and the periodic physical inventories were required by the Commission.

Receiving records at PPG were consistently good. Loss and damage of items in transit via surface vessel and airlift were considered negligible. Relief of accountability in these instances was accomplished by processing Over, Short and Damage reports at Jobsite. Practically all adjustments and claims with vendors and on-continent carriers were accomplished satisfactorily through coordinated efforts of on-continent warehousing and accounting organizations.

Relief of accountability of materials and equipment at Jobsite by loss, destruction, or normal wear and tear was accomplished by means of reports of survey containing information as to the circumstances under which the items were expended. These reports supported inventory adjustments and entries on retirement work orders.

INTERNAL AUDIT.

The primary function of the Internal Audit Section was to perform detailed audits of cash expenditures and income revenues to ascertain propriety and compliance with the terms and conditions of the Contract. During the month of December 1954, in accordance with instructions from the Commission, the detail audit procedure was discontinued in favor of a comprehensive functional audit program for both Jobsite and Home Office operations.

Under the new program internal auditing became an element in the administration of operations performed by the Contractor. Internal audits, in addition to ascertaining the allowability of expenditures, realization of revenues, and compliance with AEC Manual and contractual provisions, included reviews of the business practices and procedures having an impact upon the financial interests of AEC, including appropriations, funds, obligations, costs, property and other assets. Through examination of these practices and procedures as set forth in the AEC Manual, the essential requirements were provided for audit determination as to whether Government funds were properly used, adequately safeguarded, and accounted for.

Jobsite and Home Office audit programs are performed as follows:

Jobsite Financial Functions

- Control of Cash
- Control of Income
- Cost Distribution
- Construction Work in Progress
- Inventory Control
- Aggregate, Batch Production and Use
- Equipment Usage - Field Check
- Facilities Inventories

Jobsite Administration and Service Functions

- Administrative Services
- Security and Plant Protection
- Motor Pool
- Management of Capital Assets (P&E)
- Personnel Field Check
- Recreation
- Health and Safety
- Travel
- Monthly Inventories
  - POL Products
  - Critical Materials
  - Receiving and Inspection
  - Warehousing
  - Surplus and Excess Property
  - Cyclic Inventories - Stock Control

Home Office Administrative and Service Functions

- Budget Forecasting
- Budget Execution
- Contracting and Procurement
- Receiving and Inspection
- Traffic
- Management of Capital Assets
- Surplus and Excess Property
- Motor Pool
- Personnel Administration and Payroll
- Travel
- Administrative Services
- Insurance

Home Office Financial Functions

- Control of Cash
- Control of Income
- Cost Distribution
- Financial Accounting and Reporting

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 estimates on basic field designs. The Home Office group comprised an average of three civil and/or architectural engineers, three structural and/or civil engineers, two electrical engineers, two mechanical engineers, one statistician and three clerks, all of whom functioned under the supervision of the Chief Estimator and/or the Assistant Chief Estimator. The field estimating group incorporated within the Field Engineering Division included an average of three cost estimators, one senior accountant, and one clerk.

The estimates that were prepared are shown below in their sequence of preparation:

1. PRELIMINARY ESTIMATES. These were prepared on directives of the Deputy Director, Test Division, and reflected the total cost of anticipated engineering and construction. From these estimates there were prepared an over-all operational plan, and anticipated expenditures, commitments, and manpower requirements by months and fiscal year for inclusion in a preliminary budget estimate.

2. ORIGINAL ESTIMATES. After adoption of a general plan predicated upon preliminary estimates, engineering design was authorized. Original cost estimates, based on preliminary drawings, were then submitted to the Deputy Director, Test Division.

3. CURRENT ESTIMATES. After approving the preliminary drawings and the original cost estimate, a current cost estimate was prepared to include the cost of all changes that deviated from the preliminary design. This estimated cost, when approved, became the official cost used to determine the Contractor's fee for approved construction.

4. REVISED CURRENT ESTIMATE. When authorized changes in design occurred after the release of the current estimate, a revised current estimate was

prepared which provided for the cost of additions or deletions from the original design. This estimate superceded the previously issued current estimate in its entire scope and end use.

5. SPECIAL COST STUDIES. These were prepared as directed by the Deputy Director, Test Division, to supply general information or comparative data for the proper determination of design, manpower requirements, or construction schedules.

6. COMPLETION ESTIMATE. 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 in Estimating were used in various Contract activities at both Home Office and in the Field, such as Contract Administration, Budget, Accounting, Personnel, Security, Procurement, and Engineering.

All cost estimates detailed or segregated the relevant elements as follows:

1. Items of direct labor, direct material, equipment usage, and batch and aggregate plant production were all 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 construction experience at the Pacific Proving Ground, indirect expenses were estimated as 50 per cent of direct labor and 40 per cent of combined direct material and installed equipment.
3. Engineering design was estimated at four per cent of the total estimated construction cost of each project under the Expendable Test Facility Program, and three and one-half per cent on the total estimated construction cost of each project under the Plant and Equipment Program.

The following compilation shows the number of estimates and the total related construction costs, which appear greater than the estimates approved and incorporated into the Contract. This was due to the fact that each estimate required complete processing through the preliminary and original estimate phases prior to the preparation of approved current estimates.

TYPE OF ESTIMATES	NUMBER	VALUE
Preliminary Estimates and Cost Studies	83	\$8,300,000
Original Cost Estimates	762	\$14,500,000
Current Cost Estimates	1170	\$48,500,000
Complete Cost Estimates	119	\$11,000,000

The total value of the above estimates of \$83,300,000 was required for approximately \$20,000,000 of approved construction.

An Estimated Operations Schedule, reflecting the scheduling of engineering, procurement, and construction for each item of authorized construction, was issued and reviewed periodically by the Project Manager, his staff, and the Chief 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 Catalog of Scientific Stations was issued which provided a brief description of the construction involved, site locations, 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; reports of the percentage of physical completion were received weekly from the field. 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. The over-all percentage of completion as determined above, was supplied monthly to the Holmes & Narver Contract Administrator and AEC for evaluation of earned Contract fees.

SECTION 4
INDUSTRIAL RELATIONS

The analysis of wage trends, employment conditions, job descriptions, and general labor policies was a continuing process to enable the Company to maintain wage rates, sound personnel practices, and employment conditions equivalent to those prevailing on-contin t. The extraordinary requirements imposed by the personnel security program, combined with thorough pre-employment checks of applicants' work histories, led to the hiring of above-average employees who could adjust themselves to Proving Ground conditions. Difficulties encountered by some men in adjusting themselves to the isolated work site were, for the most part, the result of domestic or family conditions that developed subsequent to the employee's arrival at the Proving Ground. In most of these cases, the employee's problems were resolved by teletype between the Jobsite, Honolulu, and the Home Office Personnel Department, or through the media of voice radio contact with the individual's family.

Labor questions and grievances during REDWING were handled as in former Operations. Close liaison was maintained between the overseas project and the Home Office with the result that all cases were well documented. Where circumstances permitted, employees with grievances, real or imagined, were heard at the Proving Ground; appropriate action was taken which, in most cases, resulted in equitable and acceptable solutions to both Management and employee. Some employees waited until their return to the continental United States, to register their grievances with the Chief of Industrial Relations. A complete investigation was made in each case and the employee was informed of the decision reached. Less than one-half of one per cent of the total number of employees with grievances found it necessary to carry their claims to the State of California Labor Commission.

As a result of a claim filed by a terminated employee, the Deputy Labor Commissioner, Department of Industrial Relations, State of California, ruled that the Contractor's practice of withholding wages for reimbursement of travel (in case of an incompleted contract) did not conform to Sections 400 through 410 of the Labor Code. To rectify this condition, new employment Agreements were placed in effect on 1 November 1954. Essentially, these new Agreements provided for pre-payment by the employee for his outbound transportation, and payment of the inbound transportation by the Contractor.

Clarification of the administration of criminal jurisdiction at the Proving Ground was effected through various discussions held by representatives of the Contractor, AEC, U. S. Department of Justice, U. S. Attorney for Hawaii, and officials of the Trust Territory of the Pacific. As a result of these dicussions, it was determined that the provisions of Title 18, which relates to crimes against the Federal Government (espionage, sabotage, theft of Government property, fraud on the Government), apply to citizens of the United States in the Proving Ground. With respect to crimes against persons and private property, the Code of the Trust Territory of the Pacific Islands is the applicable law. Procedures were established at the Proving Ground to cover arrest, hearing, bail and confinement. The police powers needed in connection with the administration of criminal jurisdiction were granted by the High Commissioner, Office of the Trust Territories in the Pacific Ocean, located at Guam, by the appointment of the H&N Resident Manager as a Principal Administration Officer - Special Police, and three members of the H&N guard force as Deputy Sheriffs.

PERSONNEL

Upon completion of Operation CASTLE, a list of former employees considered satisfactory for rehire was compiled in the Home Office. These former employees were contacted and reinstatement processing was generally commenced early so that they could be made available when the need for them arose. This was the primary source of replacements during the interim period. The employment of "rehires", combined with limited recruiting activity, sufficed to meet all needs until April 1955.

An extensive recruiting program to meet the requirements of Operation REDWING wa initiated on-continent on 4 April 1955. An advertising program was first conducted through the classified help wanted sections of the daily newspapers of Los Angeles and San Francisc This was later extended to San Diego an Sacramento papers. Advertising was, in general, by job classification with emphasis on those categories urgently needed at any given tim Throughout the operation there existed a high competitive labor market; particularly, there was a shortage of qualified engineering personnel of all types on the West Coast. It was necessa to extend advertising for certain specific ski to newspapers in Seattle, Portland, Salt Lake City, Denver, Phoenix, Tucson and Kansas City.

Applicants from these areas were required to submit by mail a resume of their work history, and those who appeared qualified were contacted by phone or letter. On several occasions, trips were made by recruiting personnel to Mid-West cities to interview prospective employees.

The California Department of Employment granted the use of its facilities in Los Angeles and San Francisco, where recruiting teams conducted preliminary screening and scheduled processing. Acceptable applicants in the Los Angeles area were required to report to the Home Office Personnel Department on a specific date for necessary processing and medical examination. In the San Francisco area, recruiting teams completed all documents, which were forwarded (as a complete package) to the Home Office Personnel Department for assignment of clearance and for submission to the Security Department of the PSQ (Personnel Security Questionnaire).

The number and classification of personnel hired in the Honolulu area was controlled by the Home Office. The Honolulu Office was kept informed through teletype and memorandums of all information necessary to coordinate the recruiting program. During previous Operations, recruiting in the Honolulu area was limited to laborors, service operations personnel, and those skilled craftsmen who had been previously employed as journeymen at the Jobsite. Due to the tight labor market in the United States, recruiting in Honolulu was broadened in December 1955 to include the hiring of skilled craftsmen. This program was continued through February 1956 with considerable success. The Territorial Employment Service organizations on the islands of Hawaii and Maui, as well as Oahu, contributed considerably to the fulfillment of Jobsite personnel needs.

Upon firm commitment of employment, processing for transportation overseas was initiated: flight lists were prepared; airline reservations were made; teletypes were sent to Jobsite and Honolulu covering departure date, flight number, ETA at Honolulu, names of all passengers, their job classification, requisition number, and status as new or rehired employees. Nineteen copies of Government Travel Orders for each man, an additional five copies for each group of men, and three advance copies for the Honolulu office were prepared. From 1 July 1954 through May 1956, a total of 4,183 Travel Orders was processed covering single and group personnel movement. The movement of personnel to and from the Jobsite is shown in Table No. 3-1.

Figure 3-1. Ward - Elmer Infirmary

PERSONNEL TRANSPORTATION

Month	Stateside to Honolulu Via MATS & Commercial	Honolulu to Jobsite	Jobsite to Honolulu	Honolulu to TAFB	Honolulu to Mainland Commercial
July - 1954	39	61	159	92	17
August	49	72	101	62	13
September	40	57	75	44	15
October	62	71	62	36	11
	Via Commercial				
November	91	117	70	47	1
December	98	159	118	50	20
January - 1955	94	147	73	32	12
February	49	75	75	39	7
March	42	65	80	48	11
April	115	167	91	38	20
May	164	278	122	63	27
June	164	262	111	60	9
July	135	219	95	49	6
August	150	202	103	44	10
September	134	203	98	58	13
October	219	319	113	57	11
November	190	319	119	45	21
December	192	261	202	78	33
January - 1956	290	545	146	71	17
February	215	365	156	57	21
March	177	308	173	85	15
April	77	117	429	123	63
May	33	40	393	121	139
June	14	22	319	76	155
July	19	32	355	195	12

Table 3-1. Personnel Transportation

Prior to the inauguration of the new Employment Agreement, H&N employees going to Eniwetok were transported by commercial airlines from Los Angeles to San Francisco and then by chartered or US Navy bus to Travis Air Force Base for onward routing via MATS. On 1 November 1954 (the effective date of the Revised Employment Agreement) the use of MATS to Honolulu was discontinued since employees, who then paid their outbound travel, elected to travel to Honolulu on commercial tourist flights. Transportation between Honolulu and the Jobsite both inbound and outbound, was via the MATS system. Employees returning to the mainland were routed to Travis Air Force Base via MATS. San Francisco hires were returned to their point of hire by chartered bus after arriving at Travis; Los Angeles hires were furnished air transportation to Los Angeles from the San Francisco Airport.

In order to expedite processing through the MATS system in Honolulu, MATS Passenger Information Cards, together with three copies of each employee's travel order, were forwarded to the Honolulu office in sufficient time to ensure receipt by that office at least one day prior to the arrival of the group in Honolulu. For each outgoing flight, a temporary group leader was appointed who was responsible for carrying the collective records of the group to the Jobsite. Each member of a group was given a $25.00 advance on his Jobsite salary prior to departure. After a flight actually departed from Los Angeles or San Francisco, a teletype was sent to the Jobsite (with the Honolulu office as an information addressee) confirming the departure, and listing all cancellations if any occurred. Upon arrival at the Honolulu International Airport, the men were met by a Holmes & Narver representative, transported to Hickam Field, and processed through the MATS system.

H&N representatives in Honolulu assisted in the movement of AEC and TG 7.1 personnel through Honolulu. Services rendered included making airline and hotel reservations, meeting incoming flights and providing transportation to and from hotels and airports, providing storage facilities for contraband, and arranging for cleaning and storage of clothing that would not be required at Jobsite.

All personnel arriving at Eniwetok were met at the Fred airport and transported to the Personnel Department on site Elmer for processing into the Jobsite organization. Certain minor records were maintained at site Nan for personnel assigned to Bikini Atoll; all permanent personnel records, however, were maintained at Elmer, and all arriving and departing employees were cleared through that office.

Jobsite Personnel Department functions included requisitioning of personnel, reviewing job descriptions, processing Changes of Status, investigating grievances, and handling of all wage and salary matters for review by the Home Office. It was also the responsibility of the Personnel Department to schedule manpower movement, both interatoll and to evacuation ships or sites.

A manpower control chart, projected over a three-month period, was used to plan personnel strength requirements. Each Jobsite Division was required to forecast personnel requirements three months in advance, to allow sufficient time to recruit, process, and transport to the Jobsite such additions or replacements as would be needed. In order to plan for replacement needs, each employee was requested to fill out a form three months in advance of his scheduled contract completion date; this provided information as to whether or not the employee would extend his contract, terminate and return in 30 days, or terminate and not return. The build-up in personnel was accelerated in April 1955 when the shot-island camps were released for construction. This continued until a peak employment of 2717 was attained on 30 May 1956 as indicated in Figure 1-3, Chapter I.

As the construction neared completion, a surplus program similar to that of previous Operations was started. A guide was issued to all Division heads which set forth in detail the approach to the problem. The basic intent of this guide was two-fold: 1), declaring surplus those individuals with the least amount of obligated time remaining on their contracts; 2), the release of marginal and sub-marginal workers and the retention of those whose ability, conduct, and productivity were superior and whose retention through greater efficiency would result in economic savings. Prior to the initiation of the surplus program, a careful study was made of non-filled personnel requisitions; these were cancelled with the exception of a few rehires whose services were required. As an individual was declared surplus and returned to his point of hire, his particular classification was frozen with respect to Change of Status, thereby eliminating the possibility of reclassifying remaining personnel to higher classifications. During the months of April and May 1955, 542 employees were declared surplus, which, added to the normal attrition during these two months, resulted in 777 departures. This period was one of changing personnel requirements. The Personnel Department was kept informed of all needs and was able to place valuable employees declared surplus by one Division into another.

Table No. 3-2 reflects personnel turnover for each month of the Operation.

HIRES								TERMINATIONS										
												CAUSE						
Month	Ave. Job Pop.	Hono	S. F.	L. A.	Total Rehires	Total New Hires	Total Hires	L. A.	S. F.	Hono	Total	CC	VQ	Surp	PU	Dis-Charge	De-Ceased	Inj
1954																		
JULY	811	20	2	42	62	2	64	106	12	45	163	105	5	53				
AUG.	718	24	4	35	62	1	63	67	10	26	103	63	2	37	1			
SEPT.	674	9	4	43	55	1	56	50	11	27	88	70	17		1			
OCT.	674	18	7	43	63	5	68	35	8	12	55	54	1					
NOV.	680	23	8	56	83	4	87	43	6	28	77	74				1	2	
DEC.	766	71	22	104	143	54	197	64	1	49	114	113	1					
1955																		
JAN.	794	55	9	73	135	2	137	34	3	21	58	57	1					
FEB.	868	20	13	33	60	6	66	31	12	25	68	68						
MAR.	854	22	5	34	58	3	61	45	10	21	76	72	3	1				
APR.	847	45	10	80	113	22	135	41	8	22	71	63	6	2				
MAY	933	58	30	129	172	45	217	55	16	22	93	90	2	1				
JUNE	1107	128	40	158	240	86	326	95	9	20	124	120	3	1				
JULY	1227	37	15	89	94	47	141	56	9	32	97	88	7	2				
AUG.	1290	83	19	129	122	109	231	46	8	33	87	80	6	1				
SEPT.	1480	71	23	129	112	111	223	84	7	27	118	97	21					
OCT.	1608	102	38	159	91	208	299	47	10	26	83	65	17			1		
NOV.	1816	74	45	131	84	166	250	54	14	32	100	77	16	6	1			
DEC.	1999	125	62	157	99	245	344	95	23	105	223	187	26	2	5			3
1956																		
JAN.	2115	160	83	181	155	269	424	55	9	36	100	80	18	1	1			
FEB.	2420	153	54	126	93	240	333	68	11	35	114	76	27	1	7	3		
MAR.	2667	168	43	144	89	266	355	96	24	55	175	109	46	8	5	7		
APR.	2784	31	22	41	46	48	94	145	39	88	272	59	37	165	5	3		3
MAY	2473	5	8	20	27	6	33	248	62	180	490	128	20	337	2	2		1
JUNE	2078	8	-	14	21	1	22	181	45	98	324	121	7	175	4	6		1
JULY	1716	7	-	17	24	0	24	123	37	84	244	115	10	114	1	4		
AUG.																		

Hono = Honolulu
S. F. = San Francisco
L. A. = Los Angeles
CC = Completed Contract
VQ = Voluntary Quit
Surp = Surplus
PU = Physically Unqualified
Inj = Injuries

Table 3-2. Personnel Turnover

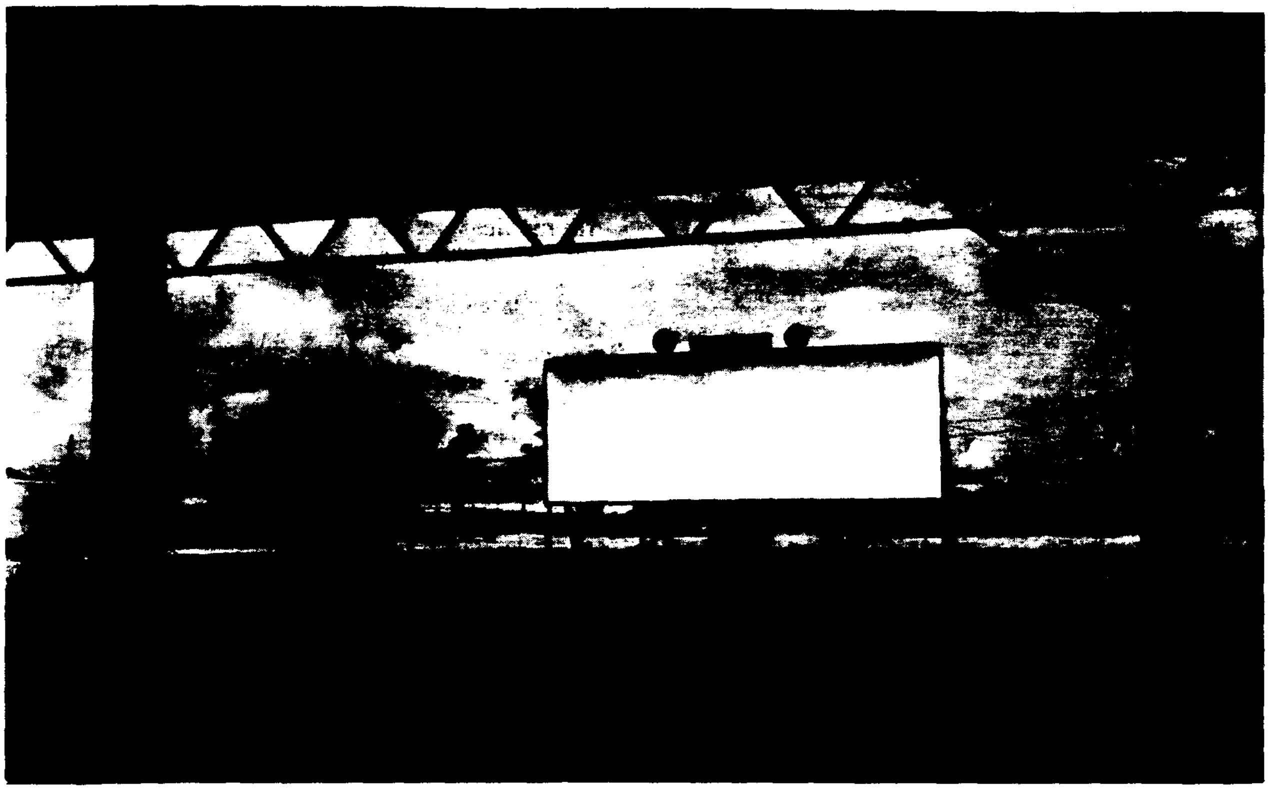


Figure 3-2. Coral Bowl Theater - Elmer

Figure 3-3. Chapel - Elmer

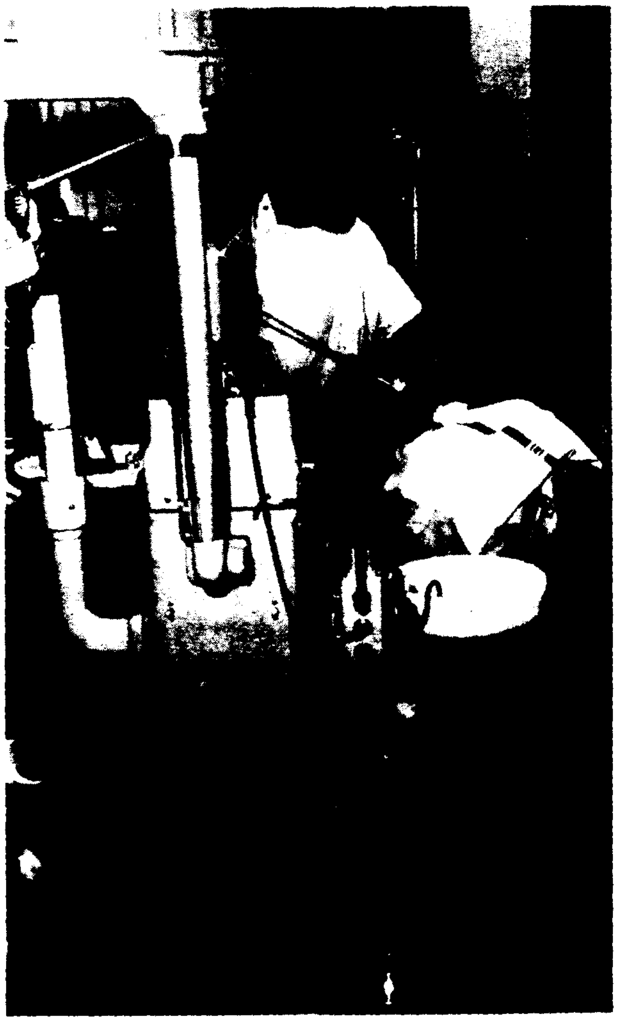


Figure 3-4. Dental Office - Elmer

MEDICAL - DENTAL.

Medical and dental care was predicated on two considerations: 1), adequate care for emergencies, including accidents and disaster; and 2), preventive measures through sanitation and medical treatment to keep personnel in good health and on a productive basis. Dental service accomplished these ends by handling dental emergencies and by providing care compatible with maintaining Jobsite employees in working condition. The Medical Department 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 Departments concerned in disaster planning, and furnishing reports and advice on over-all problems. The Medical Department also handled reports to the insurance carrier, made disability evaluations, and determined when Zone of Interior care was necessary for individuals and whether or not employees were physically qualified to carry out Jobsite duties. Close liaison was maintained with Army medical personnel, and a free exchange of services was maintained at all times. All medical service was available to supported groups as well as to Holmes & Narver employees.

Medical services were furnished through the operation of the permanent infirmary at site Elmer, the temporary infirmary on site Nan, and first-aid stations located at each shot-island camp. The permanent infirmary at site Elmer was considerably improved for the REDWING Operation. Improvements consisted of the addition of a wing to the ward space to allow for ten additional beds, relocation of medical supply storage facilities, modification of the emergency receiving room for litter cases, lead shielding of the X-ray room, installation of a new X-ray machine, installation of a hydrotherapy unit (a whirlpool bath), and remodeling of the dental office, including dehumidification and installation of a new dental unit.

A doctor and dentist were stationed at the infirmaries on sites Elmer and Nan. They were assisted by a staff consisting of an X-ray and laboratory technician, a medical clerk, and a number of first-aid men. First-aid men were located at each shot-island camp and accompanied all construction missions to off-atolls. The doctors made periodic inspections of all first-aid stations and were available for call to all sites in cases of emergency. Permanent records were maintained of all medical services furnished. Clinical medical services were facilitated through arrangements for easy referral of X-rays and laboratory specimens to specialists in Honolulu for interpretation and examination. All major surgery cases which had to be accomplished before a patient could be evacuated to a hospital in Honolulu were performed b[illegible] Army surgeons at site Fred.

From 1 July 1954 through 30 June 195[illegible] there were seven deaths: five Holmes & Narv[illegible] employees and two Task Group 7.1 employee[illegible] Only one of the deaths was due to an industrial cause. This death resulted from cranio-cerebral trauma when a worker was hit in the head [illegible] an object accidently dropped from a wat[illegible] tower. The causes of the other deaths were as follows: two due to coronary heart disease; one from accidental electrocution duri[illegible] recreational activity when the victim grasp[illegible] a live wire in salt water; one while the patient was enroute to Honolulu (having been evacuated after several surgical operations for a rupt[illegible] ed appendix, dehisence, and sub-heptic abces[illegible] and two deaths from drowning during recreational activity.

Throughout the period of the Operation, the general health of all personnel was good and compared favorably with normal standards. There was one outbreak of clinically-sure cases of staphlococcus food poisoning, which involved approximately 25 men. This was traceable to one beef roast which was used in making sandwiches for box lunches. There were no other incidents of unusual occupational or epidemic illnesses, nor any unusual frequency of ordinary illnesses usually encountered.

RECREATION.

Provision for recreation was generally a coordinated program under a Recreation Director and his assistants. Facilities and activities varied with the size of each camp, but, in general, the objective was to provide outlets for leisure time. The programs provided for movies; church services; organized shell hunting and fishing; horseshoe pitching; tournaments in chess, billiards and card games; softball, basketball and volleyball leagues; bingo games; rebroadcasts of sport events; day room and libraries with newspapers and magazines; a mimeographed newspaper; hobby shop; small golf course; gymnasium; and carnivals or other special events for holidays. The Recreation Department assisted personnel in flower ordering, EFM messages, the exchange of Christmas presents between home and the Jobsite, and in arranging for club meetings or special educational classes.

Figure 3-5. 471 lb. Black Sea Bass Caught at Pacific Proving Ground

SECTION 5
SAFETY

INDUSTRIAL SAFETY.

A continuous safety program was maintained to guard the health of employees and those User groups for whom Holmes & Narver had support responsibility; to prevent accidents through the elimination or control of conditions capable of causing personnel injuries, occupational diseases; and to prevent fires or damage to equipment, property and material.

With the activation of the Administration Division at the Jobsite on 16 November, the Safety Department was integrated into this unit with little effect on planning and operations. Safety operations, encompassing two atolls and eight separate camp sites were under the supervision of a Safety Engineer with an Assistant Safety Engineer for each atoll. Contact was maintained by means of weekly activity reports, correspondence and, in cases of urgency, by radio-telephone. Periodic exchange visits were made between atolls by the Assistant Safety Engineers and these visits were so regulated that a Safety Engineer was always present at each atoll.

The basic safety program conformed with outlines set forth in the U. S. Atomic Energy Commission Manual and with supplemental directives or bulletins received from ALOO. A Jobsite booklet was issued containing established rules for on and off-the-job safety, radiological safety, instructions for fire prevention and protection, information on the application of artificial respiration, and a chart indicating the pressure points to be used in the event of injury causing severe bleeding. All newly-arrived employees received a copy of this booklet

FREQUENCY AND SEVERITY OF INDUSTRIAL ACCIDENT RATES AT PPG
- A COMPARISON -
JULY 1954 THRU JUNE 30, 1956

	HOLMES & NARVER, INC.			ALL OTHER ALO CONTRACTORS
MONTH	**FREQUENCY**	**SEVERITY**	**MAN-HOURS**	**FREQUENCY**
July 1954	7.78	8	254,000	5.23
Aug.	4.85	5	203,000	2.77
Sept.	15.59	74	189,500	11.62
Oct.	.00	00	208,000	13.94
Nov.	5.23	78	189,000	11.26
Dec.	5.83	33	169,000	2.57
Jan. 1955	9.80	30	239,000	14.95
Feb.	4.75	19	208,000	2.88
Mar.	4.74	5	208,000	3.41
Apr.	7.58	22738	261,000	9.07
May	4.40	13	225,000	6.69
June	.00	00	254,000	12.31
July	5.51	102	363,000	4.82
Aug.	.00	41	317,000	2.47
Sept.	2.29	14	436,000	1.91
Oct.	7.83	26	383,000	8.50
Nov.	2.35	16	426,000	2.01
Dec.	1.71	7	584,000	1.55
Jan. 1956	1.77	11	489,000	5.19
Feb.	1.77	11	565,000	5.27
Mar.	6.07	15	988,000	7.67
Apr.	8.68	2629	691,000	8.78
May	5.96	13	671,000	6.82
June	9.15	53	655,500	

FREQUENCY: Disabling injuries per million man-hours worked.

SEVERITY: Days charged per million man-hours worked.

Table 3-3. Frequency and Severity of Accidents at a safety orientation discussion. This was supplemented by rules and regulations published in the form of procedures and bulletins. Safety and accident prevention education was further promoted through monthly meetings of Safety Engineers with supervisory personnel, by utilization of signs, posters and the daily newspaper, by the use of safety score boards at each camp, and through personal contact by the Safety Engineers with men in the field.

At each camp site a 4′ x 8′ safety sign, fitted with removable numbers which could be changed daily, was used to indicate the number of days that had elapsed since the last industrial disabling injury; a "target" indicated the best previous record. Site Fred attained the best record with a total of 506 days without an industrial disabling injury; site Ursula had the second best record with 367 days. (The period for Ursula encompassed the entire time from activation of the camp to evacuation and roll-up.)

Unsafe practices or conditions found on field inspections by Safety Engineers were generally corrected after discussions with supervisory personnel. Many sound suggestions relative to all phases of accident prevention were received from personnel of all levels and there was an increasing number of requests from the field for assistance in safety matters. Because of these field contacts, changes in control of hazardous solvents were effected. Different types of solvents were tested with the result that one of a high toxic effect was replaced to a large extent with one of a low toxic effect. Also through field inspections, general housekeeping at work sites was improved and unsafe conditions and practices were eliminated.

Experience has indicated that tests of fired and unfired pressure vessels must be accomplished during interim periods between operations These tests require that the equipment be taken out of service for as long as two days and, in certain cases, longer. A total of 80 such units were examined; two were found to be in such condition that they were condemned and several required overhaul of gage and safety valves.

All disabling injury cases were reviewed, and investigations were made to determine the cause factors and the steps necessary to minimize the possibility of recurrence. Studies were also made of all non-disabling injuries reported to the Medical Department in order to keep in touch with injury cause trends. Through these studies, information was developed that led to changes in types of personnel protective equipment and in work procedures.

The AEC Manual required that industrial injury experience be based on the latest edition of the American Standards Association publication ASA - Z16.1, "American Standard Method of Recording and Measuring Work Injury Experience." The latest revision of this code was effected on 1 January 1955. The experience figures for industrial injury shown below are based on this code, while figures for motor vehicle, property damage, and fire experiences were based on criteria contained in the AEC Manual.

INDUSTRIAL DISABLING (LOST TIME) INJURY STATISTICS

Average number of employees	1,268
Total man-hours worked	7,553,195
Number of industrial disabling injuries	51
Frequency rate	6.75
Total days charged	8,141
Severity rate	1.078*

MOTOR VEHICLE ACCIDENT STATISTICS

Average number of passenger and cargo vehicles	277
Number of accidents	26
Miles traveled (est.)	1,236,500
Frequency (accidents per 100,000 miles)	2.10
Total direct cost of accidents	$2,563

PROPERTY DAMAGE ACCIDENT STATISTICS

Number of accidents	25
Total direct cost	$85,743.

FIRE STATISTICS

Number of fires reported	69
Total direct cost	$469.00

* This rate is computed on the new formula, which was effective 1 January 1955. Using the old formula, the rate would be 1.08.

Of the 51 industrial disabling injuries reported, two were primarily responsible for the high severity rate. The first of these was a fatality that occurred in April 1955 when an employee was struck on the head by a pipe which was accidently dropped from the water tower at site Nan. A charge of 6,000 days lost time was required for all fatal cases. The second case occurred in April 1956 when an employee sustained 100 per cent loss of vision of the left eye as a result of being struck by a set screw from a V-belt pulley of a gasoline engine-driven concrete vibrator. A charge of 1,800 days lost time was incurred. In the other documented incidents there were no cases of permanent, partial, or total disability. Thirteen cases involved only one day lost time each. A comparison with other ALOO contractors' injury experience is shown in Table 3-3.

The high property damage loss was largely due to major damage to man-made island and causeway construction because of severe wave

FREQUENCY AND SEVERITY OF INDUSTRIAL ACCIDENT RATES AT PPG - A COMPARISON - JULY 1954 THRU JUNE 30, 1956

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Mar.	4.74	5	208,000	3.41
Apr.	7.58	22738	261,000	9.07
May	4.40	13	225,000	6.69
June	.00	00	254,000	12.31
July	5.51	102	363,000	4.82
Aug.	.00	41	317,000	2.47
Sept.	2.29	14	436,000	1.91
Oct.	7.83	26	383,000	8.50
Nov.	2.35	16	426,000	2.01
Dec.	1.71	7	584,000	1.55
Jan. 1956	1.77	11	489,000	5.19
Feb.	1.77	11	565,000	5.27
Mar.	6.07	15	988,000	7.67
Apr.	8.68	2629	691,000	8.78
May	5.96	13	671,000	6.82
June	9.15	53	655,500	

FREQUENCY: Disabling injuries per million man-hours worked.

SEVERITY: Days charged per million man-hours worked.

Table 3-3. Frequency and Severity of Accidents action resulting from a storm on 17 December 1955. The total direct cost of this damage was estimated at $70,256.00.

One of the high points relative to safety during the Operation was the presentation of the National Safety Council President's Medal to a Holmes & Narver, Inc. employee. The presentation was made by the H&N Resident Manager on the evening of 21 May 1956 over Armed Forces television station WXLE-TV. Award of the medal was made for saving the life of a member of TG 7.2 on site Fred by the application of the Holger-Nielson back-pressure arm-lift method of artificial respiration on the afternoon of 5 August 1955.

In the matters of safety, fire protection, and health, extensive liaison with AEC and Task Group officials was necessary for coordinating test activities with Holmes & Narver operations. Through periodic visits to the Jobsite by representatives of the Safety and Fire Protection Division of ALOO, clarification of the reports required by AEC and interpretation of the safety requirements of the AEC Manual were effected. These representatives provided valuable suggestions for incorporation into the Contractor's safety program as well as descriptive material or sources of material for use in safety activities.

RADIOLOGICAL SAFETY.

Experience during previous test operations indicated the need for more direct control by the Contractor over employees in the matter of radiation exposures. As a result of this, the AEC assigned to Holmes & Narver the responsibility for radiological safety of AEC and the Contractor's personnel. On 15 August 1955, the Contractor's Rad-Safe unit was activated within the Industrial Relations Division(later changed to Administration Division) as a section of the Safety Department. This unit functioned independently, except for policy direction by the AEC Radiological Officer, until 15 April 1956, at which time it was integrated into the TG 7.1 radiological safety unit for REDWING operational purposes. Upon departure of TG 7.1 from the Proving Ground on 6 August 1956, the responsibility for radiological safety reverted to the Contractor's Rad-Safe Unit.

Figure 3-9. Decontamination Area - Elmer

The H&N Rad-Safe unit was assigned the over-all responsibility of preventing over-exposures through effective safety measures, including the functions of photodosimetry; monitoring; repair and calibration of instruments; and control of protective clothing and equipment.

As this was a new field of endeavor for the Contractor, the Senior Rad-Safe Electronics Technician, the head of H&N's Rad-Safe Unit, was sent to Fort McClellan, Alabama, and then to Los Alamos for three weeks training. Upon his return to the Jobsite, a course of indoctrination in Rad-Safe measures was given to carefully selected personnel. This on-the-job training, supervised by the AEC Radiological Safety Officer, qualified four other technicians who, in turn, conducted courses in monitoring as well as radiological safety in general.

An instrument repair shop was provided at site Elmer. Of the more than 350 instruments turned over to the H&N Rad-Safe Unit, only 150 were of modern design, and many of these required modification. All instruments were inventoried, repair parts were ordered, and a program of rehabilitation of instruments was undertaken. By 15 April 1956, all instruments for which H&N was accountable were readied for REDWING.

In October 1955, at the time of the activation of the Contractor's Rad-Safe Unit, many islands in both Eniwetok and Bikini were still subject to residual radioactivity. All sites were thoroughly monitored and designated as Radex areas if necessary. By 15 April 1956, through natural decay and through decontamination by earth removal or fill, only sites Charlie and Tare on Bikini Atoll presented radiation hazards. The maximum permissable exposure to Gamma radiation had been established by the AEC as 3900 mr every thirteen weeks. All personnel entering radex areas were required to carry film badges, and complete records of all individuals exposed to radiation were maintained. The radiation safety control during the build-up stage was effective; no one was subject to overexposures during this period.

In anticipation of further contamination (as a result of REDWING events), a vehicle and equipment decontamination area at site Elmer was provided with a steam boiler and salt and fresh water service. A gun was made available for use with high pressure steam, alone or mixed with other solutions. The principal agents for use in these solutions were as follows: synsuds for general decontamination; sodium metasilicate (Metso 99) for heavy duty on painted surfaces; and oxalic acid for use with steel. Separate areas were provided for sandblasting and storage of contaminated equipment. For personnel decontamination, two 96-man stations were set up, one each, at Elmer and Nan. A barge was also outfitted as a personnel decontamination station in case operations were shifted to bases afloat as was the case in Bikini Atoll during Operation CASTLE. This barge was equipped with laundry facilities, clothing change and issue tents, showers, electric power and steam generating facilities, and a supply of fresh water.

As a result of the REDWING events, contamination was widespread in both atolls and tight Rad-Safe control was mandatory. All personnel were required to wear film badges, which were exchanged approximately every six weeks. Special mission badges and dosimeters were issued to personnel entering radex areas. Upon completion of each mission, vehicles and personnel were monitored at conveniently located check points. Contaminated vehicles were sent to decontamination areas, and personnel showing evidence of radioactivity were required to proceed to the personnel decontamination station. Mission badges and photodosimeters were returned to the Rad-Safe Office where the results were entered on the individual's record. A list of all personnel with an accumulative exposure of 1000 mr or more was furnished daily to Jobsite management, and before assigning personnel to tasks in contaminated areas, this list was checked in order to eliminate those men who might be subject to overexposure. Because of the requirements of recovery and other essential work in contaminated areas, a number of personnel received dosages which approached the maximum permissable. Those scheduled for retention at the Proving Ground were assigned employment at the uncontaminated base camps at Elmer and Fred. However, as a result of the Tewa event, the last test of Operation REDWING, fall-out occurred at these two sites and the radioactive level reached approximately 110 mr/hr and remained at this intensity for several days. Measures were initiated to evacuate personnel with records of high exposures to houseboats in Bikini Atoll. The decay of radioactivity, aided by heavy rain, was faster than had been anticipated and evacuation measures were abandoned. Approximately 100 Holmes & Narver employees received accumulative dosages between 3.9 and 8.0 r. In order to retain key personnel at the Proving Ground, CJTF-SEVEN authorized an increase in the maximum permissable dosage to 7 r for the remainder of the operational period - to 10 August. The Test Director of the AEC later authorized the retention of these personnel for the post-operational period, provided the average quarterly dose for the last three quarters of 1956 would be less than 3.9 r. These authorizations permitted the retention of personnel whose services were required for urgent recovery and roll-up activities.

FIRE PROTECTION AND PREVENTION.

Throughout the early build-up stage, sufficient fire apparatus were made available from surplus AEC equipment and through loan from Military sources to provide a minimum of equipment at each camp. Considerable maintenance was required to keep several pieces of the equipment in operating condition. All the equipment available at this time, with the exception of two units, were rear axle drive only, and therefore, unsuitable for use in certain areas. Furthermore, the equipment was designed for use by a minimum crew of five, which was more than could be justified for employment at shot-island camps. As a result of these conditions, three new pieces of apparatus were procured, all having both front and rear drive. One of the new units was a foam apparatus mounted at the Jobsite on a Reo chassis, primarily for use in the POL area. The other units were 500-gallon capacity rigs mounted on four-wheel chassis so equipped to supply high pressure streams of water or fog. These two units were each equipped at the Jobsite with two 50-pound CO^2 cylinders. Other equipment available was as follows:

AEC apparatus:

2 Chevrolets with 500 GPM Center Mount Pumps.

1 Ford with 500 GPM Center Mount Pump

1 Maxim with 750 GPM Center Mount Pump

1 Chevrolet with 100 GPM Front Mount Pump

1 International with high pressure Center Mount Pump

2 Macks with high pressure Center Mount Pump

On loan from Military sources:

1 GMC with 500 GPM Front Mount Pump

1 La France with 750 GPM Center Mount Pump

The Maxim, La France, International, and a Chevrolet were retained at site Elmer where the principal warehousing, shop, office and User facilities of the permanent base were located. The Chevrolet was used as an aircraft crash fire truck, since it was equipped with wheel drive, a large CO^2 supply, and foam. One each of the remaining apparatus were stationed at each temporary camp. At Fred and at the Nan airstrip coverage was provided for all operations by a military fire organization. Aircraft fire crash jeeps and trailers secured on a loan basis from military sources were maintained and operated at airstrips or helicopter pads at Yvonne, Tilda, Gene, Elmer, Fox and Tare.

Water supply for fire protection was obtained from the tower tank salt water system with additional supply available by cutting in stand-by pumps.

During peak activity there were eleven trained firefighters under one Fire Chief, providing for at least two trained men at sites Elmer and Nan, and one trained man at all other sites. Sufficient volunteer firemen were recruited from other departments to provide Nan and Elmer with crews of seven men each and all other sites with crews of three men. All volunteers underwent four hours of drill monthly. Guard personnel were also given basic courses in fire protection and prevention, for familiarization with types of lires and appropriate emergency action to be taken.

Through safety indoctrination discussions, bulletins, insertions in the daily newspaper, and personal contact by trained firemen, all personnel were alerted to their individual responsibilities with respect to fire protection and prevention. Instructions were issued in the three classes of fires and the proper extinguishing agents to be used for each class, the action to be taken when a fire was discovered, in good housekeeping as related to fire prevention, and principal fire hazards. Increased emphasis was placed on fire prevention. The rather low total fire loss in view of the extremely high valuation of the installations, equipment, and materials, and the fact that the greatest loss in any singe fire was less than $100.00, indicated that the fire prevention education program was effective and that the fire fighting organization and its methods were sound.

SECTION 6
SUPPLY

PROCUREMENT.

The Home Office Procurement Department was responsible for all on-continent purchasing and shipping. Purchasing, traffic, and expediting activities of this Department continued on a normal level from the end of CASTLE until early 1955. With the receipt of authorization to initiate procurement of materials for RED-

WING in early 1955, the tempo of activities increased rapidly and reached peak activity in the latter months of 1955 and early months of 1956. On-the-job training of new personnel was necessary since those persons experienced in buying, expediting, and shipping, particularly under governmental procedures, were not readily available.

As plans and drawings for REDWING test facilities became available late in 1955, it was apparent that a large volume of equipment and material would have to be procured and shipped in a limited time in order to meet established construction schedules. The normal lead time on materials, particularly for specially-designed or fabricated items, was three to four months. However, it was quite evident that this much time could not be allowed, and in a market in which the demands from industry were the greatest in the history of the nation, this sometimes became a serious problem. In addition, devestating floods in the Northeastern United States and in Northern California and Oregon, plus prolonged strikes in some key manufacturing plants, aggravated the situation.

Within the specially-fabricated category were such items as the rollers for the vacuum pipe support system, blast doors, dehumidifying units, many small generating units, control panels, and other control appurtenances. Electrical items presented a proportionally larger problem than did those of other items because of the market condition in the electrical field and because many of these items required special factory orders to meet design specifications.

In view of these conditions, it was necessary to plan for and take unusual action in many phases of the procurement process. Vendors had to be canvassed in advance of requisitioning to determine where materials were available and which vendors could be depended upon to keep delivery promises. To break into their backlog of orders and to obtain precedence in delivery, firms had to be convinced of the importance of the order. Many fabricators willingly set aside their normal production schedules and made men and materials available when informed that the work was of high priority for the Atomic Energy Commission. In some cases it was necessary to ask priority assistance from the Supply Office of the Albuquerque Operations Office through Defense Order Priorities.

As time became the all-important factor, almost daily contact was maintained with the various vendors fabricating critical items; on-the-spot inspection provided the means necessary to check delays. Assistance was given to some vendors in obtaining parts from other suppliers or factories. Substitutions were made to ensure acceptable deliveries, but in all such cases prior approval of design or operating personnel was obtained. Overtime for certain fabricators and on-continent premium transportation (air freight, air or railway express) were authorized. All such expediting action was taken only after the need for the item became so critical that any delay in deliveries would jeopardize completion dates of vital facilities.

The procurement of pipe and other components for the vacuum pipe arrays was one of the most complex of the problems encountered; it is cited here as an example. After the purchase order for the pipe had been awarded, it was found that the vendor could not keep his promised delivery date. Various steel mills were then canvassed and pipes were located that could be delivered on acceptable dates; however, a decision had to be made to accept certain sizes that were not in accordance with the rigid specifications but that were considered useable. The rollers for the support system also gave indication of late delivery. With the cooperation of the vendor and through direct contact with the factory in Atlanta, Georgia, the quoted delivery dates were improved and certain items were rescheduled to effect delivery of the sizes most urgently required. The cross-country shipments of these rollers were closely followed and as a result, were moved to the export packers in much less time than would normally be required. One overseas air shipment of the rollers was jettisoned from a plane in distress, and hurried replacements had to be ordered from the factory. A separate purchase order contract was let to process the pipes before shipment to the Jobsite to ensure their arrival with the high degree of cleanliness and rust freeness required. Inside surfaces were grit-blasted, cleaned with acetone, and then blown with hot air. This work had to be accomplished during a period of record rainfall. After they were thoroughly cleaned, the pipes were fitted internally with a square cardboarc paper tube impregnated with a rust inhibite and then capped for shipment. When the pipes were opened at Jobsite, it was found that some rust had set in and it was necessary to reproces them in the field. Grit for blasting had to b rushed by airlift in order to have the pipes ready in time so that construction schedules could be essentially met.

Pertinent statistics covering procurement activities were as shown in Table No. 3-4.

Where export packing was not provid by the vendor, it was accomplished either unaer contract with Richmond Export Services (FY 1954) and Pacific Ports Industries (FY 195 , or by the Holmes & Narver warehouse in I s Angeles, California. The methods and procedures used in handling, packing, and exporting con-

MONTH	REQN'S. RECD.	LINE ITEMS	P. O. ISSUED	VALUE
1954				
July	317	1538	276	115,089.84
Aug.	274	2057	394	248,612.15
Sept.	393	1539	288	184,710.61
Oct.	420	2611	311	301,394.78
Nov.	462	1974	347	263,070.78
Dec.	331	1931	411	303,423.62
1955				
Jan.	275	1270	489	405,805.10
Feb.	510	3408	364	163,509.05
March	686	3347	605	419,850.25
April	470	1766	523	597,205.81
May	552	2812	604	961,666.00
June	733	3821	795	1,155,967.40
*TOTAL	5423	28,074	5,407	$5,121,205.39
1955				
July	526	2477	733	1,554,604.27
Aug.	805	4538	593	902,961.40
Sept.	604	2502	865	1,651,834.81
Oct.	756	2590	880	1,535,293.82
Nov.	993	3921	781	1,741,934.18
Dec.	793	3501	828	1,163,333.33
1956				
Jan.	860	3584	1064	1,696,349.58
Feb.	1181	4926	1191	1,496,310.32
Mar.	661	3334	1101	1,045,663.23
April	595	3226	731	370,608.45
May	589	3766	553	334,119.49
**TOTAL	8363	38365	9328	$13,493,012.88

*For this period, petty cash transactions amount to 277 actions, with a dollar value of $1,125.91, and open account transactions amounted to 295 actions, with a dollar value of $1,909.39.

**For this period, petty cash transactions amounted to 210 actions, with a dollar value of $1,206.77, and open account transactions amounted to 602 actions, with a dollar value of $6,218.27.

Table 3-4. Procurement Statistics

formed as nearly as possible with the methods established by the Bureau of Foreign and Domestic Commerce, U. S. Department of Commerce. The markings on all cargo, packing lists, and all documents pertaining to shipment were in accordance with existing governmental directives.

OVERSEAS TRANSPORTATION.

Scheduling of all shipments began upon the receipt of requisitions. All requisitions were first screened in the office of the Chief of Operations where the urgency of the items and the method of transportation were determined. Purchase orders were then written with delivery at the shipping point as determined by the Material Control Section of the Operations Division.

Material scheduled for transshipment to the Proving Ground via water was delivered to the Naval Supply Center in Oakland where it was manifested and held for loading aboard cargo vessels. Task Force SEVEN standard procedures required that the estimated quantities of cargo destined for Jobsite be firmly established four months in advance; space was allocated aboard these vessels accordingly. Shipping schedules in the early part of the Operation were based on providing needed surface transport with one cargo vessel approximately once each month. Due to the need for accelerated shipping that developed during the period of peak construction activity, schedules were revised to provide for sailings approximately once each three weeks. Contractor's representatives were stationed at NSC to check and supervise incoming cargo and to coordinate outgoing cargo with a JTF-7 Transportation Liaison Officer. The space provided and the frequency of shipments were generally adequate to meet the needs of the Jobsite. However, certain unanticipated difficulties developed which caused serious disruptions in the orderly progress of construction. The loading and departure time of vessels were subject to unannounced changes and there were instances where urgently needed cargo was deferred to later carriers. Some of this cargo had to be diverted to air transportation. The amount of cargo shipped monthly by surface vessel is shown in Chart 3-3.

Subsequent to mid-1954, shipment of refrigerated cargo was made via commercial carrier to Honolulu and from there the cargo was transshipped in Naval vessels to the Proving Ground. So long as the schedules of the commercial carriers were coordinated with the schedules of the Naval vessels, transportation in this manner was satisfactory. The purchase and delivery of fresh produce was generally timed with loading schedules to provide for a minimum number of days out-of-the garden, but the schedules of the commercial carriers were subject to sudden and unannounced changes; these changes were usually made after perishable products were enroute to loading points. Where the schedules were delayed, the changes increased the out-of-the garden period and called for additional storage and handling. In some cases, schedules were advanced, which called for expediting packing and movement to the loading port. These changes (in the commercial carrier schedules) were also reflected in the transhipment point in Honolulu. Incoming reefers missed outgoing reefers and additional handling and cold storage were required. In many cases, perishable subsistance had to be hauled from the downtown docks in Honolulu to Pearl Harbor. To overcome some of the difficulties encountered, a procedure of "sight buying" of perishable products was established. This provided for quality produce at a minimum of cost; it also permitted obtaining produce in a minimum of time after harvest. Food losses due to spoilage were kept at a minimum because of this "sight buying" procedure.

Overseas air transportation was provided through the MATS system, with the on-continent terminal located at Travis Air Base. With the need for accelerated delivery of materials in the latter months of the Operation, a considerable amount of cargo had to be diverted from surface to air transportation. Only those items of such urgency that to hold them for surface transportation would seriously affect construction schedules were shipped by air. Initially, requirements for air transportation were estimated four months in advance of needs as required by Task Force operating procedures; as the amount of cargo that became critical kept increasing, estimates for space had to be changed to a month-to-month basis. The demands on MATS from all agencies became heavy and were subject to radical variations. As a result, Contractor's cargo could not be lifted in accordance with allocations for the months of September, October, and November 1955, and backlogs of urgently-needed cargo developed. In late December the condition worsened, and an investigation was made a to the availability of commercial charter plane as an emergency means of reducing backlogs. This was found feasible, but since the MATS facilities were thereafter augmented rapidly charter planes were not needed. Monthly air cargo shipments are shown in Chart 3-4. Of approximately 550 tons airlifted from 1 Ju 1954 through 30 May 1956, 318 tons we moved during the months of February, March, and April of 1956.

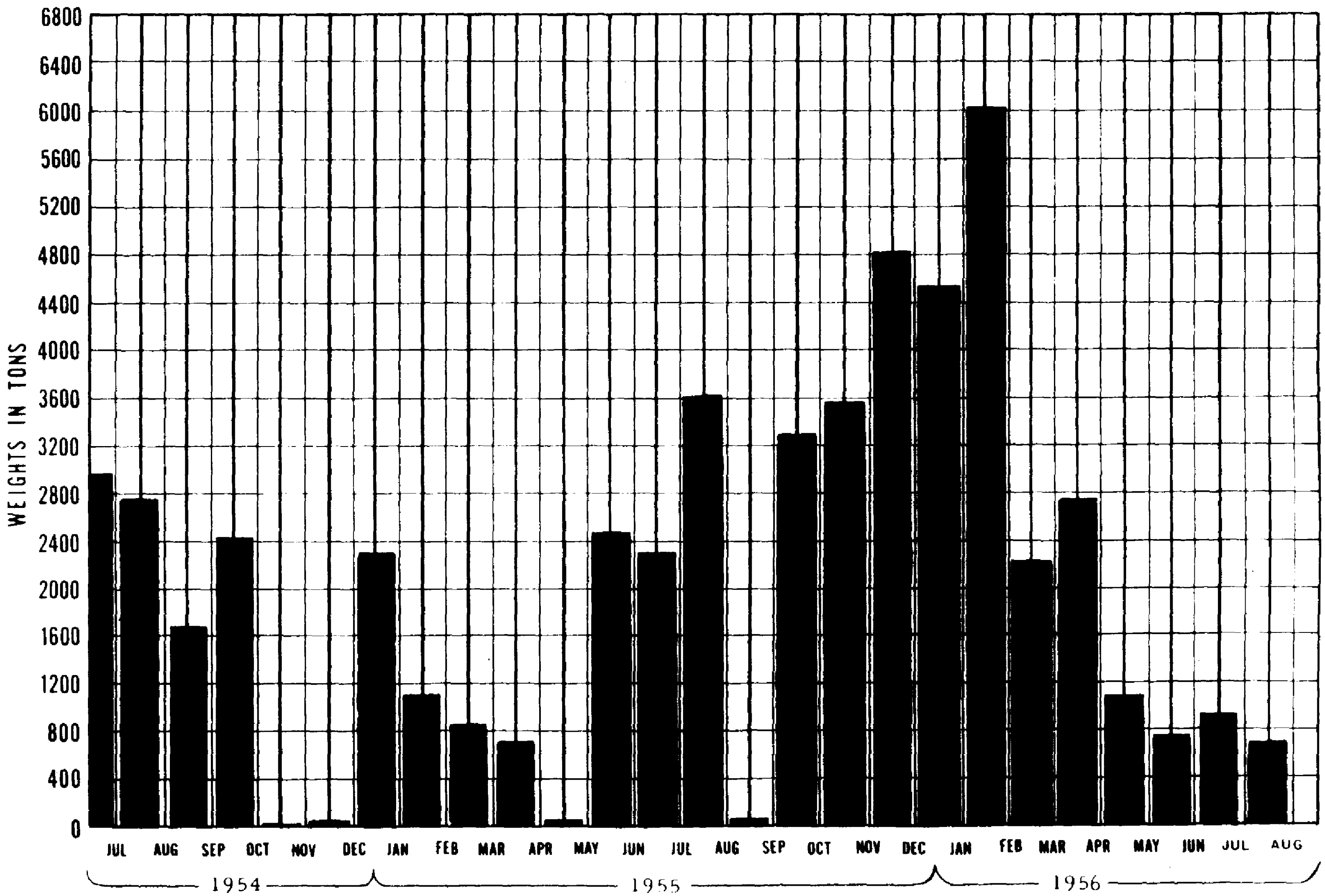


Chart 3-3. Water Shipment

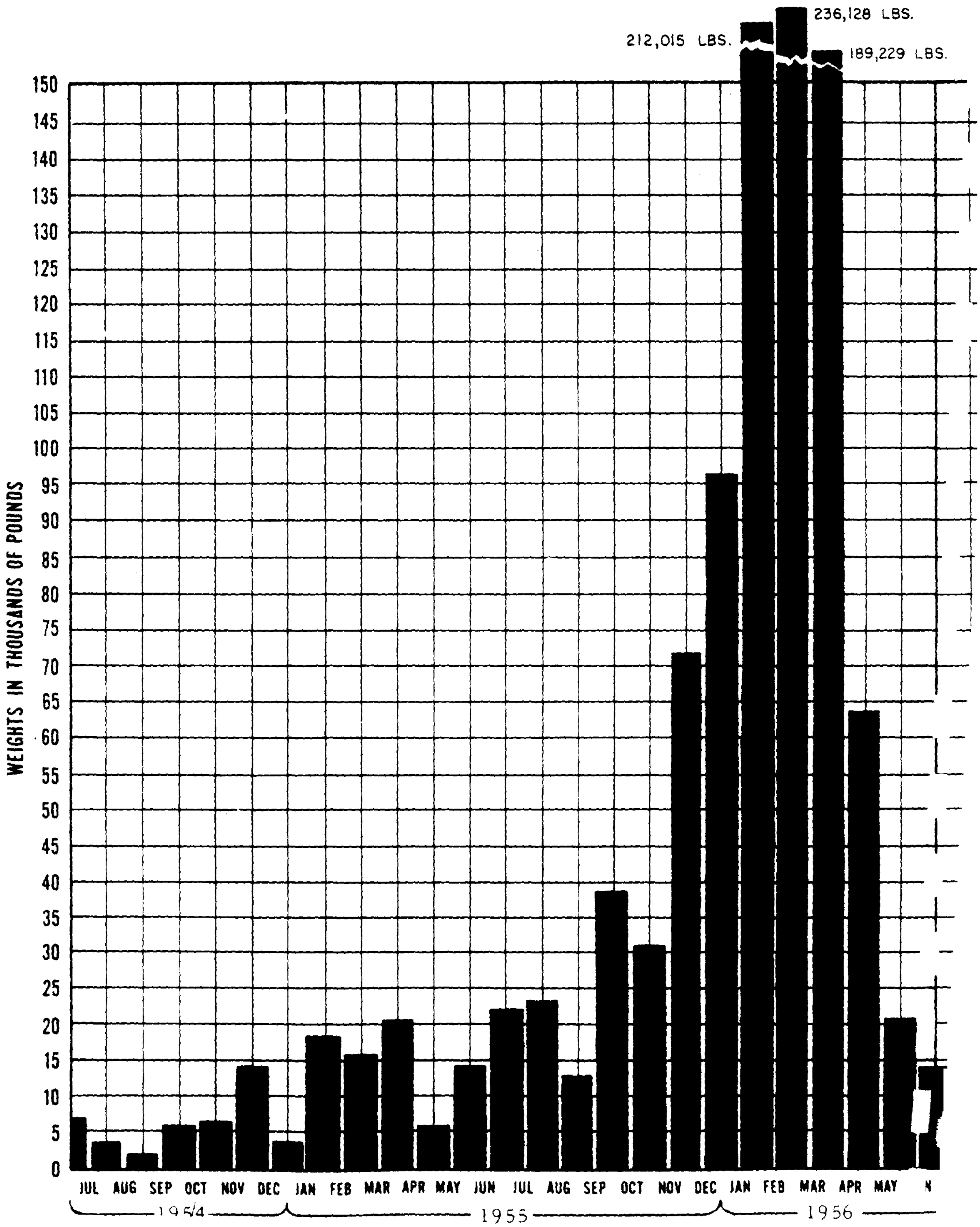


Chart 3-4. Airlift Shipment

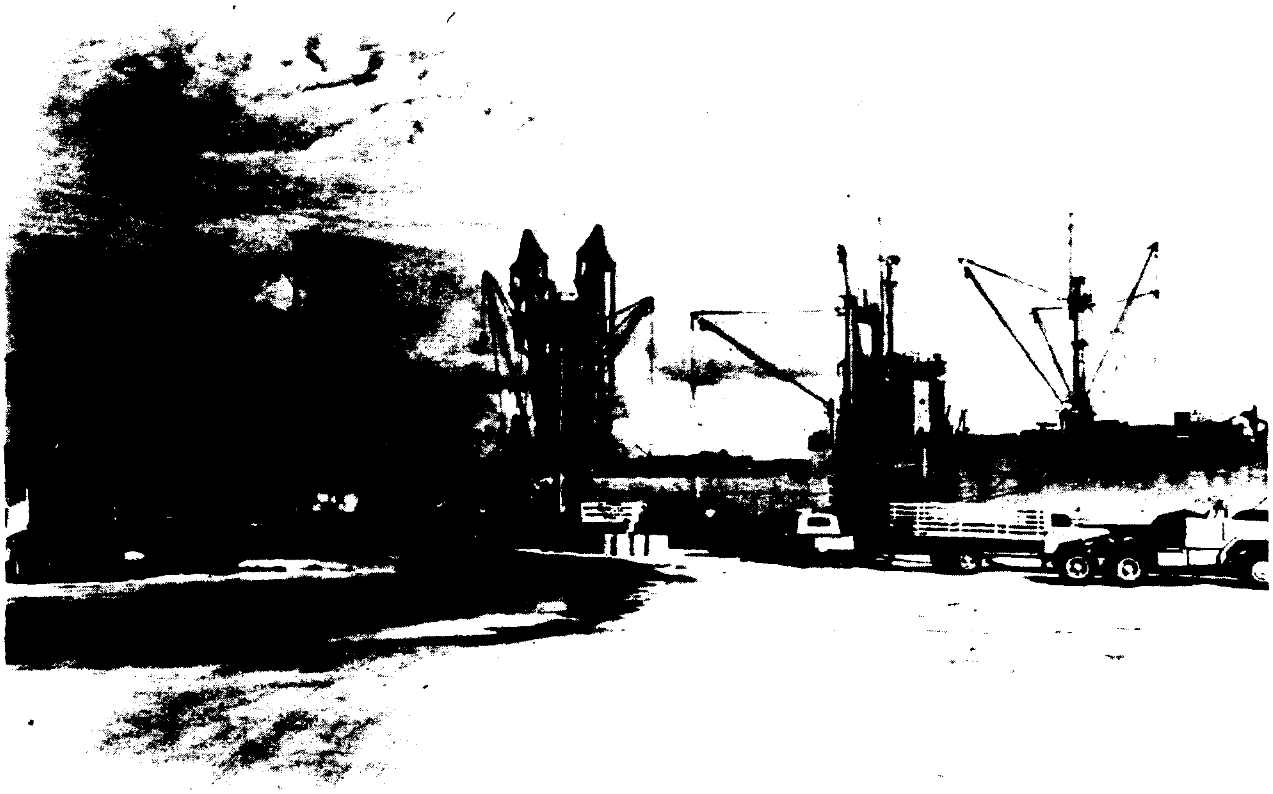


Figure 3-10. Cargo Vessel at Pier - Elmer

JOBSITE SUPPLY

STEVEDORING.

On 1 July 1955, Holmes & Narver was assigned the responsibility for all stevedoring operations at the Proving Ground except onshore at sites David and Fred. All such operations on board ship were previously performed by Army personnel. The responsibility for the port operation and related activities remained vested in the Atoll Commander. A Stevedore Department was established within the Supply Division consisting of 44 men; this provided for four gangs. In order to meet the urgent offloading demands of incoming cargo and to fill the tight shipping schedules that were established, it was necessary during the peak period (from December 1955 to April 1956) to augment this group with one additional stevedoring gang comprising men temporarily assigned from the Construction-Maintenance Division. This permitted the working of five hatches simultaneously. Because of the inherent intermittent requirements for stevedoring, it was impracticable to provide personnel for more than one shift. The requirement for rapid offloading of vessels in port called for a normal work schedule for stevedores from 0730 to 2400 hours, resulting in considerable overtime. During the busiest month (February 1956), a work schedule of 15 hours per day was maintained for 15 days out of the 29 days of the month. Stevedoring personnel were closely observed during peak offloading operations; work was accomplished without harm to the men and with a minimum of damage to cargo.

During periods when ocean-going vessels were not in port, stevedore personnel were kept continuously employed in such operations as loading LSTs and small marine craft, stacking and stowing dunnage, and repair of gear, or they were temporarily assigned to other departments. (It is of interest to note that it was not necessary to purchase lumber for dunnage purposes as the dunnage saved from offloading operations sufficed for backloading.)

Stevedoring problems encountered were, in general, adequately resolved through the cooperation of the Port Commander, the Masters of vessels, and loading authorities at NSC, Oakland. Because sufficient winch cable was not available, the first vessels that were worked could not be simultaneously unloaded inshore to the dock and offshore to a barge. This method of discharge was desirable in that cargo assigned to site Fred could be offloaded onto a barge outboard of the vessel while cargo assigned to Elmer was offloaded onto the pier. This condition was rectified and wing-to-wing discharge was initiated and permitted more rapid offloading of the vessels. Another problem was the loss of working hours due to the necessity of closing and reopening hatches because of frequent rain squalls and the need for overnight cover. This was overcome by the use of hatch tents fabricated at the Jobsite from scrap canvas. The use of these tents on the SS Swarthmore Victory eliminated the need for closing and opening the hatches 22 times during one operation, representing a saving in many hatch hours.

At first, reefer cargo assigned to Elmer was offloaded at the deep water pier, and that for Fred was offloaded offshore and into LCMs for ferrying to the site. This proved cumbersome and time-consuming, particularly since cargo was sometimes stowed aboard the ocean-going vessel in a manner that required alternate discharge for each site. Therefore it became the practice to offload all refrigerated cargo at the Elmer deep water pier and to transship cargo assigned to Fred via trucks in LCUs. During the peak of construction activity, difficulties developed because marine craft were urgently needed for other purposes. Experiments disclosed that refrigerated cargo could be moved by barge with no loss, provided it was well covered with tarpaulins; therefore this method of handling Fred refrigerated cargo was adopted.

Because of the intense over-all shipping activity that developed during the peak construction period, the old cargo pier had to be used frequently. At one time there were a major cargo vessel and an LST at the deep water pier, an LST at the old cargo pier, and a reefer vessel in the lagoon being worked simultaneously.

The wind and currents at times made ship handling and docking difficult, and the deep water pier sustained damage on several occasions and had to be taken out of operation until repairs could be effected; the old cargo pier was put into use during these repairs.

The per-vessel tonnage of cargo that arrived at Jobsite is shown in Table No. 3-5 and 3-6.

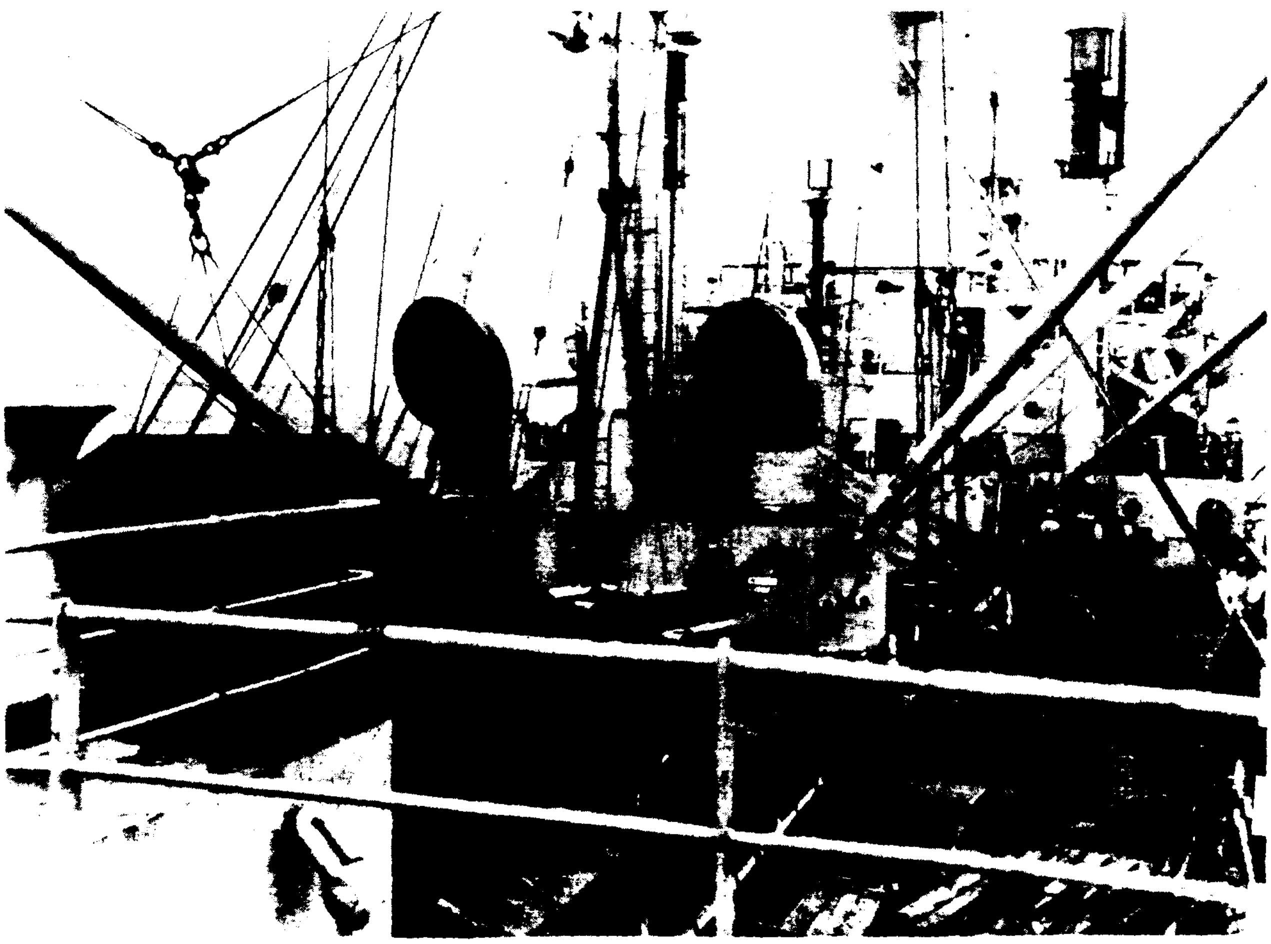


Figure 3-11. Tents Used for Hatch Covers

TONNAGE OF CARGO SHIPPED VIA SURFACE VESSEL TO JOBSITE FROM THE STATES

DATE	VESSEL	HOLMES & NARVER L/T	HOLMES & NARVER M/T	MILITARY L/T	MILITARY M/T	L/T	M/T
1954							
28 July	USNS Pvt. Frank J. Petrarcan	1,783.0	2,495.0	109.0	231.0		
5 Sept.	USNS Pvt. Merrill	1,455.0	1,761.0	123.0	199.0		
25 Oct.	USNS Jack Pendleton	443.0	1,231.0	112.0	277.0		
	TOTAL	3,681.0	5,487.0	344.0	707.0	4,025.0	6,194.0
1955							
1 Jan.	USNS Sgt. Archer T. Gammon	1,556.0	2,236.0	152.0	452.0		
7 Feb.	USNS Pvt. Joe E. Mann	959.0	1,586.0	230.0	329.0		
26 Mar.	USNS Jack Pendleton	841.0	1,897.0	194.0	770.0		
				(24#)	(2′)		
15 April	USNS LST 664	642.0	976.0	54.0	259.0		
				(96#)	(5′)		
10 June	SS Norwalk Victory	1,685.0	2,236.0	60.0	260.5		
15 July	SS Linfield Victory	2,109.0	4,216.0	317.0	862.0		
27 Aug.	SS Franklin Berwin	3,122.0	5,099.0	378.0	805.0		
28 Aug.	SS Norwalk Victory	609.0	360.0	68.0	569.0		
8 Oct.	SS Swathmore Victory	3,206.0	4,998.0	396.4	1,231.0		
9 Nov.	USNS LST 306	1,028.0	1,215.0				
15 Nov.	USNS Pvt. Joe E. Mann	172.0	456.0	73.0	126.0		
17 Nov	USNS Sgt. Archer T. Gammon	2,310.0	3,488.0	357.0	863.0		
24 Dec.	SS Tucson Victory	4,679.0	5,686.0	376.0	1,223.0		
	TOTAL	22,918.0	34,449.0	2,655.4	7,749.5	25,573.4	42,198.5
1956				(120#)	(7′)		
27 Feb.	USNS LST 618	711.0	687.0	173.0	871.0		
5 Mar.	USNS Andrew Miller	492.0	988.0	588.0	2,848.0		
				(256#)	(9′)		
8 Mar.	USNS Marine Fiddler	1,586.0	2,693.0	790.0	3,025.0		
16 Mar.	USS Badoeng Strait			212.5	6,910.6		
30 Mar.	USNS Pvt. Joe E. Mann	1,439.0	3,273.0	667.0	2,495.0		
2 April	USS Chickasaw		1,497.0				
13 April	USNS Sgt. Archer T. Gammon	582.0	1,406.0	411.0	1,258.0		
26 April	USNS F. C. Ainsworth	18.0	76.0	2.0	9.0		
4 May	USNS Pvt. Joe E. Mann	1,002.0	2,055.0	581.0	1,305.0		
7 June	USNS Sgt. Archer T. Gammon	1,067.0	2,351.0				
	TOTAL	6,897.0	15,026.0	3,424.5	18,721.6	10,321.5	33,747.6
				(256#)	(9′)		
	TOTAL	33,496.0	54,962.0	6,423.9	27,178.1	39,919.9	82,140.1
				(376#)	(16′)		

Table 3-5. General Cargo Shipped Via Surface Vessel to Jobsite

REEFER CARGO SHIPPED VIA SURFACE VESSEL TO JOBSITE

DATE 1954	VESSEL	HOLMES & NARVER L/T	HOLMES & NARVER M/T	MILITARY L/T	MILITARY M/T	L/T	M/T
29 July	USS Arequipa		52.8		103.8		
24 Aug.	USS Merapi	93.0	196.0	115.0	218.0		
17 Sept.	USS Arequipa	31.0	56.0				
14 Oct.	USS Arequipa	26.7	85.2				
17 Nov.	USS Arequipa	13.1	29.5				
15 Dec.	USS Karin		102.8		7.6		
		163.8	522.3	115.0	329.4	278.8	851.7
1955							
17 Jan.	USS Karin		124.8		24.2		
21 Feb.	USS Sussex	42.0	71.2				
19 Mar.	USS Grainager	72.9	126.0		1,025.0		
14 April	USS Merapi		94.2				
19 May	USS Merapi	123.8	1,685.0	20.9	60.0		
16 June	USS Karin	193.3	320.3				
12 July	USS Merapi	209.0	334.6				
6 Aug.	USS Karin	84.8	154.0				
29 Aug.	USS Sussex	4.3	8.4				
16 Sept.	USS Merapi	101.3	178.8	49.6	91.3		
Oct.	USS Faribault		36.7		38.5		
Nov.	USS Karin	131.0	221.2	84.7	228.0		
15 Nov.	USS Merapi	58.1	99.4	23.4	44.1		
6 Dec.	USS Karin	135.1	223.4	113.7	216.2		
20 Dec.	USS Faribault	32.2	93.9	16.0	1,449.6		
		1,187.8	3,771.9	308.3	2,254.4	1,496.1	6,026.3
1956							
15 Jan.	USS Karin	359.0	710.0				
9 Feb.	USS Sussex	346.0	840.0				
22 Feb.	USS Karin	359.0	710.0				
14 Mar.	USS Merapi	353.1	563.9	66.9	171.6		
26 Mar.	USS Sussex		137.5		149.9		
11 April	USS Karin		216.6		227.3		
26 April	USS Merapi	310.4			695.5		
26 May	USS Karin		153.1		215.3		
		1,727.5	3,331.1	66.9	1,459.6	2,489.9	4,790.7
		3,079.1	7,625.3	490.2	4,043.4	4,264.8	11,66 7

Table 3-6. Reefer Cargo Shipped Via Surface Vessel to Jobsite

FREQUENCY OF VESSEL ARRIVALS

MONTH	GENERAL CARGO	REEFERS	TANKERS	TOTAL
1955				
January	1	1	1	3
February	1	1	0	2
March	1	1	1	3
April	1	1	0	2
May	0	1	2	3
June	1	1	1	3
July	1	1	1	3
August	2	0	2	6
September	0	1	1	2
October	1	1	1	3
November	3	2	0	5
December	1	2	1	4
1956				
January	0	1	1	2
February	1	2	1	4
March	4	2	2	8
April	2	2	1	5
May	1	1	2	4
June	1	1	2	4

Table 3-7. Frequency of Vessel Arrivals

Figure 3-12. All Off-Loading Berths Occupied

The deep water pier also facilitated the handling of bulk fuel at site Elmer. The installation of fuel lines on the pier permitted pumping during the hours of darkness, which was not formerly possible when fuel was being received through the old submarine hose system. Separate lines were provided for motor fuel and diesel oil, thereby eliminating the comingling of bulk fuels. Bulk fuel was received at site Nan in a fuel barge moored offshore which served as a reserve storage facility and eliminated the need for extra tanks onshore. The barge was divided into compartments, which were used as follows: four compartments of 25,000 gallons each, providing storage for 100,000 gallons of diesel oil; one compartment of 33,800 gallons for Avgas; one compartment of 33,800 gallons for Mogas.

The receipt and issues of bulk fuel during the Operation were as shown in Table No. 3-8.

WAREHOUSING.

Initially, all incoming cargo was first received through the Elmer central warehousing facilities from where it was transshipped to site Nan for Bikini distribution. Eniwetok off-island sites and all off-atolls were served directly from the Elmer warehouses.

During the period of peak activity it was necessary to store approximately 4,000 cu. ft. of dry subsistance stores under tarpaulins. Proper precautions were taken to ensure that losses from corrosion of cans would be held to a minimum. Oxygen and acetylene tabernacles, where good ventilation was available, were used to store potatoes and onions which proved to be satisfactory. Throughout the Operation, available cold storage spaces were crowded. At one time the cold storage problem became critical and was resolved only through the receipt (on a loan basis from the Army at Eniwetok) of 12 mobile reefers with a total storage capacity of 6,000 cu. ft. Without these additional reefers, delivery of all incoming freeze cargo on one vessel could not have been accepted.

The cement shed was inadequate and a large quantity of cement had to be stored under canvas. Improvements in warehouse facilities that have been authorized will provide for more adequate cement storage during future Operations.

Figure 3-13. Interior of Warehouses

MOGAS - DIESEL STATISTICS
July 1945 - May 1956

SITE ELMER

MONTH		TANKER	GALLONS MOGAS RECEIVED	GALLONS ISSUED	TANKER	GALLONS DIESEL RECEIVED	GALLONS ISSUED
JULY	1954	NATCHAUG	18,104	17,571	NATCHAUG	166,194	146,895
AUGUST	1954	GENESEE	16,317	15,167	GENESEE	177,675	147,476
SEPTEMBER	1954	—	—	12,985	—	—	148,703
OCTOBER	1954	—	—	12,768	NATCHAUG	179,928	158,536
NOVEMBER	1954	TOMBIGBEE	37,756	12,328	TOMBIGBEE	198,324	101,460
DECEMBER	1954	—	—	11,999	NEMASKET	121,464	129,322
JANUARY	1955	RIO GRANDE	41,700	16,874	RIO GRANDE	181,314	153,611
FEBRUARY	1955	—	—	12,939	—	—	115,507
MARCH	1955	TOMBIGBEE	36,057	13,909	TOMBIGBEE	144,564	108,054
APRIL	1955	—	—	12,560	—	—	56,735
MAY	1955	NAMAKAOON	27,798	22,199	NEMASKET	454,188	146,091
JUNE	1955	—	—	23,352	—	—	181,161
		US ARMY-FF	6,400				
JULY	1955	AGAWAM	25,656	13,521	AGAWAN	330,246	159,909
AUGUST	1955	—	—	20,605	—	—	212,562
		AGAWAM	25,016		AGAWAN	233,142	
SEPTEMBER	1955	NAMAKAOON	53,192	29,965	NAMAKAOON	220,500	192,410
OCTOBER	1955	—	—	28,721	—	—	193,951
NOVEMBER	1955	NEMASKET	38,455	33,619	NEMASKET	237,888	216,326
DECEMBER	1955	TOMBIGBEE	35,154	42,030	TOMBIGBEE	213,585	204,677
JANUARY	1956	KISHWAUKEE	54,124	38,962	KISHWAUKEE	279,903	227,108
FEBRUARY	1956	KISHWAUKEE	46,888	53,181	KISHWAUKEE	226,674	207,914
		NAMAKAOON	41,000	68,974	NAMAKAOON	140,288	
MARCH	1956	AGAWAM	63,685		KISHWAUKEE	170,184	244,832
APRIL	1956	KISHWAUKEE	72,711	72,839	AGAWAM	328,650	328,263
		NEMASKET	11,938		AGAWAM	50,000	
MAY	1956	NATCHAUG	13,425	44,512	NEMASKET	194,905	325,453
TOTALS			665,376	631,580		4,249,616	4,106,956

SITE NAN

MONTH		TANKER	GALLONS MOGAS RECEIVED	GALLONS ISSUED	TANKER	GALLONS DIESEL RECEIVED	GALLONS ISSUED
JANUARY	1955	RIO GRANDE	35,000	4,820	RIO GRANDE	128,982	9,550
FEBRUARY	1955	—	—	13,027	—	—	25,602
MARCH	1955	—	—	15,543	—	—	29,124
APRIL	1955	—	—	8,742	—	—	19,279
MAY	1955	NAMAKAOON	22,518	7,905	NEMASKET	91,140	27,400
JUNE	1955	—	—	9,760	—	—	33,639
JULY	1955	AGAWAM	28,320	17,758	AGAWAM	73,332	58,600
AUGUST	1955	—	—	6,301	—	—	28,890
SEPTEMBER	1955	NAMAKAOON	9,455	20,157	NAMAKAOON	79,296	71,714
OCTOBER	1955	—	—	6,470	—	—	31,324
NOVEMBER	1955	NEMASKET	18,060	12,719	NEMASKET	79,800	66,232
DECEMBER	1955	TOMBIGBEE	6,332	9,888	TOMBIGBEE	71,820	52,422
JANUARY	1956	KISHWAUKEE	21,504	14,085	KISHWAUKEE	74,718	66,490
FEBRUARY	1956	KISHWAUKEE	25,463	6,780	KISHWAUKEE	93,408	35,599
		NAMAKAOON	8,103		NAMAKAOON	23,791	118,944
MARCH	1956	AGAWAM	19,504	40,170	AGAWAM	57,540	
APRIL	1956	KISHWAUKEE	32,823	18,720	KISHWAUKEE	96,516	87,182
		NEMASKET	13,000		MISPILLION	65,142	
MAY	1956	NATCHAUG	20,008	56,534	NEMASKET	48,720	121,318
TOTALS			260,090	269,379		984,205	883,309

MOGAS — 14,800 gallons on hand prior to January 1955 (Transfers from Elmer)
DIESEL — 22,290 gallons on hand prior to January 1955 (Transfers from Elmer)

Table 3-8. Mogas - Diesel Statistics - May - July 1945 - May 1956

Warehousing facilities maintained at all off-island sites were adequate and no problems of significance were encountered.

The packing of all cargo for overseas shipment by Pacific Ports Industries was very satisfactory and the documents connected with the shipment of materials were accurate. Packing materials were good and very little damage to arriving materials was experienced. The high quality containers used permitted their reuse many times for shipments within the PPG.

Trailers were in short supply throughout the Operation and many shipments to off-island sites had to be made as "deck loads" on marine craft. The trailer shortage was due to two primary causes: extensive construction on reefs called for the use of trailers for mounting drill rigs and other construction equipment; and off-atoll construction requirements necessitated that trailers be out of the Proving Ground for long periods.

A considerable amount of on-site logistic planning was essential because of the large area over which construction activities were conducted. All shipments, irrespective of origin, were controlled through the Shipping Section of the Supply Division. During the operational phase, the Supply Superintendent was delegated the authority to coordinate air shipments to off-atolls with all agencies.

The movement of cargo via surface transportation between Bikini and Eniwetok is shown in Chart No. 3-5. Shipments made to the off-atolls were as shown in Table 3-9.

WATER FREIGHT TO OFF-ATOLLS

DATE	TO	L/T	M/T
1955			
September	Kapingamarangi	515.9	5,654.8
	Ponape	352.2	1,324.5
November	Tarawa - Kusaie	386.3	744.6
		1,254.4	7,723.9
1956			
January	Rongerik	454.8	987.6
February	Rongerik	234.6	413.2
February	Wotho	698.0	6,282.9
February	Kusaie	320.7	709.6
February	Tarawa	254.7	373.9
March	Wotho	9.0	26.6
March	Kapingamarangi	876.5	6,473.2
March	Tarawa - Kusaie	278.7	766.0
March	Rongerik	162.4	477.4
March	Ujelang	142.0	1,092.3
April	Rongerik	2.5	66.8
April	Uterik	241.1	2,556.4
April	Wotho	9.1	512.4
		3,684.1	20,738.3
		4,938.5	28,462.2

Table 3-9. Water Freight to Off-Atolls

A definite corrosion control program was instituted. Metal bins in warehouses were sanded and painted in a continuing cycle; replacements should not be necessary for a number of years. For preservation of small items and tools, a plastic dip method was initiated. A large capacity dip tank was purchased that can be used for a variety of items requiring anti-corrosi' protection. The savings to be effected over a period of years should be substantial.

The warehouse and outside storage are at the PPG for Operation REDWING (not including military) are shown in Table No. 3-10.

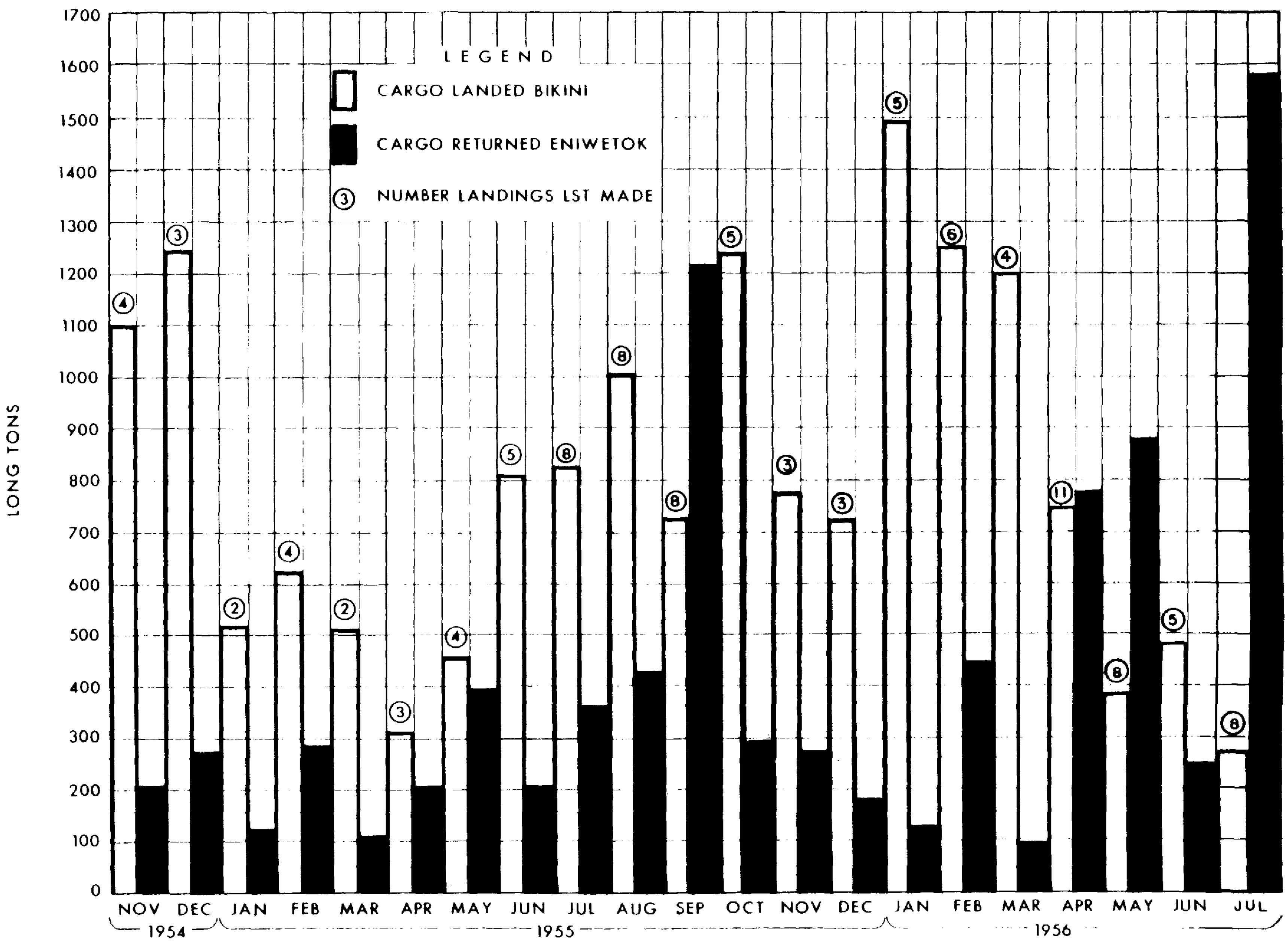


Chart 3-5. LST - Cargo - Eniwetok - Bikini

WAREHOUSING STORAGE

SITE	WAREHOUSE	INSIDE (Square Feet)	OUTSIDE (Square Feet)
ELMER	SHIPPING AND RECEIVING	4,000	
	PLUMBING	7,200	
	ELECTRICAL	7,200	
	SUBSISTENCE BLDG. 504	4,000	
	BLDG. 308	5,000	
	PROPERTY, CAMP SUPPLIES	11,200	
	PARTS, MECHANICAL	14,400	
	TOOLS ,HDWE., WELDING ROD, STAT.	8,144	
	CHILL HOUSE	1,152	
	REFRIGERATION	23,525 CUBIC FEET	
	OXYGEN, ACETYLENE	3,500	
	NITROGEN	144	
	DYNAMITE BUNKER (REX)	2,200	
	CAP SHED (REX)	480	
	CEMENT SHED	3,000	
	POL PUMP HOUSE	768	
	PAINT, BUILDING MATERIALS	8,000	
	TOTAL	103,913	
	STEEL YARD		47,800
	MATERIAL YARD		328,200
	CABLE YARD, CLASSIFICATION YARD		135,900
	WAREHOUSE AREA		190,000
	SALVAGE YARD		21,800
	TOTAL		723,700
WAREHOUSE STORAGE - OFF ISLAND			
NAN		8,640	60,000
TARE		1,440	10,000
FOX		465	5,000
YVONNE		1,440	10,000
URSULA		465	5,000
GENE		1,440	8,000

Table 3-10. Warehouse and Outside Storage Areas

Figure 3-14. Outside Storage Area - Elmer.

MATERIAL CONTROL.

All store requisitions were screened through Kardex records before materials were issued to ensure that allocated materials were not being used for other purposes or, if the materials were released for use, that adequate replacements or substitutions were procurable. Allocations of material were made against specific or general construction commitments until such time as definite requirements were known; they were then posted to "use" feature. Reviews were made of stock levels against established reorder points, and maintenance stock replenishment requisitions were subsequently initiated for items which were of standard stock nature.

"Standard packaging" was introduced in hardware and was gradually extended to other commodities. The expense of the monetary and quantity control for such items as screws far outweighed the value of the item. Therefore, a standard package for screws (one gross) is charged to a special account; individual issue from this package is then made on a "no charge" basis. Inventory control was maintained only on unbroken packages. Many man-hours in accounting and material control were saved by the introduction of the standard package system.

Special excess reports were submitted to the Home Office calling attention to items of inventory that could have no further possible use at the Jobsite. These items were mainly parts for heavy equipment, motor vehicles of a type no longer at the Jobsite, or items of special design which became obsolete. With the disposition of these excess items, the total inventory at the Jobsite should be materially reduced.

SECTION 7
SECURITY

GENERAL.

The basic security requirements for REDWING were essentially the same as those established for Operations GREENHOUSE, IVY AND CASTLE. The H&N Security Department was responsible for assisting Management in formulating policies and implementing procedures to ensure compliance with existing A&C security directives, and for safeguarding the mission at the Pacific Proving Ground by educating H&N employees, both on-continent and overseas, in security responsibilities.

Functional control of the security program was the responsibility of the Home Office Security Department.

Initially, one Security Officer was assigned to the PPG, but as the Operation progressed, three Assistant Security Officers were added: one at Bikini Atoll and two at Eniwetok Atoll.

The H&N Honolulu Office Manager was assigned the responsibilities of Security Representative for Hawaiian Territory activities, under guidance of the Home Office Security Department.

All personnel clearances and identification media were processed within the Home Office. Each applicant for employment was photographed and fingerprinted. A limited non-governmental, pre-employment investigation was conducted on all prospective employees. Any derogatory information which developed as a result of these pre-employment checks, was coded. The cooperation of the various AEC Security Offices contributed greatly to the favorable security record maintained by H&N personnel during the Operation.

PERSONNEL CLEARANCE.

At the commencement of the Operation, only "P" approval and "Q" clearances were in effect, but on 9 March 1955 the Commission authorized the Good Security Risk (GSR) certification, and on 17 March 1955 the "L" clearance. The "P" approval was granted after an evaluation of the fingerprint and name checks on the files of the Federal Bereau of Investigation and other national agencies. It afforded access to Secret Defense Information on a "need-to-know" basis but did not allow access to Restricted Data. The "Q" clearance was granted after the Civil Service Commission conducted a background investigation. This clearance authorized access up to and including Top Secret Restricted Data on a "need-to-know" basis. The "L" clearance was granted after a check of various national agencies and afforded access to Secret Defense Information and to Confidential Restricted Data. The first "L" clearance was granted on 12 April 1955. The GSR determination was based upon the results of local law enforcement agency checks in addition to a review of Personnel Security Questionaires. Personnel with GSR certification could not have access to classified information. The GSR certification was instituted to provide for the build-up of personnel during the construction phase of the Operation. In the case of high caliber employees willing to undertake overseas employment, few are willing to stand-by for a long period to await security clearance. If they were otherwise employed at the time security processing commenced, events could take place in the long intervening period of processing so that, by the time their clearances were approved, they would for one reason or another not accept the overseas employment. As the GSR certification could be obtained within six to eight days, difficulties in recruiting resulting from the long security processing period were mostly overcome.

In the process of checking for GSR certification, much information was obtained from police files throughout the United States by sending form letters of inquiry to the Chiefs of Police of the towns or cities mentioned in the applicant's PSQ'S. In addition to police checks, information was obtained from investigations by commercial agencies. This checking generally provided an adequate basis for determining whether or not an employee could be sent tc the Proving Ground in the early stages of the Operation certified as a Good Security Risk. The first GSR certification was received on 12 April 1955. During the period of the Operation 1692 GSR certifications were requested an 1386 were approved. Of those not receiving approval, 156 were canceled because of derogatory information and 150 were canceled be cause of medical or other reasons. Of the 138 sent to the Proving Ground, only 15 had to be returned because of derogatory information developed in the later processing for appropria "L" or "Q" clearance.

In July 1955, the deletion of the "P" approval program was proposed. As this would a versely affect the build-up in manpower, d cussions were held with AEC Security representatives which resulted in the further e of "P" approvals. This was continued until 21 November 1955 when the AEC requested the Contractor to discontinue processing Jobsite applicants for "P" approval, and on 12 December, to discontinue processing these approvals for the Honolulu and Home Office employees. A date limit of 15 February 1956, later changed to 15 March 1956, was set after which the "P" approval would not afford access to classified information. Personnel then in process for "P" approval were resubmitted for processing of an "L" or "Q" clearance as appropriate for each case.

Cutoff dates after which personnel at the Proving Ground would be required to be either "Q" or "L" cleared were initially established as 1 January 1956. This date was first advanced to 15 March 1956, and on 20 February 1956 was again advanced to 7 April 1956, with the provision that GSR certified personnel could be retained at Fred until 20 April 1956. At a meeting held in Albuquerque on 19 and 20 December 1955, attended by security representatives of the Contractor and AEC, a decision was reached that personnel with GSR certification could be transported to the Proving Ground provided they could be cleared by the cutoff date. (It was established that a reasonable period for processing the "L" clearance was 60 days and for the "Q" clearance, 120 days.) It was also agreed at this meeting that a request for both the "L" and "Q" clearances could be made for certain individuals in order to permit the required build-up of cleared personnel.

Until the Spring of 1955 it had been the practice to cancel an applicant's "Q" clearance if he had not been hired within 90 days after granting the clearance. The "Q" clearance was also canceled on terminated employees who were not rehired within 90 days. In March 1955, an agreement was reached with the AEC Security representatives that in order to maintain a pool of cleared personnel, H&N would discontinue canceling clearances until 1 January 1956 which, at that time, was contemplated as the cutoff date. As the cutoff date had been extended until 15 March and as personnel procurement was extremely critical, on 29 December, the Contractor obtained permission to maintain all "Q" and "L" clearances on an active status until the new cutoff date. On 16 February 1956, the AEC directed the Contractor to cancel all clearances granted (prior to 1 October 1955) to those individuals who had not been hired and further, to terminate all clearances that had been granted and were not utilized within a 120-day period.

Initially, all security papers required to obtain clearances were submitted to the AEC Security Branch in Los Angeles for screening and granting of clearance. On 15 June 1955, AEC screening activities for clearances were transferred to the Albuquerque Operations Office. One AEC representative remained in Los Angeles to act in a liaison capacity and to grant the GSR certification.

Pertinent statistics of the personnel clearance program are shown in the following table:

NON-CLEARED PERSONNEL

EMPLOYEES AT PPG.	DATE	NUMBER OF GSR'S	NUMBER OF PETER APPROVED
1927	10 August 1955	90	21
1412	10 September 1955	41	13
1577	10 October 1955	32	30
1789	10 November 1955	53	29
1974	10 December 1955	67	42
2025	10 January 1956	57	45
2401	10 February 1956	144	44
2643	10 March 1956	87	16
2695	10 April 1956	26	0
2262	10 May 1956	0	0

TYPE	AVERAGE* PROCESSING DAYS	REQUESTED FROM 1 JULY 1954 THRU	GRANTED 30 JUNE 1956
Q	94	1128	865
P	43	853	657
L	52	2660	2197
QR	24	1382	1335
GSR	8	1692	1386

* During peak activity - early months of 1956.

Entry into the Pacific Proving Ground is controlled by the Commander-in-Chief of the Pacific Fleet. In former operations, this entry was authorized by the Port Control Director, Long Beach Naval Station, through the issuance of travel orders, countersigning identification badges, and the initiation of a dispatch addressed to CINCPAC certifying the clearance status of the employee enroute to the PPG. The Deputy Director Test Division requested that for this operation, the functions formerly performed by the Port Control Director be delegated to the Contractor; on 16 November 1954, H&N was advised that this was approved with the concurrence of CINCPAC and CJTF-7. This delegation of authority was accomplished by appointing the Chief Security Officer, one assistant, and the Honolulu Office Manager and his assistants as Subadjutant Generals of TG 7.5. This provided for more expeditious procedures in preparing travel orders and in clearing Holmes & Narver personnel for entry into the Proving Ground. The first set of travel orders was issued under this authority on 25 January 1955. Travel orders were issued at the employee's point of hire and served as his authority to travel to the Proving Ground, and, upon proper endorsement by H&N at the Proving Ground, to return via Military aircraft. The Subadjutant General's offices were authorized to issue the message to CINCPAC which warranted the clearance status of the individual. Copies of these messages were furnished to all interested parties. This procedure was very effective in saving layover time in Honolulu and in providing for a smoother flow of personnel into the MATS system. These Subadjutant Generals were also authorized to issue AEC Pacific Proving Ground identification cards. These cards satisfied the State Department requirements for passports and were first issued to employees in April 1955. On 17 March 1955, the Security Officer at Jobsite and his assistant were designated as issuing officers for this identification card. The authority granted with respect to the travel orders and the identification card eliminated the time-consuming process required in former operations and effected a considerable saving in travel between the Contractor and the Port Control Director offices.

PHYSICAL SECURITY - HOME OFFICE.

All physical security measures were implemented in accordance with directives received from the AEC. The responsibility for protecting classified material extended to every location in which H&N had a security interest. In Los Angeles, this included all office spaces, the records-storage warehouse, and subcontractor facilities. Access to restricted areas was controlled by armed "Q" cleared guards on a 24-hour basis and by an identification badge system.

In May 1955, a new type polaroid land camera was installed for use with identification cards. With this camera it was necessary to photograph only the personnel hired, whereas previously it was necessary to photograph all applicants. The use of this camera provided a considerable saving in time and cost.

PHYSICAL SECURITY - JOBSITE.

At the PPG, physical security was maintained by Security Officers and the Guard forces. Repositories containing classified information were checked regularly in accordance with established procedures.

On 12 March 1956, Military Police assumed the responsibility for guarding access to designated exclusion areas, and AEC and other Task Force offices at Elmer and Nan. Simila responsibilities were assumed at off-island site from the last week of March through the first week of April 1956. In the areas assigned to the Military Police, H&N guards were relieved (the responsibility for checking classified repos tories. On 1 July 1955, the Jobsite Security Office assumed the functional responsibility (under policy direction of the AEC Securi Offices), for the Pass and Badge Office. Th responsibility included the preparation of badges used at the PPG; accountability of identification media, film, and photographic equipment used in the office; maintenance of personnel clearance records of persons authorized access to AEC controlled areas; and the preparation of a monthly list of arrival and departure dates of personnel in travel status to and from the Proving Ground. It was originally estimated that 8,000 badges would be required for REDWING; however, since difficulty was encountered in obtaining information for badging other task group personnel, often necessitating that duplicate badges be prepared, a total of 12,783 was issued. The Pass and Badge Office was operated in accordance with procedures established by the AEC Security Office of ALOO.

INFORMATION SECURITY.

The scope of H&N activities during Operation REDWING, the number of personnel requiring access to classified information, and the necessity of transferring a voluminous amount of classified documents between the various departments within the Home Office and between the Home Office and the PPG called for controlled procedures and practices. In December 1954, the H&N Security Procedures Manual was published, which covered basic security matters relative to safeguarding classified information, instructions for classifying documents, changes of classification, preparation for transmission and the accountability production, storage, and distribution of classified documents.

Joint Task Force SEVEN Standard Operating Procedure 205-2, issued on 1 February 1956, pertained to security education and required that indoctrination letters be read and followed by an examination. One letter was prepared for key personnel in supervisory positions or above and one for lower echelon employees. The men who took security examinations during Operation CASTLE were exempt from the examination but required to sign a certificate of compliance; all others were given a written examination based on the test of the indoctrination letters. Notations were made in all H&N personnel records to reflect that an examination had been taken or a certificate of compliance signed.

A log of security activities was inaugurated on 18 October 1955, in accordance with a directive issued by CJTF-7. This log was maintained on a weekly basis and served as a chronological history of all security activities.

All employees terminating in the Home Office were given a lecture and required to execute a security termination statement, Form AEC-136, which included certain provisions of the Atomic Energy Act of 1954 and U. S. Code Title 18. Jobsite employees were given a termination security lecture prior to their departure from the Proving Ground and were also required to sign Form AEC-136. Upon arrival at their places of hire-whether it was Honolulu, San Francisco or Los Angeles-each terminating employee was again given a security lecture and required to sign Form AEC-136. He was reminded at this time of his responsibility to notify the Atomic Energy Commission of any anticipated foreign travel.

SECTION 8
COMMUNICATIONS

The tasks assigned to Holmes & Narver for Operation REDWING included the responsibility for all communications of TG 7.1 and TG 7.5 and the interatoll communications service for the Task Force. This was considerable expansion in functional responsibilities over that of previous Operations at the Proving Ground and led to the establishment of a Communications Department within the Contractor's Administration Division. During the peak of the Operation, 30 teletype operators were required to cover all channels. These men, with a relatively short period of on-the-job indoctrination, were readily able to adapt themselves to the procedures involved. In general, a high quality service was provided, with errors and security violations being very few.

Indoctrination of personnel was facilitated by the issuance of a Communication Operation and Instruction Plan. This plan covered the communication system capabilities and the standard procedures which outlined definite practices and methods for the in-station handling of messages. Particular emphasis was placed on security, accuracy and speed-of-message handling.

Practically all the overseas teletype traffic at Jobsite was routed through the Army Command and Administrative Net (ACAN), via the relay stations in Hawaii, San Francisco and Eniwetok. The ACAN net enabled traffic to be exchanged with all CONUS points, including service with commercial telegraph and cable companies. A supplementary "through circuit"-Los Alamos to PPG-equipped with Sampson devices permitted traffic to be handled with faster over-all service and more fully secured facilities. This circuit was used as an alternate for H&N when the normal ACAN channels were jammed with traffic. When such messages were received at Los Alamos, they were refiled into the ACAN net for all CONUS addresses. Teletype traffic at Jobsite reached peak activity during the months of April and May. Traffic for these two months is detailed below:

MESSAGES	APRIL	MAY
Sent	2,513	2,765
Received	3,097	3,238
Relayed	555	1,071
Services	160	148
Total	6,325	7,222
PRECEDENCE		
Operation Immediate	1.7 per cent	11.2 per cent
Priority	32.1 "	32.1 "
Routine	59.5 "	32.1 "
Deferred	6.7 "	5.3 "
CLASSIFICATION		
Secret	1.7 per cent	6.3 per cent
Confidential	9.7 "	14.2 "
Unclassified	88.6 "	79.5 "
HANDLING TIME		
Incoming	2.1 minutes	2.7 minutes
Outgoing	4.0 "	5.2 "
Relayed	2.2 "	1.1 "
Average	2.7 "	3.0 "
DAILY AVERAGE GROUP COUNT		
Outgoing	13,487	16,954
Incoming	16,837	14,028
Relayed	183	3,639
Telecons	596	503
Services	-	215

Communications from the Home Office to Jobsite were one of the functional responsibilities of the Office Services Section. During the early stages of the Operation, two operators sufficed for all communications traffic, but in July 1955, an additional operator was required. On 10 February 1956, unattended teletype service was provided for the receipt of messages transmitted via the ACAN network. Messages were thus received during non-working hours and available for delivery upon the return of operators to duty. The peak of Home Office traffic was i February 1956 when a total of 3,150 messages were handled for the month.

An overseas voice channel between th PPG, Hawaii, and the ZI was first activated December 1954 by the Armed Forces. To date, because of technical difficulties in this circuit, transmission between Jobsite and Honolulu h been only fair and between Jobsite and t ZI, unsatisfactory; the circuit was therefore seldom used.

Prior to the activation of the VHF interatoll system, the communication link between Eniwetok and Bikini Atolls consisted of a two-channel HF system with capabilities of one unsecured voice channel and one on-line crypto teletype channel. During the build-up phase, the telephone channel became overloaded and delays of three to four hours were experienced. However, with the activation of the VHF circuits, satisfactory service was provided. The HF circuit was kept activated as a back-up system in case of VHF system failure.

The VHF system (See Chapter II, Section 4,) consisting of 17 circuits for both classified and unclassified voice teletype communications, was first activated in April 1956. Terminals for this system were located at Elmer and Nan as well as on the USS Curtiss and USNS Ainsworth. An aircraft repeater provided: replacement of the Nan repeater in case of equipment failure; replacement of the Nan repeater during the times when the Curtiss was in transit between atolls and out of range of the Nan repeater but not yet in range of the Elmer facility; and for direct communications between the ships and Elmer. The aircraft repeater was also used to effect line-of-sight communications between the USS Curtiss at Bikini and site Elmer, if ionospheric disturbances disrupted the transmission path. The airborne repeater was tested at the time of the Cherokee and Zuni events, but as there were no interruptions because of ionospheric conditions, this facility was no longer required.

Traffic was generally heaviest just prior to the test events, falling off shortly after. No serious backlogs occurred - the system as installed was adequate in all respects; it was capable of carrying an additional 10 to 20 per cent more traffic on the Elmer-Nan circuit and even greater increases on the other circuits. No major variations from the original planning for message handling were necessary. The Contractor's personnel, because of Cryptographic Clearance requirements, were not involved with the operation of the AFSAY 806 cyphony equipment. However, it was determined that this equipment was not satisfactory for use by scientific personnel. Unscrambled voice signals were badly distorted and a considerable amount of repetition and rephrasing was necessary. Because of this condition, scientific personnel avoided the use of this equipment.

Teleconference service between Elmer and Nan was first established in late April. At Elmer this consisted of a special teleconference room; at Nan, conferees assembled outside of the Comcenter and messages were hand-passed. This service proved very satisfactory, and during the first weeks of operation, fourteen conferences were held with an average time of one and one-half hours each.

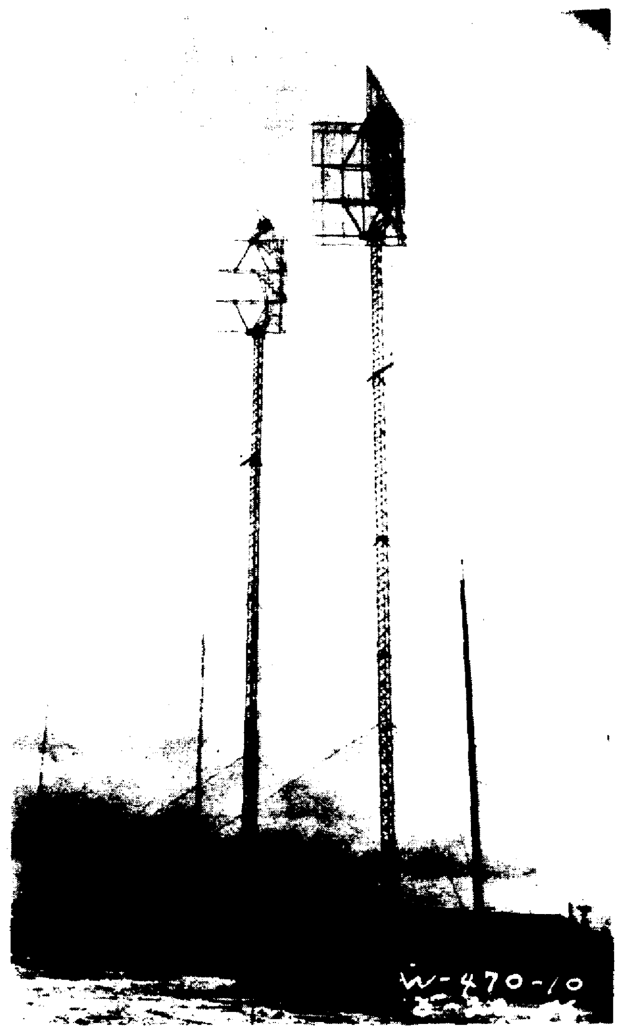


Figure 3-15. Antennas of VHF - Interatoll Communications

Eniwetok and Bikini Atolls were each provided with an integrated wire telephone system consisting of a 280-line manual board at Elmer with connecting service to Fred, Yvonne, Ursula and Gene and an 80-line manual board at Nan with connecting service to Fox and Tare. The Fred board was a 400-line dial exchange operated by TG 7.2. This exchange did not have information or assistance operators and all such calls were handled by the Elmer operators at the "Toll" operating position.

During the operational phase, the Elmer telephone switchboard was often heavily overtaxed with every available line in service. The telephone operating positions were insufficient to enable operators to keep ahead of incoming calls and completed (disconnect) calls had to be handled by support operators standing behind the regular operators.

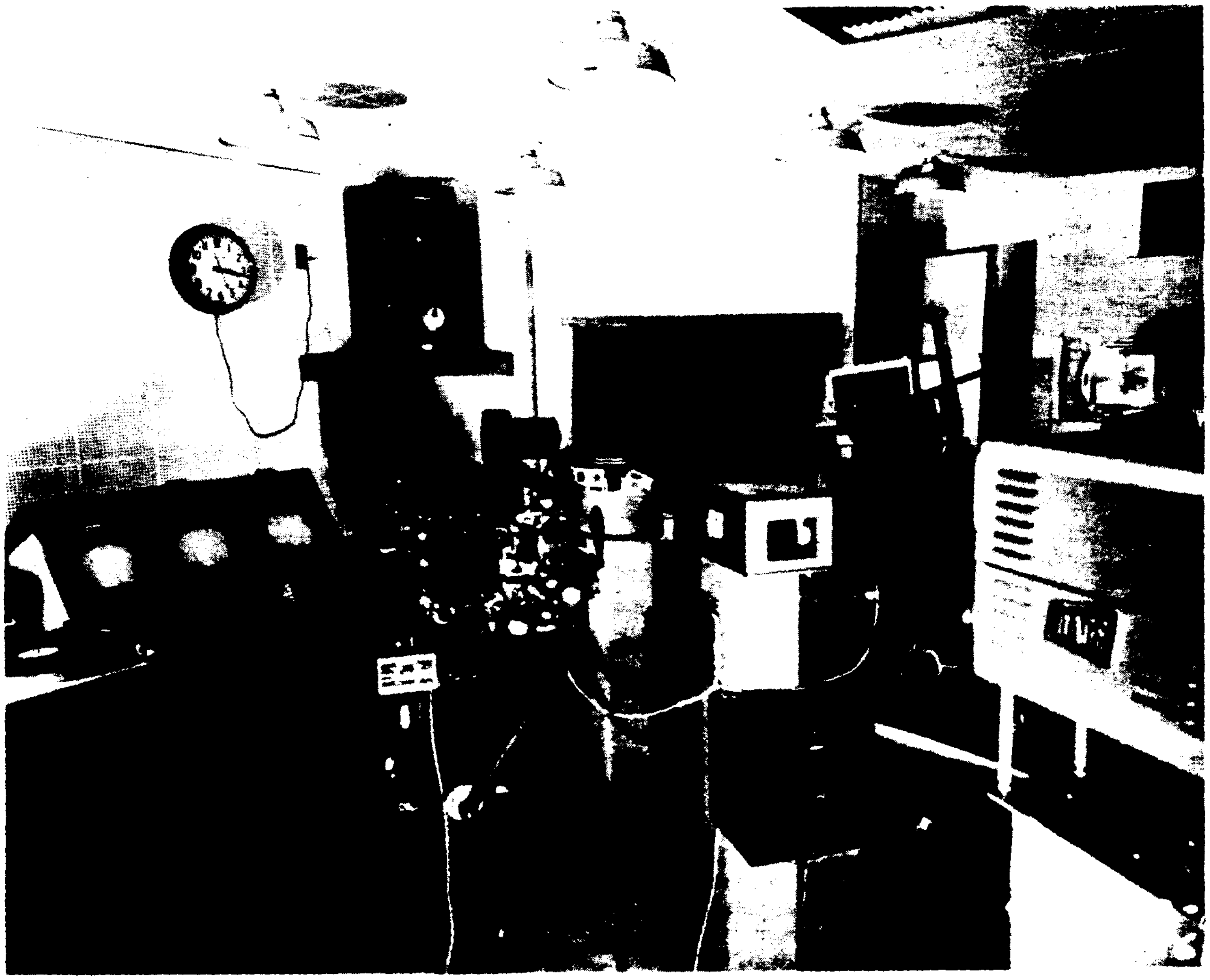


Figure 3-16. Interior of WXLE - TV

When outlying camps were rolled-up and switchboards removed, field telephones were installed in certain trunk lines, providing telephone service for last-minute preparations and re-entry teams.

Voice radio networks were operated within each atoll for transmission of unclassified traffic for marine and construction operations, and aircraft dispatcher passenger control. The marine network provided control of all H & N marine craft within each atoll, enabling dispatchers and craft operators to keep in touch with each other. The rapid exchange of information prevented unnecessary trips and permitted rerouting, readying stevedore parties, and disseminating urgent local weather conditions. The Construction operations network provided a means of contact between field personnel and offices. This provided the needed communications at construction sites where wire telephone service was unavailable. The air dispatcher network was a direct point-to-point radio contact between dispatchers for the exchange of information regarding passenger loading and flight schedules. No communication with airborne craft was possible on this network. Aircraft commanders kept radio contact with their own base station.

The H&N guards were assigned one base station and one mobile unit at Elmer on the frequency assigned to the Military Police. This provided military police radio benifits for H&N guards.

CHAPTER IV
SERVICE OPERATIONS

SECTION I
CAMP OPERATIONS

GENERAL.

All personnel of Joint Task Force SEVEN were housed, fed, and furnished with the usual camp services at the Contractor-operated facilities (except those men quartered in Naval vessels, at David and Fred, and on the weather station islands where the facilities were operated by the military services). The peak number of personnel supported by the Contractor was 4,643; this total was reached on 23 April 1956.

Life on the atolls was subject to many restrictions due to the geography and security regulations. Housing and messing facilities were crowded, and the men were under the tension of a tight construction schedule affording a minimum of opportunity for normal relaxation. In maintaining a high level of morale under such conditions, the quality of food and the comfort of housing facilities becomes especially important to the individual; consequently, every reasonable effort was made to provide the highest practicable camp standards. However, because of congestion at several of the camps during the period of peak activity, these standards could not always be maintained. This congestion engendered many operating problems, all of which, were eventually overcome without any threat to the health and safety of personnel.

After the completion of CASTLE, only the base camp at Elmer was operated. In December 1954, construction was started for the port-of-entry and base camp for Bikini Atoll (Nan). Operating from these two bases, shot-island camps were established at sites Ursula, Yvonne, and Gene in Eniwetok Atoll, and at Tare and Fox in Bikini Atoll; limited camp facilities were established at Wotho, Ujelang and Uterik. Charts 4-1, 4-2, 4-3, 4-4, 4-5, 4-6, and 4-7 show total H&N employees and personnel supported by H&N at each camp for the period of the REDWING Operation. The dates of activation and deactivation of each camp with their respective peak populations are tabulated below:

CAMP	DATE ACTIVATED	DATE OF PEAK POPULATION	PERSONNEL AT PEAK POPULATION	DESIGNED CAPACITY	DATE EVACUATED
Elmer	Base Camp	*5 May 1956	*2,751	**2,208	
Yvonne	17 May 1955	20 Mar. 1956	393	300	30 May 1956
Ursula	3 May 1955	24 April 1955	288	350	29 April 1956
Gene	23 Aug. 1955	6 April 1956	189	125	29 April 1956
Nan	11 Dec. 1954	24 May 1956	891	1,000	15 Aug. 1956
Fox	8 June 1955	20 April 1956	285	200	9 May 1956
Tare	19 July 1955	21 April 1956	277	200	26 May 1956
Wotho	15 Feb. 1956	May 1956	12		6 Aug. 1956
Ujelang	3 April 1956	May 1956	15		31 July 1956
Uterik	12 April 1956	May 1956	10		5 Aug. 1956

* During evacution of Ursula, Yvonne and Gene

** Without double bunks.

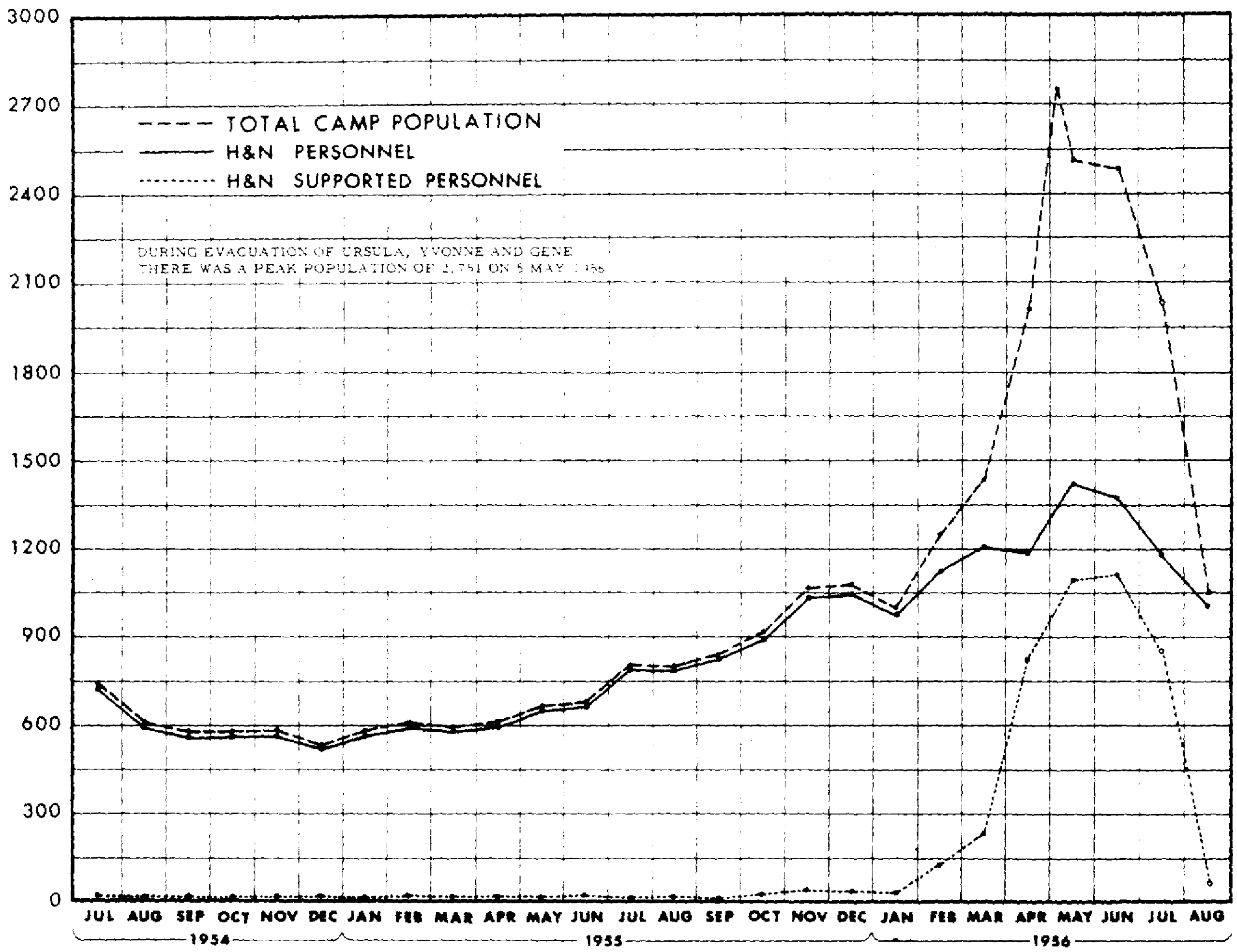


Chart 4-1. Camp Population - Elmer

Temporary camp facilities were also provided afloat by outfitting LCUs as houseboats. These vessels were used in the beachhead phase of the Nan camp, during the construction of off-atoll weather stations and scientific projects, and for supporting scientific project personnel at both Bikini and Eniwetok Atolls after the shot-island camps were deactivated. For a short period in the month of May 1956, limited camp facilities were also provided on a scientific station barge temporarily diverted to camp use off site Ursula.

A fundamental concept of the Operation was that shot-island camps would have to be considered expendable in the testing of nuclear devices. Therefore, these temporary camps were constructed as simply and inexpensively as possible. The possibility of damage by blast effects or inundation and the crash requirements of evacuation dictated the selection of equipment and utensils for these camps. Wherever practicable, the older and more obsolete camp equipment was used in the shot-island camps; the newer equipment was retained in the permanent base camps.

At each of the camps operated by the Contractor within the Proving Ground, all services such as messing, housing, PX store, barber shop, refreshment bar, post office, and laundry were provided. However, the only completely outfitted laundry was located on Elmer; the other camps being provided with laundromat-type washing machines for local spun-dry service. Personnel at temporary camps were afforded finished service on a weekly schedule through the Elmer laundry. A snack bar was provided at Elmer only; at all other camps a light serve-yourself supper was available after the movie.

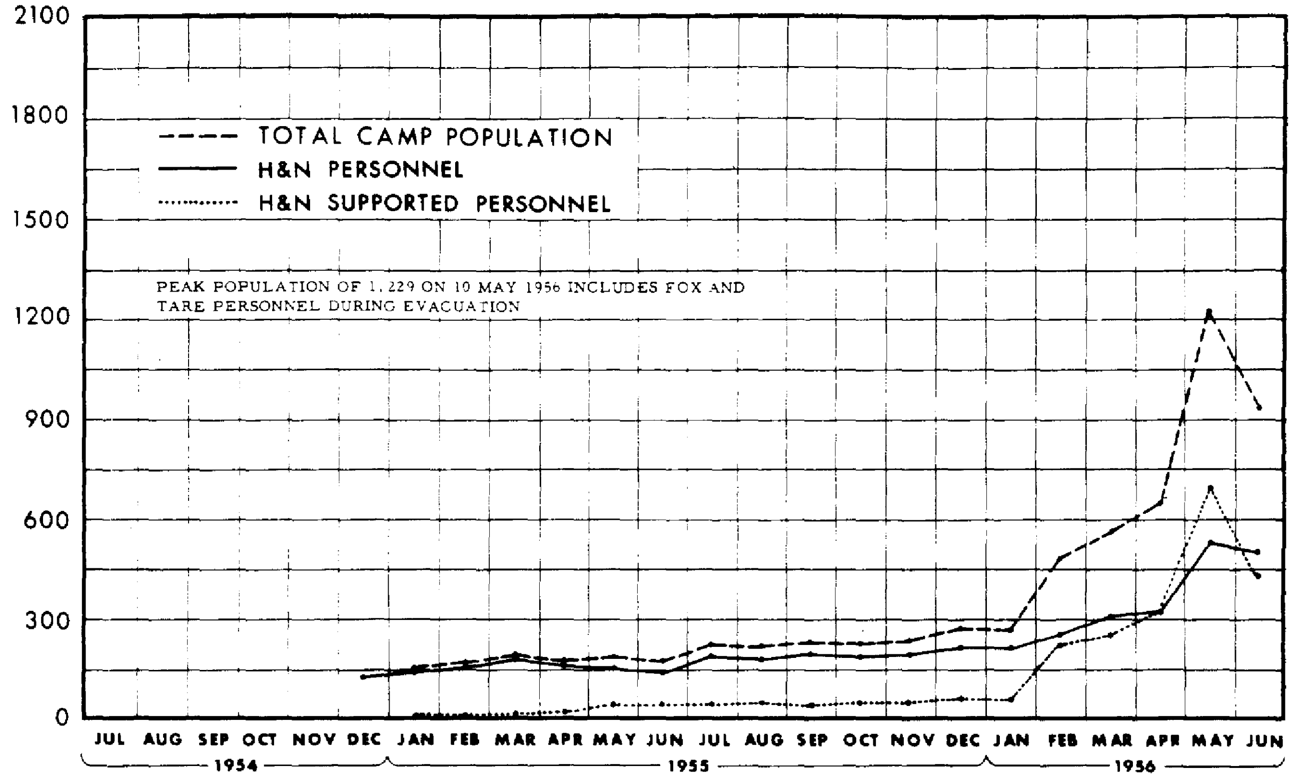


Chart 4-2. Camp Population - Nan

Three beach clubs and an officers' club were operated at Elmer.

For the test events at Bikini Atoll, operational procedure provided for evacuating all personnel to sea on board TG 7.3 ships. This involved berthing, messing, and other camp services for short periods, generally overnight. Contractor and TG 7.1 personnel were accommodated mostly on the MSTS Transport Fred C. Ainsworth. Holmes & Narver personnel augmented the ship's services by providing janitors for spaces occupied by TG 7.5 and TG 7.1 personnel, and by operating the troop galley and mess hall when the total number of passengers exceeded three hundred.

Orders for subsistence, PX, and beverage items were determined by usage factors and population estimates. The ordering procedure was reduced to a formula whereby each order could be, and was, readily checked by administrative personnel. This ordering procedure also resulted in an automatic review of stock on hand based on latest inventory and adjustment of stock levels to accomodate changes in population. Consumable supplies were ordered on the basis of maintaining a 45 to 60-day reserve during the build-up phase, a 30-day reserve for the operational phase, and a 30 to 45-day reserve during the phase of decreasing population. A reduction in reserve was necessary during the peak operating period because of (1) lack of adequate storage facilities for the great volume of supplies required, and (2) the possibility of radical reductions in population as a result of test operations. Operation REDWING, because of its magnitude, was a severe test of the ordering system. The effectiveness of the system was manifested by the fact that no serious shortages or overages occurred.

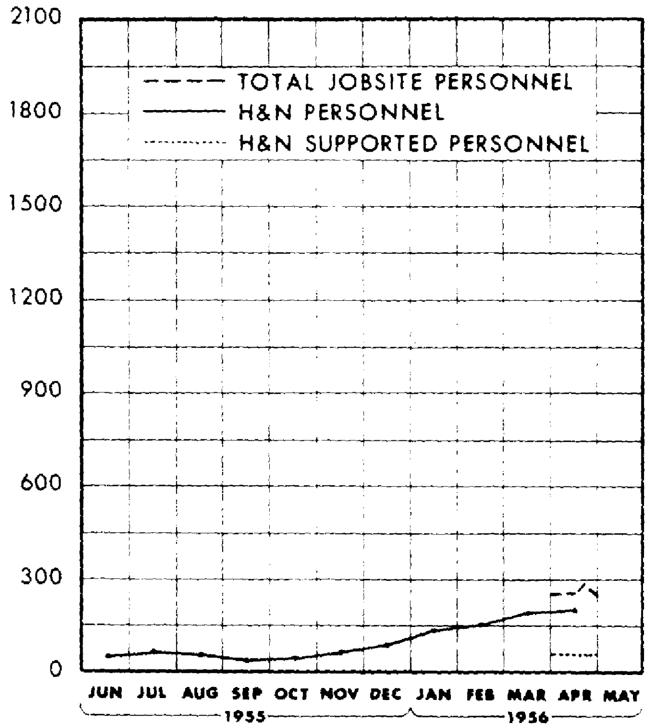


Chart 4-3. Camp Population - Fox

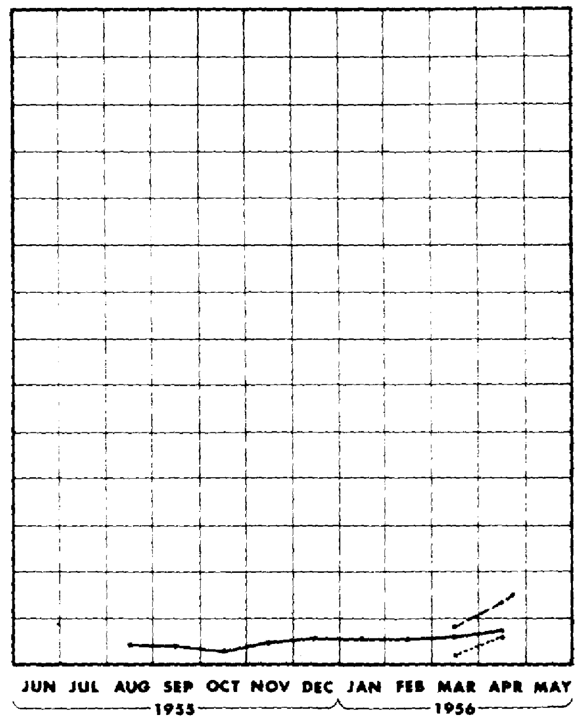


Chart 4-5. Camp Population - Tare

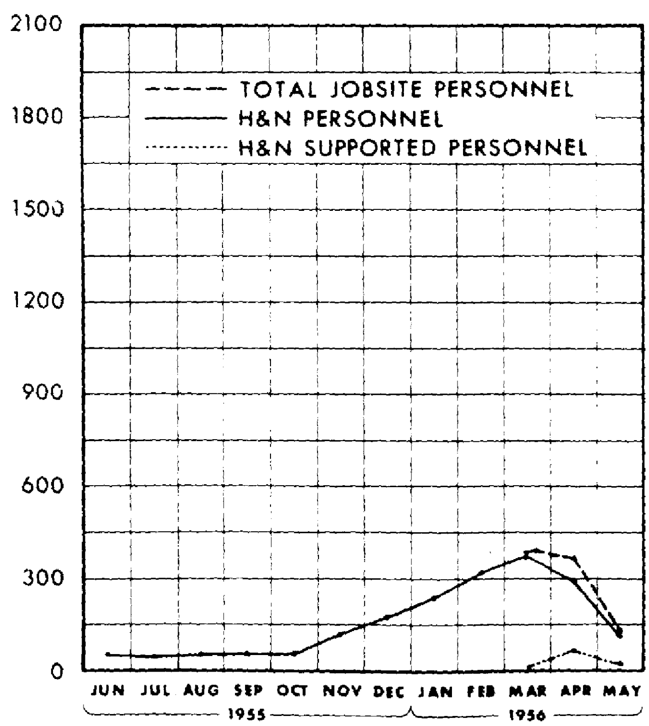


Chart 4-4. Camp Population - Yvonne

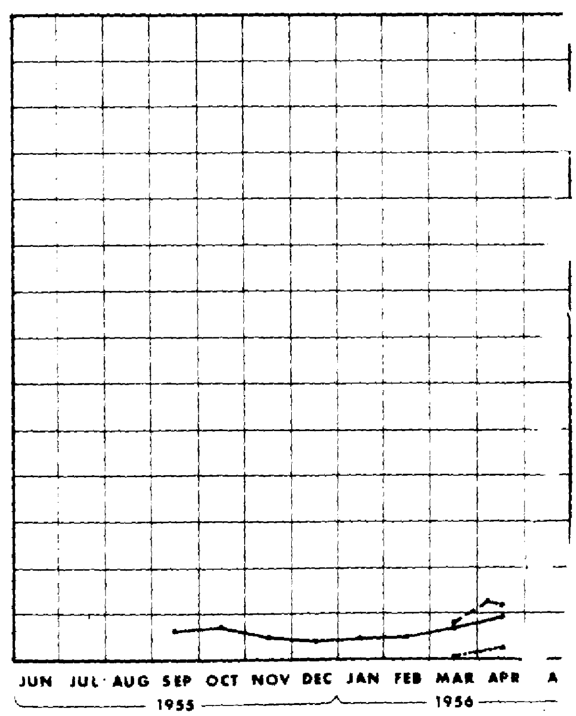


Chart 4-6. Camp Population - Gene

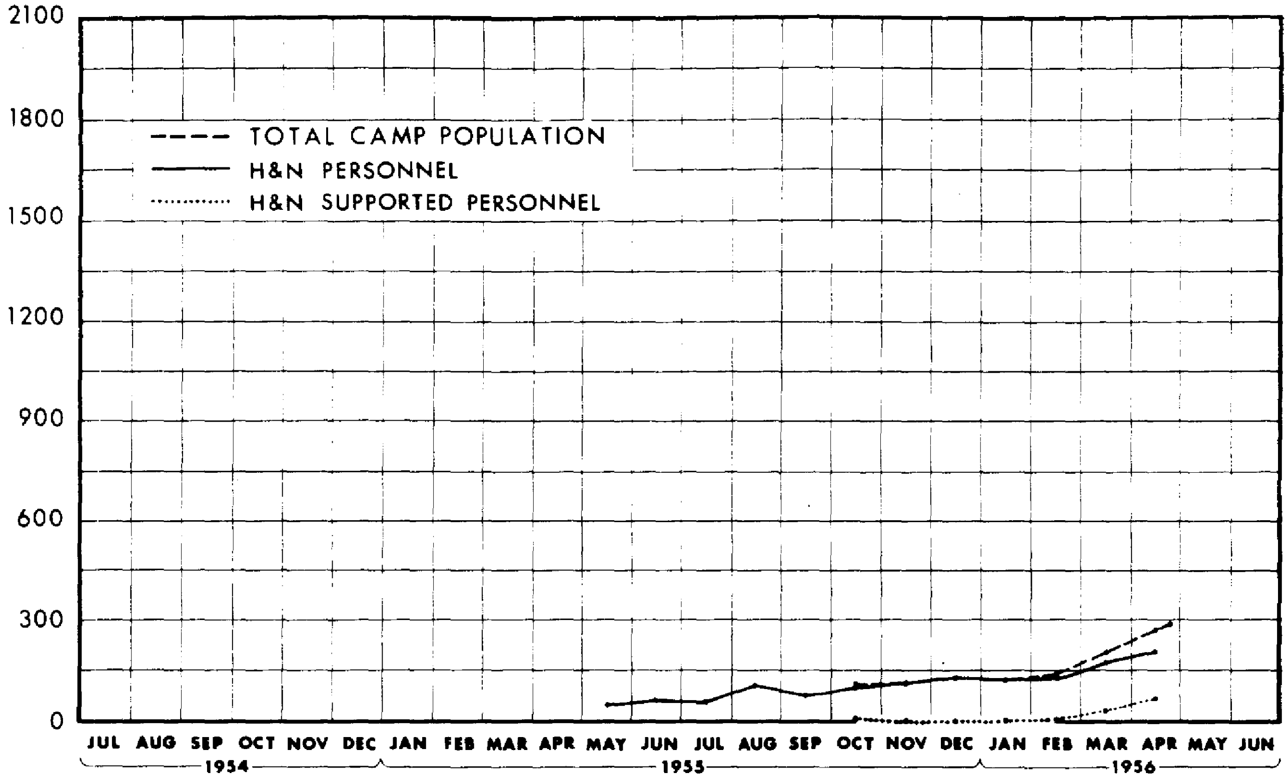


Chart 4-7. Camp Population - Ursula

MESSING.

Upon completion of Operation CASTLE, a study was made of mess operations at Jobsite with the result that refinements in food control were effected. This control was accomplished through the establishment of a Food Control Section within the Camp Department in August 1954 to provide for the following: (1) the establishment of quantity standards (the amount of each food item required per man per meal) for the preparation of basic menus; (2) periodic surveillance of requisitioning to ensure a close relationship between procurement and requirements based on the quantity standards; (3) menu control for all camps to ensure coordination of usage and procurement; (4) control to determine the amount and kind of kitchen and table waste in order to eliminate waste as far as practicable; (5) determination of individual meal cost standards using uniform menus, quantity standards, and average prices; (6) measuring of each camp mess operation against individual meal cost standards, using uniform menus insofar as possible; (7) and evaluation of any proposed or actual change in the method of feeding through the use of standard quantities, uniform menus, and average costs. The establishment of the food control system resulted not only in a cost savings but also in a much smoother mess operation than was hitherto possible.

Planning for mess operations contemplated the use of standard designs for galley and mess halls, the establishment of standard allowances for equipment and utensils (based on 200-man camp increments), and the staffing of all facilities so that the work could be accomplished with a minimum of overtime. The size, layout, and equipment installations at each temporary camp were satisfactory as designed in almost every detail. However, operating difficulties developed due to the overloading of mess facilities. The fluid operational schedules of scientific and other personnel also placed a burden on mess facilities not apparent from camp population figures. Quite frequently large numbers of men would have to be fed, particularly at lunch time, without any advance notice. When the mess personnel and physical facilities were taxed to maximum capacity, the quality of service and food could not always be maintained to meet normal standards.

Family-style service was provided in the mess hall at Elmer. Cafeteria style was used at

Figure 4-1. Mess Hall - Elmer

all other camps; however, at Nan, family style was initiated on 11 November. Until March 1956, only the metal - compartment - type trays were used, but with the arrival of User personnel at that time, diners were given their choice of metal trays or plastic trays with dishes. Bus service to pick up trays and dishes was inaugurated at the same time. Meal schedules were adjusted in accordance with population and work schedules. Because the dining room at Elmer could accomodate only 824 individuals in one seating, it was necessary to arrange for two seatings commencing 13 February 1956 and for three seatings starting 11 April 1956. Two seatings were required at Nan in April 1956, while at shot-island camps schedules were adjusted to meet varying demands.

Field forces working away from established mess halls were generally so widely scattered on the various islands that it was not always practicable to furnish regular luncheons. Small parties were usually provided with box lunches consisting of sandwiches, fruit, cake, and cold drinks. Work parties of 15 to 25 men were given prepared foods in thermos containers with hot and cold drinks; these lunches were picked up by the work party before departing from the camp site. Parties of 25 men or more were usually sent the regular luncheon via truck and boat. In these cases the luncheon was served by a mess helper.

Storage space for dry stores at shot-island camps could accommodate about a month's supply for 300 men. Therefore, the resupply of the stores at these camps was on a monthly basis, except at site Yvonne where it became necessary to obtain supplies semi-monthly. The resupply of cold-storage supplies was made monthly for camp populations up to 200, twice-monthly for populations between 200 and 300, and weekly for camps with populations exceeding 300. Eight mobile reefers were available on a loan basis from the U. S. Army at Fred foı use in interisland shipment of refrigerated cargo. Just prior to the arrival of reefer vessels, shot-island camps were supplied with frozen products in order to provide space at the bas camps for incoming cargo. It was necessary a times, however, to use from four to six of the mobile reefers for temporary storage of arrivin cargo. Also, covered facilities for dry stores a Elmer were inadequate to warehouse the larg quantities required, and a considerable quantity had to be placed in open storage. There we times, due to water transportation schedule when dry stores arrived from 15 to 45 days before the date for which they were ordered; this aggravated the existing shortage of covered st age space. Through the use of tarpaulins a l close surveillance of subsistence items stored in the open, losses were kept at a minimum.

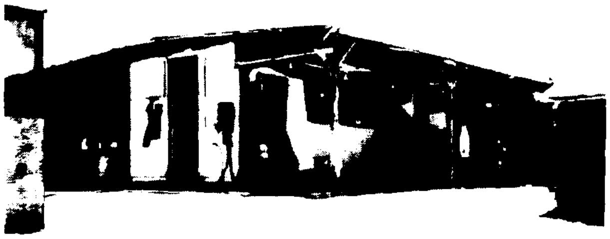


Figure 4-2. Beachhead Galley

Pertinent statistics of mess operations are tabulated at end of this SECTION.

TABLE 4-1.

Provides a ratio of mess personnel used to the number of men served. This ratio was maintained fairly constant for base camps, but it varied considerably at shot-island camps due to the difficulty of phasing mess personnel changes with population fluctuations.

TABLE 4-2.

Provides the total values of the food inventory and the food per man for each month of the operation. It is of interest to note that during the operational phase, when a shortage of storage facilities existed, the food value per man was at a minimum.

TABLE 4-3.

Provides the direct costs of food and labor for each month of the operation.

TABLE 4-4.

Shows allocation of the reefers available at Jobsite.

HOUSING.

At Elmer, men were housed in aluminum barracks and tents, while at all other camps standard Army tents with outer flies were used. Quarters were provided with aluminum or wooden hot lockers, beds, tables, and chairs. Janitorial services were provided daily in all barracks and latrines; linen was changed weekly. Whenever possible, individuals were given a choice of roommates and every effort was made to provide pleasant living conditions.

Prior to the start of the build-up for Operation REDWING, all personnel at Elmer were housed in barracks and in the 4-man tent area (#1-50), which had been activated for the convenience of personnel who preferred tents to barracks. As the population increased, empty barracks were activated on an as-needed basis. By 16 July 1955, all barrack-buildings (except for #120) were being used. The first group of the old style 8-man tents (#51 to 75) was activated in September 1955, and by 15 October 1955 the remaining tents (#76-99-H inclusive) were utilized.

In October 1955, a study of billet requirements for all Task Groups indicated that additional housing facilities would be required at Elmer. Therefore, the Deputy Director, Test Division, authorized the construction of two 48-man barracks and seventy-two 8-man tents plus five latrines with necessary utility extensions.

On 30 November 1955, available billets at Elmer were allocated to the various Task Groups by the Deputy Director, Test Division, in accordance with their anticipated requirements. In January 1956, the Contractor began using double bunks in the barracks allocated to H&N in order to make billet spaces allocated to other Task Force personnel available. By 13 February 1956, this program was completed with the exception of six barracks. Planning contemplated that all space allocated to the various Task Groups would be available by 1 March 1956. This planning was not practicable due to unavoidable delays in the construction of the two 48-man barracks and the seventy-two 8-man tents. However, by 20 March 1956, all spaces were turned over to the respective Task Groups. The table below shows the allocation of berths (as approved by the Deputy Director, Test Division, on 30 November 1955), the normal capacity of housing units available, and the number of berths that eventually had to be provided.

Figure 4-3. Typical Room in Barrack

	ALLOCATED	NORMAL CAPACITY	BILLETS PROVIDED
JTF-7 Headquarters	199	185	199
TG 7.1	919	706	985
TG 7.2	79	132	151
TG 7.3	212	208	212
TG 7.4	46	44	46
TG 7.5	1,267	925	1,656

Normal capacities were based on housing 18, 36, or 48 men in each of the various sizes of barracks, eight men to an 8-man tent, and four men to a 4-man tent. The number of billets required above normal capacity were provided by installing double bunks in the various barracks and by putting ten or more bunks in the 8-man tents. Four barracks assigned to TG 7.1 and eight barracks to H&N were fully double-bunked to provide twice the normal occupancy; the remaining barracks were, in general, double-bunked to provide one and one-half times normal occupancy. Sixty of the seventy-one 8-man tents assigned to H&N were provided with 10 bunks each. To accomodate all H&N personnel at Elmer, it was also necessary to install 186 bunks in the new Machine Shop as an emergency measure, and for one night during the evacuation of the northern islands, 82 bunks were erected in the Day Room. Through May and June 1956, H&N population varied from 1,300 to 1,436 men, except for the first week in May when the northern islands were evacuated and the total reached 1,610 at this site.

These population figures do not reflect truly the number of billets actually required. There was usually a number of transients moving in and out of camp who had to be temporarily accommodated. Requirements for temporary accommodations were particularly heavy at the base camp during the peak period of activity. There was also a number of men whose duties entailed frequent movement between islands, and as a result they required accommodations at more than one camp. Experience indicates that at the base camps, housing should be provided in excess of anticipated population by at least ten per cent.

The camps at Yvonne and Fox were also required to house more men than had been originally contemplated. Billets were made available by placing bunks in the Recreation and Office tents and by setting up 10 or more bunks in each 8-man tent. Additional tents for these camps were authorized and erected on an as-needed basis.

Various factors contributed to the overloading of housing facilities. Under normal operating conditions, reductions in the construction force should start about the time instrumentation personnel start arriving at Jobsite. However, during this Operation, peak construction activity had to be continued to the first detonation, and reduction of construction personnel could not be effected as early as had been anticipated. It had also been contemplated that the camps on Gene and Ursula would be reoccupied after the first test. This reoccupation was not possible because of radioactive contamination, thereby placing an additional load on the housing facilities at Elmer.

The congestion in housing facilities presented many operating problems; some H&N personnel were required to move as many as three times within a short period. Overloading of housing facilities for relatively long periods was the cause of many complaints not hitherto experienced. For a good workable standard of living during the fairly short period of peak population, barrack occupancy should be limited to one and one-half the normal capacity, and tent occupancy should be limited to designed capacities. In order to provide for a workable standand in future Operations with magnitudes comparable to REDWING, recommendations for additional housing facilities were submitted to the Atomic Energy Commission in the Long Range Improvement Report for 1956.

POST OFFICE.

Postal facilities were initially operated as branches of APO 187 on Fred; the central H&N facility located on Elmer served postal facilitie located at other camps. All incoming and outgoing mail was processed through both the Elmer and Fred facilities.

In January 1956, the address for all incoming mail of H&N personnel was changed from APO 187 (HOW) to APO 435. The use of this address permitted segregation of t mail forwarded for the H&N facility from th destined to the Army and also facilitated processing and distribution. On 10 April 1956, an

Figure 4-4. Interior 8-Man Tent

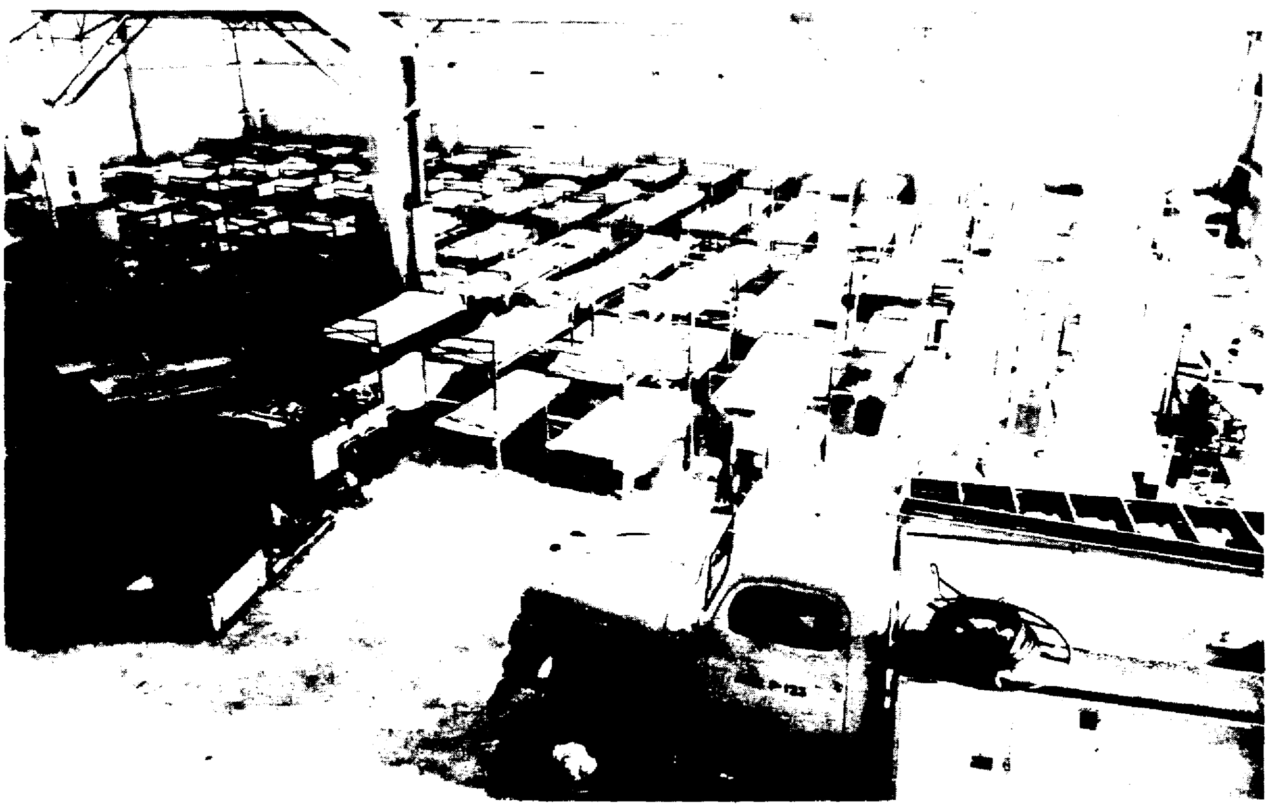


Figure 4-5. Temporary Billet Facilities-Machine Shop

Army facility, APO 437, was activated on Elmer, and on 26 April 1956, another unit, APO 436, was activated on Nan. The establishment of these two facilities eliminated the need for processing through the Post Office on Fred. All incoming mail addressed to APO 435 was picked up by personnel of APO 437 at the MATS terminal. All incoming mail for Bikini Atoll was flown direct from the MATS terminal on Fred to Nan where it was processed through APO 436. The establishment of APOs 436 and 437 provided complete postal facilities at both H&N base camps. The H&N postal facilities functioned primarily as mail distribution centers.

Prior to the activation of APOs 436 and 437, the only available facility for the sale of money orders was the Army Post Office (APO 187) located on Fred. All papers and money necessary for the execution of a money order from an off-island camp had to be processed at the camp post office, then through the H&N central post office on Elmer, and finally through APO 187, with receipts and change money traveling the reverse route. This procedure was cumbersome and required a great deal of record keeping. To provide a more workable system, negotiations were completed enabling Holmes & Narver to act as a subagent for the American Express Company. This permitted the establishment of a sales facility at each camp site within H&N accounting facilities. Remittance of the sales plus a portion of the sales commission were made weekly to the American Express Company by means of a check drawn on the Revolving Fund Bank Account. The sale of American Express Company money orders was first initiated on 16 January 1956 and served the need for a good workable system until the activation of the Army Post Offices on Elmer and Nan. Because the sale of postal money orders was facilitated through these Army Post Offices, the use of American Express money orders was temporarily discontinued.

Figure 4-6. Monte Carlo Room-Refreshment Bar - Elmer

BAR AND CLUBS.

A refreshment bar, an officers' club, and three beach clubs were operated at Elmer, and a refreshment bar functioned at all other established camps. In order that the use of beer and liquor would not be abused, stringent controls were established governing the handling and sales of these beverages. Liquor and beer were sold retail across the bars only at scheduled hours. A chit system with denominations varying from five cents to thirty cents in books of two and five-dollar value were used for such sales. A ration card system was used in supplying one bottle of liquor per week to personnel authorized to make such purchases by their Task Group Commander. One ration card also authorized the purchase of five bottles of liquor for a "take-home" supply; when the "take-home" card was used, all other unused ration cards were voided. In general, bar operations funtioned smoothly. All money from such facilities was deposited in the Contract Advance Fund. Pertinent statistics are provided in Table 4-5.

SNACK BAR.

A snack bar was operated at Elmer for the morale and convenience of personnel. This bar was operated for the sale of sandwiches, light refreshments, coffee, and fountain drinks. On Sunday mornings, from 0900 to 1100 hours, a late breakfast was available at reasonable prices. The "chits" used in the bars and clubs were also acceptable in the snack bar. Cash could be used only to purchase "chit" books which, since the books were serially numbered, provided for a tight control of cash receipts. The snack bar monthly operating statement is shown in Table 4-6.

POST EXCHANGE.

Post Exchange stores were operated at each camp for the convenience of Contractor and Task Force personnel which provided articles for ordinary use and recreational purposes at reasonable prices. The prices established by the Resident Controller covered cost of the merchandise, salaries of employees, and esti-

Figure 4-7. Post Exchange - Elmer

Figure 4-8. Typical Off-Island Post Exchange

mated overhead. A cashier was accountable for all monies received from sales of merchandise, and all accounting and cost records were maintained by the Accounting Division. All other PX functions were the responsibility of the Camp Department in the Service Operations Division.

Store hours were scheduled to meet the requirements of each camp. Normal hours of business were during the luncheon periods and from 1715 to 1930. During the period of peak activity, the store on Elmer was generally crowded, and it was necessary to prolong business hours in order to serve all personnel adequately. Some difficulty was also experienced due to the lack of covered storage needed for the large quantity of merchandise carried in this Operation.

All PX supplies were first received at Elmer and then equitably distributed to the other stores. Heavily-locked, metal and waterproof transportainers were utilized for this distribution.

Statistics covering Post Exchange Operations are shown in Table 4-7.

LAUNDRY.

A completely outfitted laundry was operated only at Elmer, but the service of this laundry was made available to personnel at all other sites. Regular days for pick up and delivery were established and the entire operation was placed on a scheduled basis. During the peak operational period, three shifts were required to meet the demands. The day shift consisted of a capacity crew of 30 men, and the swing shift had a half-crew of 15 men; a graveyard shift of two men was also required in order to operate the flatwork ironer on a 24-hour per day basis to meet the demands for clean bed linens. Throughout the Operation, no limitations were placed on the quantity of finished laundry serviced for each individual. Overtime was kept at a minimum but was sometimes required because of temporary shortages of qualified personnel for special work or to make up for lost time due to equipment failures.

In the initial planning for the laundry operation it was deemed advisable to acquire an additional flatwork ironer. However, by modifying the existing flatwork ironer to operate at increased speed, its production was increased twenty-five per cent. This modification eliminated the need for the additional ironer and thereby effected a savings of approximately $35,000.00 in plant equipment.

Mechanical breakdown of the existing boiler was frequently experienced because it had to be forced to meet all steam demands. However, with the installation of a second boiler, breakdowns were practically eliminated.

Automatic-type washing machines were installed at all the temporary camps. Personnel desiring the service of these machines were required to bring their laundry to an employee in charge of each installation. The laundry was spun dry and ready for pick-up within 24 hours; clotheslines were conveniently located in camp areas. This service met with such favor that the Elmer facility was rarely used by employees based at temporary camps, particularly by personnel assigned to camps in Bikini Atoll where delays in transportation could occur.

All bed linens were laundered at Elmer, and to meet all demands it was necessary to have five changes for the camps in Bikini Atoll and three for those in Eniwetok Atoll. These extra linens were necessary because laundry requirements could not always be phased with transportation schedules. The supply of sheets was adequate but shortages of pillow slips existed for short periods.

Laundry service for decontaminating radioactive clothing was furnished from Elmer on a daily basis; one machine was utilized solely for this purpose. Laundry personnel were given special training in the handling of contaminated clothing. A beta gamma survey meter was used to check each article before and after washing and this work was accomplished without incident.

TABLE 1. MESS PERSONNEL VS. POPULATION

ENIWETOK ATOLL

MONTH	ELMER AV. POP.	ELMER AV. MESS PERS.	ELMER % MESS PERS.	GENE AV. POP.	GENE AV. MESS PERS.	GENE % MESS PERS.	URSULA AV. POP.	URSULA AV. MESS PERS.	URSULA % MESS PERS.	YVONNE AV. POP.	YVONNE AV. MESS PERS.	YVONNE % MESS PERS.
July 1954 thru July 1955	613	59.7	9.7									
August	803	83	10.3	91	12	13.2	113	12	10.6	47	8	17.0
September	828	80	9.7	103	12	11.7	89	11	12.4	58	8	13.8
October	952	92	9.7	104	13	12.5	101	12	11.8	74	9	12.1
November	1,028	97	9.4	77	12	15.6	126	12	9.5	141	12	8.5
December	1,024	110	10.7	61	10	16.4	126	12	9.5	185	16	8.6
1956												
January	1,093	112	10.2	71	10	14.1	124	13	10.4	255	21	8.2
February	1,264	129	9.5	80	10	12.5	145	13	8.9	326	28	8.6
March	1,533	138	9.0	117	15	12.8	190	18	9.5	378	34	8.9
April	2,033	132	6.5	173	17	9.8	251	22	8.8	315	33	10.5

BIKINI ATOLL

MONTH	NAN AV. POP.	NAN AV. MESS PERS.	NAN % MESS PERS.	FOX AV. POP.	FOX AV. MESS PERS.	FOX % MESS PERS.	TARE AV. POP.	TARE AV. MESS PERS.	TARE % MESS PERS.
Dec. 1954 thru June 1955	172	15	9.0						
July	220	23	10.5	63	7	11.1	60	7	11.7
August	215	23	10.7	49	9	18.4	66	7	10.6
September	235	23	9.8	35	8	22.9	57	7	12.3
October	234	25	10.7	48	7	14.6	52	7	13.5
November	246	26	10.6	69	8	11.6	79	9	11.4
December	261	28	10.7	104	10	9.6	79	10	12.7
1956									
January	275	30	10.9	148	13	8.8	81	10	12.3
February	472	37	7.8	167	16	9.6	86	10	11.6
March	563	56	9.9	196	17	8.7	134	12	9.0
April	741	60	8.1	249	16	6.4	195	16	8.2

Table 4-1. Mess Personnel vs Population

FOOD INVENTORIES VS POPULATION

MONTH	*TOTAL JOBSITE PERSONNEL	TOTAL VALUE OF FOOD INVENTORY	VALUE OF FOOD INV. PER MAN
1954			
June	827	$222,531.05	$269.08
July	753	235,707.08	313.02
August	681	211,804.73	311.02
September	653	232,822.48	356.54
October	676	212,823.43	314.84
November	671	186,313.82	277.67
December	752	176,919.23	235.26
1955			
January	837	147,396.56	176.10
February	855	134,313.80	157.09
March	837	114,098.33	136.32
April	848	137,323.31	161.94
May	935	92,629.74	99.07
June	1125	250,512.20	222.68
July	1214	311,233.79	256.47
August	1328	307,873.96	231.83
September	1475	274,958.69	186.47
October	1638	260,504.96	159.04
November	1866	292,266.01	157.63
December	1966	288,486.20	146.74
1956			
January	2175	225,918.73	103.87
February	2596	253,835.09	97.78
March	3384	341,850.45	101.02
April	4312	352,931.00	81.85

* H&N Supported

Table 4-2. Food Inventories vs Population

DIRECT FOOD and LABOR COSTS

MONTH	BIKINI ATOLL DIRECT FOOD COST	BIKINI ATOLL DIRECT LABOR COST	ENIWETOK ATOLL DIRECT FOOD COST	ENIWETOK ATOLL DIRECT LABOR COST
1954				
June			.6475	.5633
July			.6470	.5544
August			.6332	.6240
September			.5888	.5775
October			.6440	.6120
November			.5751	.5779
December			.6190	.6170
1955				
January	.543	.5558	.6175	.6285
February	.597	.515	.592	.557
March	.541	.498	.530	.555
April	.5095	.5154	.5854	.5858
May	.5663	.4931	.6358	.6943
June	.7689	.6565	.5337	.7890
July	.5204	.4410	.6276	.5466
August	.4268	.6753	.6039	.6330
September	.6272	.7235	.6139	.5781
October	.5863	.7538	.5908	.6010
November	.5608	.6838	.5833	.5716
December	.5969	.6470	.5346	.6160
1956				
January	.5137	.6671	.5811	.6277
February	.5886	.5893	.5934	.6154
March	.5285	.5720	.5632	.5919
April	.5720	.5583	.5330	.5120

Table 4-3. Direct Food and Labor Cost

REEFER FACILITIES

ELMER

NO. OF REEFERS	SIZE OF REEFERS	USABLE SPACE PER REEFER	TOTAL USABLE SPACE	USE
23	675 cu. ft.	400 cu. ft.	9200 cu. ft.	Sub. Whse. (Freeze)
3	675	400	1200	Sub. Whse. (Chill)
1	675	400	400	Butcher
1	1000	600	600	Sub. Whse.
1	1000	600	600	Butcher
1	150	125	125	Post Exchange
3	450	270	810	M.H. Veg.
2	150	125	250	M.H. Baker
1	150	125	125	M.H. Fruit
6	650 (Mobile)	390	2340	Transport
42			15,650 cu. ft.	

NAN

NO. OF REEFERS	SIZE OF REEFERS	USABLE SPACE PER REEFER	TOTAL USABLE SPACE	USE
10	675 cu. ft.	400 cu. ft.	4000 cu. ft.	Freeze
6	675	400	2400	Chill
2	150 (Mobile)	125	250	Transport
18			6,650 cu. ft.	

TYPICAL OFF-ISLAND CAMP

NO. OF REEFERS	SIZE OF REEFERS	USABLE SPACE PER REEFER	TOTAL USABLE SPACE	USE
2	675 cu. ft.	400 cu. ft.	800 cu. ft.	Freeze
1	675	400	400	Chill
1	150	125	125	Bar
4			1,325 cu. ft.	

Table 4-4. Reefer Facilities

REFRESHMENT BARS
Monthly Profit Statement

MONTH	GROSS - PROFIT	LABOR	NET - PROFIT
July 1954	$ 4,913.40	$ 2,345.67	$ 2,567.73
August	4,058.13	1,942.78	2,115.35
September	3,596.35	1,898.99	1,697.36
October	3,931.41	1,952.70	1,978.71
November	5,765.27	2,629.47	3,135.80
December	6,219.20	3,262.41	2,956.79
January 1955	7,477.53	3,609.59	3,867.94
February	6,169.76	2,817.67	3,352.09
March	6,411.80	2,806.43	3,605.37
April	7,075.17	2,814.34	4,260.83
May	9,870.12	5,314.73	4,555.39
June	9,280.17	3,431.83	5,848.34
July	9,557.10	5,556.55	4,000.55
August	9,303.64	5,556.55	3,747.09
September	14,204.03	7,827.15	6,376.88
October	10,752.86	6,545.11	4,207.75
November	16,789.93	8,729.44	8,060.49
December	14,187.02	6,590.96	7,596.06
January 1956	18,676.70	6,542.95	12,133.75
February	29,695.75	9,036.56	20,659.19
March	27,346.59	9,022.76	18,323.83
April	32,141.60	10,795.53	21,346.07
May	42,721.27	14,706.23	28,015.04
June	46,842.19	13,993.20	32,848.99

Table 4-5. Refreshment Bars-Monthly Profit Statement

SNACK BAR OPERATING STATEMENT

MONTH	GROSS PROFIT	LABOR COST	CREDIT FOR SUNDAY BREAKFAST	CORRECTED PROFIT
June 1954	$1,462.85	$2,452.00	$ 452.00	$ 537.15 *
July	987.85	1,666.95	342.00	337.10 *
August	732.46	1,355.80	365.00	258.34 *
September	775.12	1,599.52	562.00	262.40 *
October	606.34	1,241.64	422.00	213.30 *
November	700.73	1,260.80	402.00	158.07 *
December	1,002.39	1,637.78	567.00	68.39 *
January 1955	900.34	1,372.50	483.00	10.84
February	1,094.27	1,574.52	629.00	148.75
March	795.49	1,296.47	349.00	151.98 *
April	728.81	1,319.47	320.00	270.66 *
May	750.06	1,331.09	406.00	175.03 *
June	1,276.53	1,972.18	427.00	268.65 *
July	1,099.06	958.20	891.00	1,031.86
August	1,102.11	1,352.40	623.00	372.71
September	1,554.72	1,969.20	526.00	111.52
October	1,294.04	1,190.40	757.00	860.64
November	1,673.21	1,290.70	875.00	1,257.51
December	1,206.18	1,036.80	763.00	932.38
January 1956	1,382.65	1,016.40	338.00	704.25
February	1,948.71	1,296.00	1,044.00	1,696.71
March	1,843.55	1,036.80	1,065.00	1,871.75
April	1,897.66	1,036.80	NONE	860.86

* Denotes Loss.

Table 4-6. Snack Bar Operating Statement

POST EXCHANGE
MONTHLY OPERATING STATEMENT

MONTH	GROSS PROFIT	LABOR	NET PROFIT
July 1954	$ 2,405.59	$ 1,566.11	$ 839.48
August	1,619.67	1,358.56	261.11
September	1,432.54	1,382.42	50.12
October	1,732.01	1,398.87	333.14
November	2,049.67	1,800.26	249.41
December	2,043.74	1,561.09	482.65
January 1955	3,068.19	2,065.12	1,003.07
February	2,079.97	1,575.85	504.12
March	2,248.32	1,700.06	548.26
April	2,570.84	1,724.18	846.66
May	4,000.44	2,903.10	1,097.34
June	2,770.62	2,094.37	676.25
July	4,327.53	3,601.00	726.53
August	5,443.76	5,074.87	368.89
September	5,543.51	4,795.63	747.88
October	9,785.64	5,669.95	4,115.69
November	6,168.75	4,600.62	1,568.13
December	5,204.39	5,095.88	108.51
January 1956	9,907.59	6,465.80	3,441.79
February	8,640.32	5,501.78	3,138.54
March	12,887.90	5,871.73	7,016.17
April	11,962.27	7,274.56	4,687.71
May - June	19,370.90	7,916.40	11,454.50

Table 4-7. Post Exchange Monthly Operating Statement

Figure 4-9. Laundry - Nan

Figure 4-10. Pressing Operations-Laundry - Elmer

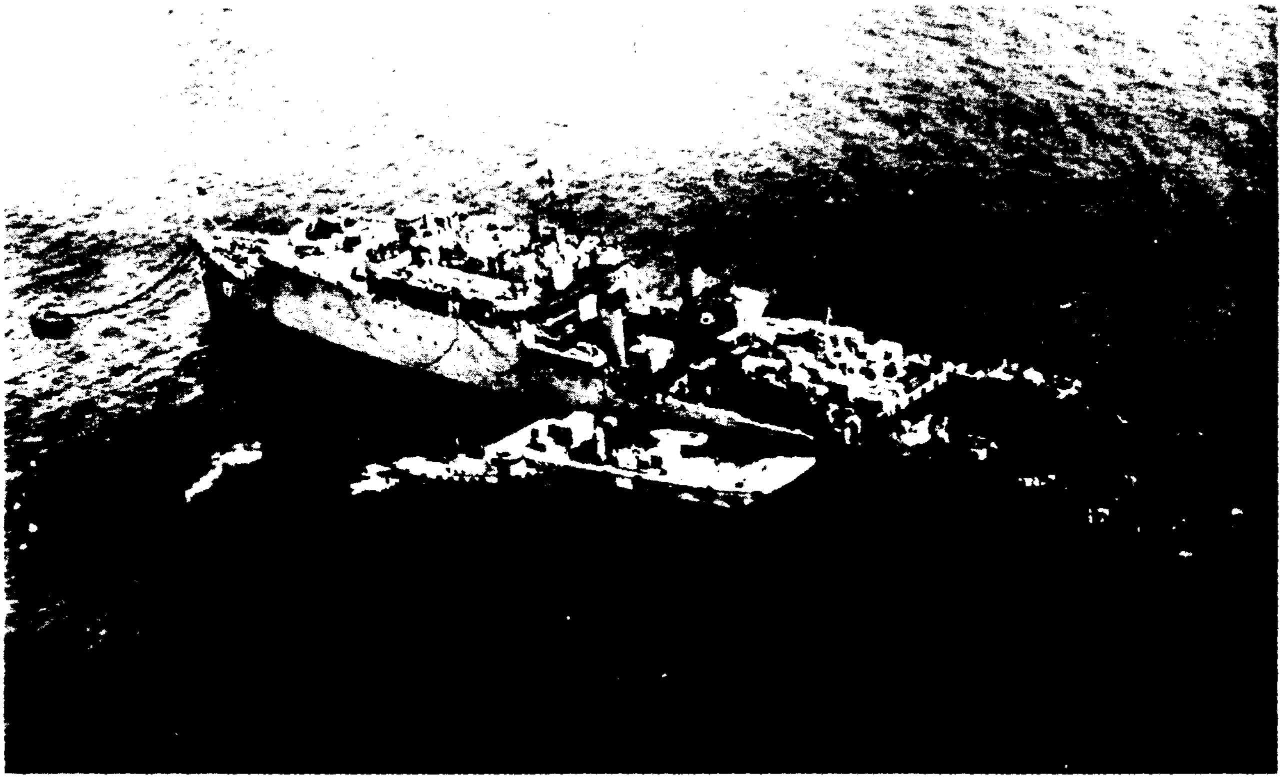


Figure 4-11. Loading LSD For Off-Atoll Mission

Figure 4-12. LCU Used for Aggregate Haul - Elmer to Fred

SECTION 2
MARINE OPERATIONS

MARINE OPERATIONS

A large marine facility was operated and maintained to provide intra-atoll water transportation and for other marine services such as locating, improving, and marking boat channels; installing and maintaining small craft mooring buoys; assisting ocean-going vessels in docking; installing and maintaining underwater pipelines; operating cable-laying boats; deep and shallow water diving; and mooring of scientific barges.

Upon completion of Operation CASTLE, three water taxis were returned to the United States and sold; four LCUs, one tug and two LCMs were returned to the U. S. Navy. During the interim period, 50 small craft of all types remained at Jobsite, of which approximately twelve were kept activated. To meet the requirements of REDWING, additional craft were acquired as follows: seven LCMs, nine LCUs, and one tug, all on a loan basis from the U. S. Navy; 41 DUKWs on a loan basis from the U. S. Army; and three water taxis and one sea mule by purchase. In all exchanges of craft with the U. S. Navy, joint inspections were made by H&N (representing the AEC) and Navy personnel in accordance with existing agreements. The craft were activated on an as-needed basis for meeting requirements of Operation REDWING; during the peak of activity, all available craft were required. Essentially, the number of craft available were adequate, although there were a few isolated cases in which calls for water transportation could not be fulfilled immediately. The number of craft available and their assignment to atolls during the peak period of activity are tabulated as follows:

TYPE	ENIWETOK	BIKINI	
LCU	6	8	
LCM	18	11	
DUKW	16	23	(one DUKW was surveyed
WATER TAXI	3	0	and one sunk.)
BARGES	11	2	
SEA MULE	1	0	(Six expended for
TUG (YTL)	2	0	scientific use.)
Totals	57	44	
Grand Totals:	101		

For the operational phase, the craft assigned to Bikini Atoll were augmented by those available from a Navy-operated boat pool. These Navy craft were assigned on an as-needed basis and were used to carry approximately 25 per cent of the peak load in Bikini Atoll. The H&N Superintendent of Marine Operations was delegated the duties of Transportation Control Agent for coordinating the use of boats in support of the scientific program. The working relationship established between the Navy and Contractor-operated boat pools was effective in providing satisfactory boat service.

Transportation of cargo and personnel in both atolls was provided by boats on scheduled runs between camps or by the daily assignment of craft to specific missions. All requests for the use of cargo space in boats were submitted to a Marine Dispatcher on the day prior to departure. This procedure permitted an accurate breakdown of requirements for each day and provided for the maximum use of available operating craft. All craft and marine dispatchers' offices were interconnected through voice radio, facilitating the control of craft and providing for the interchange of operating information.

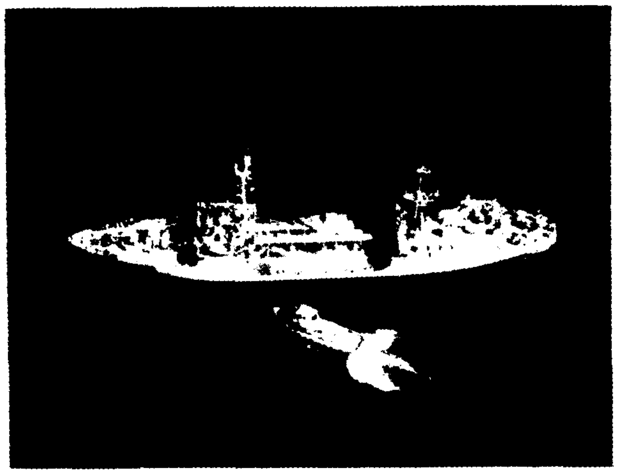


Figure 4-13. Tug Approaching Tanker

Arrangements could thereby be effected prior to the arrival of the craft at destination for the services of stevedores, heavy equipment operators, boat trouble-shooters, and others. In this way, the length of time the craft remained at the landing was reduced.

The cargo and passengers carried each month of Operation REDWING are shown in Table 4-8.

Boat channels leading to the various sites in Eniwetok and Bikini Atolls were well established during previous Operations. As early as practicable all entry channels were checked, and some blasting was found necessary. All channel buoys were checked, overhauled, and replaced if necessary. Empty 50-gallon fuel drums, being both satisfactory and economical, were used for marker buoys. Lighted range markers were installed at those sites where night entry by boats was required. Entry to a number of sites had to be arranged in accordance with tidal conditions. These conditions are shown in Chart 4-8 for Eniwetok Atoll and in Chart 4-9 for Bikini Atoll.

Water areas of the off-atolls were not well charted; information on the condition of beaches for use by LST or small craft was particularly lacking. Therefore, a reconnaissance was made of each site to gather information with respect to the use of the beaches by boats. Lack of time and transportation held the surveys to a minimum. However, sufficient data were obtained to permit subsequent landings without much difficulty, although minor hull damage was sustained by several of the craft used.

As a result of the sinking of a Navy-operated PBM plane in Lele Harbor, Kusaie Island, a hydrographic survey was requested in order to establish a safe seaplane landing area. A fairway was wire-dragged to a depth of eleven feet at low water springs. Charts of the dragged area were distributed to interested parties at the Proving Ground and the data were forwarded to the Hydrographic Office in Washington D. C. The wire drag assembly and marker buoys were made and tested at Elmer.

Approximately 200 small craft mooring buoys were lifted, overhauled, and replanted. Experience during previous Operations at the Proving Ground indicated that such work was required every 18 to 24 months. In Eniwetok Atoll, this work was accomplished by the Marine Riggers using the self-propelled pontoon barge (sea mule) fitted with an "A" frame. In Bikini Atoll, the work had to be accomplished by using a crane placed in an LCU. Through the use of a high safety factor in the mooring gear and constant surveillance of all tackle in use, no craft were lost or damaged because of mooring failure. Overhaul of large buoys for ocean-going vessels and the inspection and overhaul of buoys that mark large ship channels were performed by U. S. Coast Guard or Naval vessels.

Six 585-ton barges were outfitted at Elmer for use as Scientific Stations 10 through 15. Five of the barges were moved to and moored in Bikini Atoll; one of these was returned and moored in Eniwetok Atoll. The sixth barge was also moored in Eniwetok Atoll. In addition, four smaller barges were constructed and moored in predetermined positions in Bikini Atoll: two for use with Station 13, and two for use with Station 11. The responsibility for the movement and mooring of these scientific barges always rested with the Contractor except when the barges were within an LSD for interatoll movement. As the mooring scheme used in the CASTLE Operation proved effective in maintaining the barge within the allowed tolerance in movement, the scheme was used again in REDWING.

Figure 4-14. Personnel Boat

INTRA - ATOLL WATER TRANSPORTATION

	ENIWETOK		BIKINI	
MONTH	TONNAGE	PASSENGERS	TONNAGE	PASSENGERS
July 1954	87,500	8,900		
August	149,000	7,900		
September	89,000	8,100		
October	44,000	7,600		
No ember	61,000	8,200		
December	42,000	6,100	5,200	800
January 1955	29,000	5,700	7,000	690
February	24,000	5,600	4,000	750
March	21,000	5,200	6,000	720
April	41,000	8,800	6,500	850
May	42,000	9,200	6,000	900
June	39,000	8,700	11,000	1,500
July	39,000	9,100	15,500	2,100
August	62,000	12,300	16,000	2,500
September	112,000	9,800	16,000	2,100
October	119,000	13,100	13,000	2,200
November	114,000	14,300	16,000	4,300
December	107,000	14,500	26,000	7,700
January 1956	104,000	15,200	34,000	7,800
February	106,000	15,900	33,000	7,000
March	131,000	21,900	51,000	7,900
April	158,000	27,200	49,000	9,000
May	148,000	30,200	39,394	24,304
June	112,441	31,335	23,339	28,480
July	99,391	28,367		

Table 4-8. Intra-Atoll Water Transportation

For submarine cable-laying operations, two LCMs were fitted with cable dollies and handling gear in a manner similar to that used in Operation CASTLE. The shallow draft of these boats permitted the very close inshore work required. Cable laying was a continuous operation throughout the build-up phase.

The submarine fuel lines at Fred had badly deteriorated, and required continuing underwater repairs. Therefore, the existing mogas and diesel lines were replaced. A jet fuel line was also added. This improvement involved laying and anchoring 3,130 feet of 6-inch steel pipe and 600 feet of 6-inch flexible hose.

A total of 206 vessels, excluding combat-type, entered Eniwetok during the period from December 1954 through 1956. Services made available to ocean-going vessels were as follows: (1) tug boats; (2) transportation of liberty parties; (3) docking instructions; (4) limited fresh water and fuel; (5) stevedoring and lighterage; (6) minor repairs; (7) diving inspection. On several occasions the catwalks were damaged by vessels in making their approach to the deep water pier. In order to facilitate docking, moorings were placed and information of the prevailing local conditions were made available to the masters as indicated in Chart 4-10.

Figure 4-16. LCM and Sea Mule Used in Salvage of Helicopter

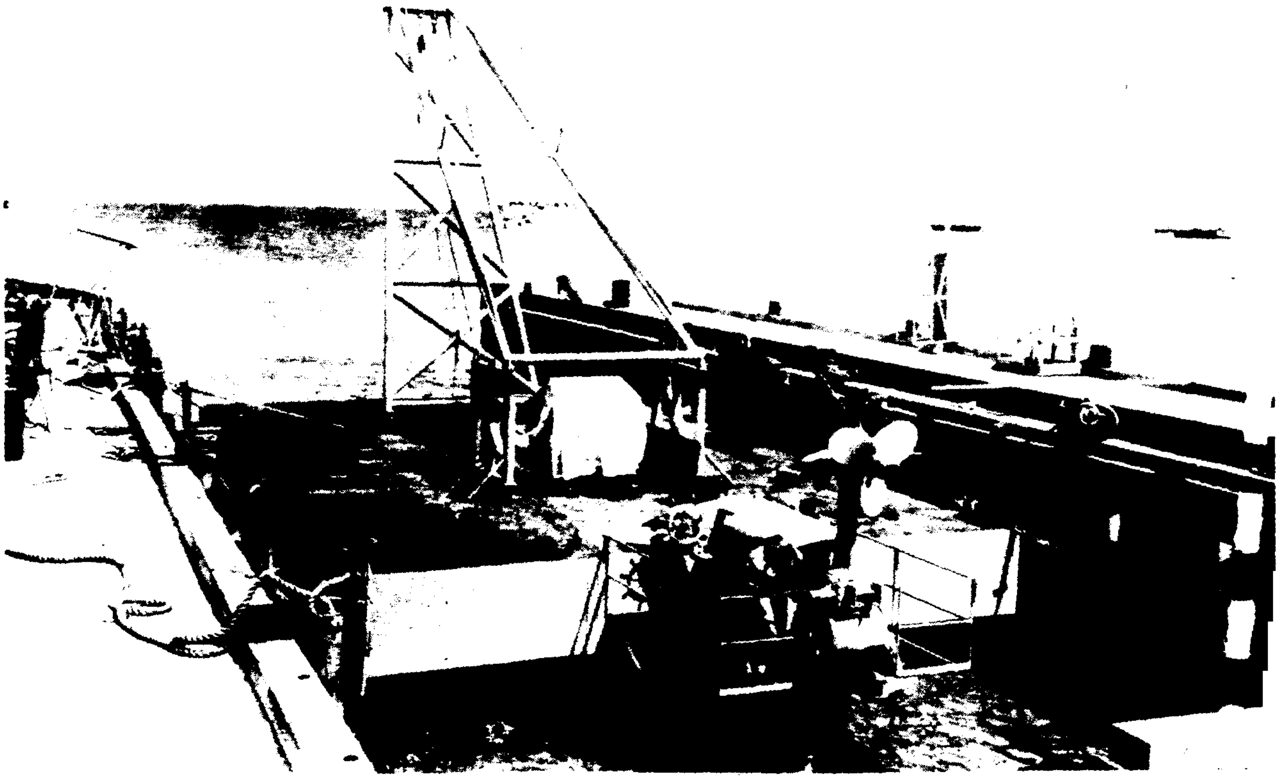
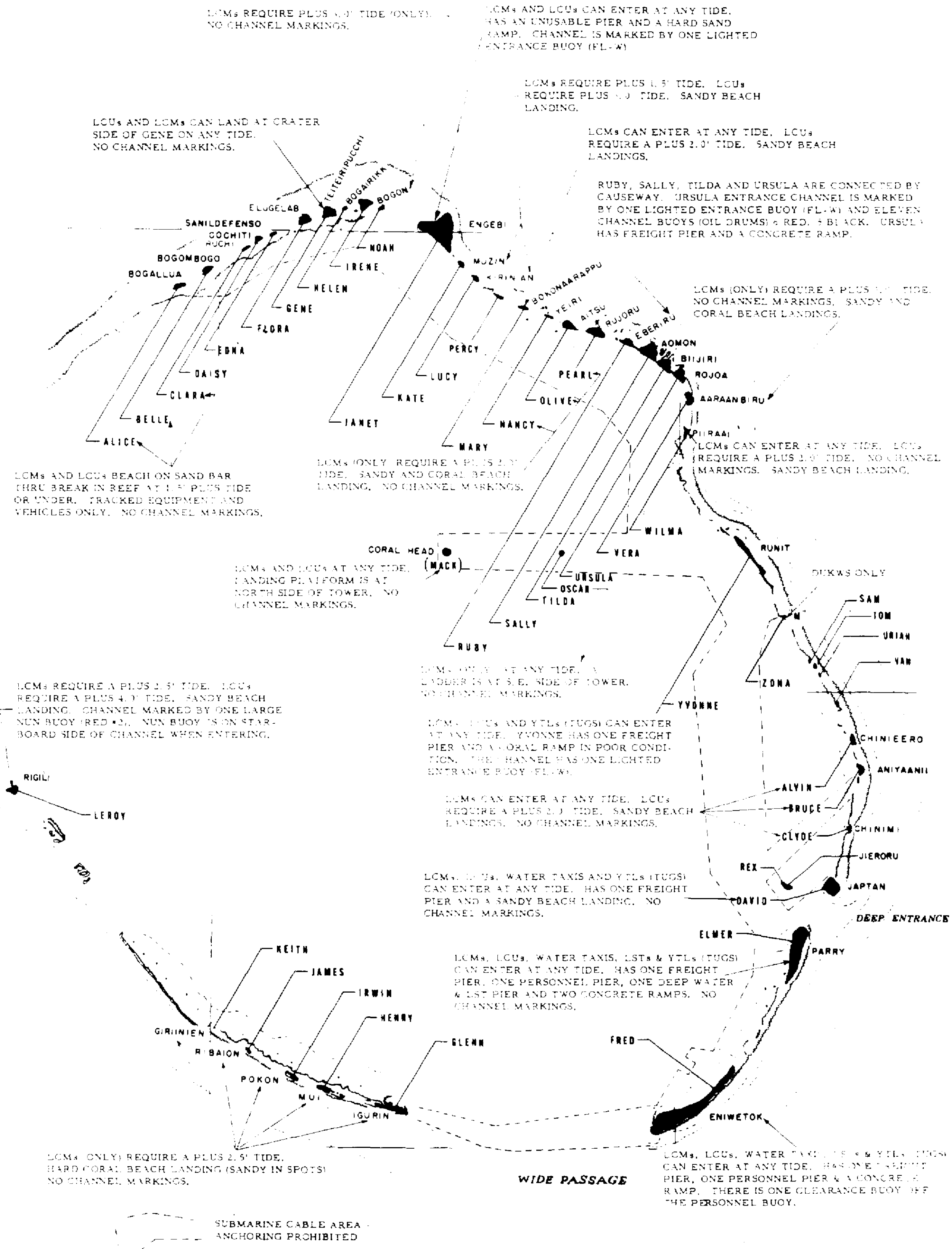


Figure 4-15. New Sea Mule Nearing Completion



NOTE: CONDITIONS SHOWN ARE AS OF 12 OCTOBER 1955

Chart 4-8. Beaching Conditions - Eniwetok Atoll

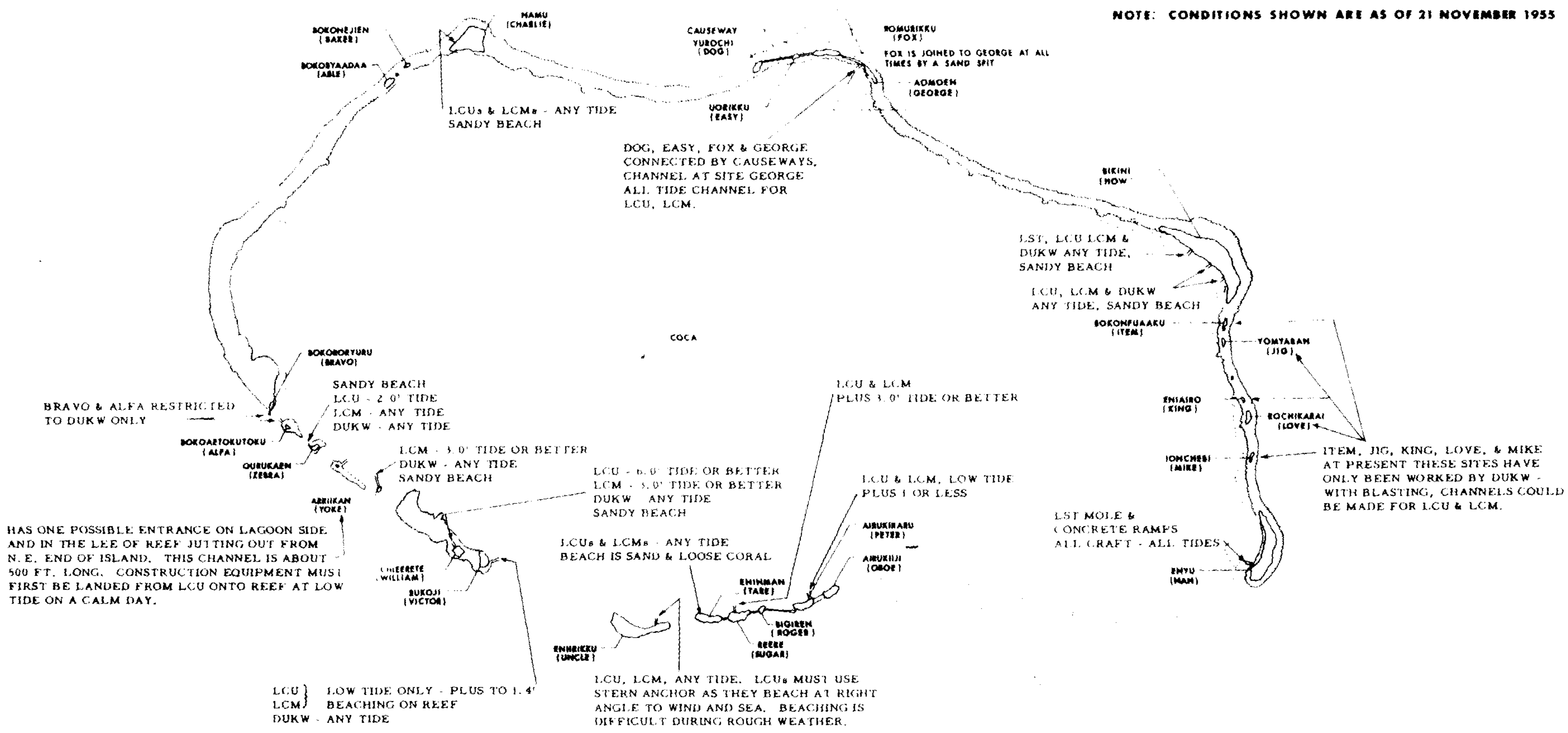


Chart 4-9. Beaching Conditions - Bikini Atoll

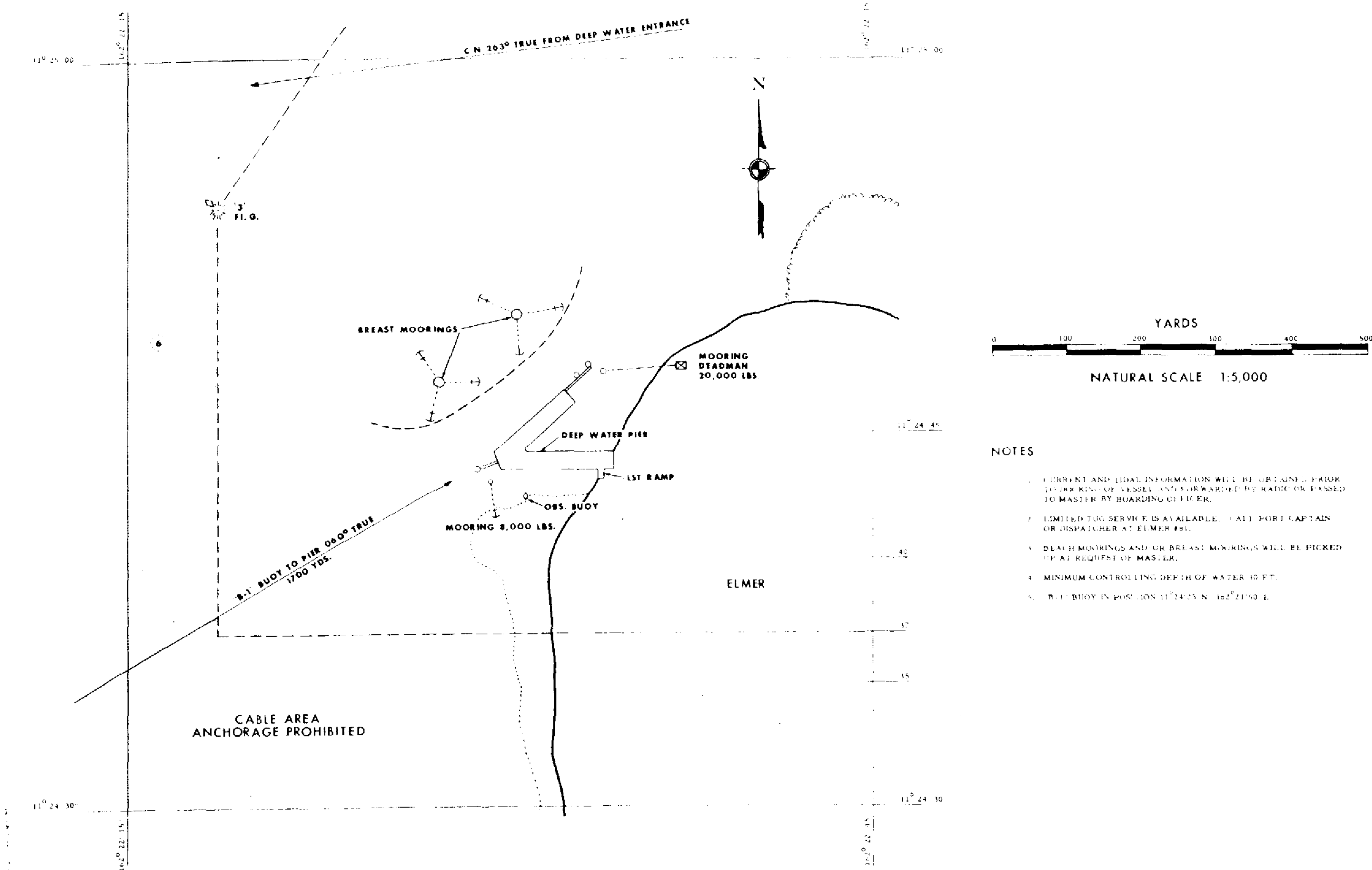


Chart 4-10. Approach to Deep Water Pier

SECTION 3
ELECTRIC POWER GENERATION AND DISTRIBUTION

DISTRIBUTION.

On completion of the roll-up after CASTLE, all power plants at the Proving Ground had been deactivated except the plant at Elmer. This plant supplied all power demands for both Elmer and Fred until 18 October 1955, at which time increased power demands necessitated the reactivation of the Fred power plant. Power demands increased progressively at these two sites and it became necessary to acquire two 600 KW portable units to augment the generating capacity. One of these units was installed adjacent to Building 301 on Elmer and was placed on the line on 5 March 1956. The other unit was installed adjacent to Building 650 on Fred and was placed in service on 21 March 1956. Because of the critical power situation on Fred, three self-contained 150 KW units were installed as stand-by generators for vital circuits in case the shutdown of a main power plant became necessary.

As temporary camps were established, power requirements were met by using portable generators until the existing power plants could be activated or plants built. The existing plants were located at sites Yvonne, Ursula, and Nan in earth-covered, reinforced-concrete structures that were partially subsurface and designed to withstand anticipated blast pressures. The power plants for Gene, Fox, and Tare were set up in expendable structures that served to house both power-generating and water distillation units.

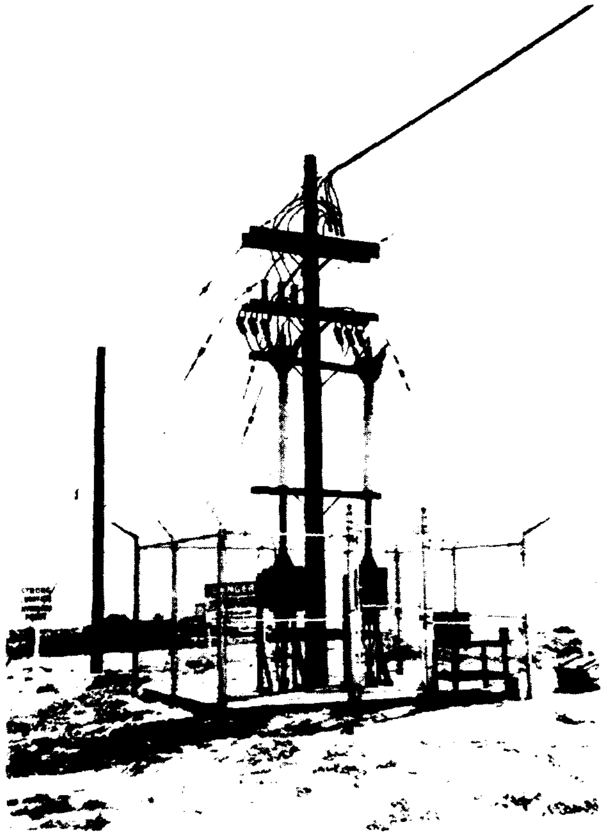


Figure 4-17. Submarine Power Cable Terminal - Elmer

The Ursula power plant was reactivated on 19 September 1955. This plant was used for both camp and scientific requirements. To meet power demands, it was necessary to install two additional units of 150 KW, which increased the plant capacity to 600 KW.

The Yvonne plant consisted of four 150 KW units in Building 75, which could be connected in parallel with two other 150 KW units located in the vicinity of Station 1524. These units combined provided 900 KW, which was used for both camp and scientific purposes.

As a result of damage incurred during CASTLE, the prime mover of unit No. 2 in the NA 500 plant, Nan, had to be surveyed. The remaining two units were overhauled and were placed on the line on 9 March 1955. On 5 April, a 135 KW unit was added to this plant. Power demands increased and a 122 KW unit was removed from the Fred power plant and installed in the Nan plant in August 1955. Three other 150 KW generating units were installed adjacent to the plant. Through switch gear, the camp and scientific load could be carried by one set of machines or, the loads could be divided for close voltage regulation on scientific circuits.

Generating capacities at each camp site are summarized below. At all other sites generators for meeting scientific requirements were provided in numbers and capacities as shown in Tables 4-9, 4-10 and 4-11.

SITE	NO. OF UNITS	RATED CAPACITY EACH	TOTAL CAPACITY KW
Elmer	4	1,000 KW 3/60/2400 V	4,000
	1	600 KW 3/60/2400 V	600
Total			4,600
Fred	4	122 KW 3/60/2400 V	488
	1	167 KW 3/60/2400 V	167
	1	600 KW 3/60/2400 V	600
	2	135 KW 3/60/2400 V	270
Total			1,525
David	1	60 KW 3/60/208 V	60
		75 KW 3/60/208 V	75
Yvonne	6	150 KW 3/60/4160 V	900
Ursula	2	150 KW 3/60/2400 V	300
	3	101 KW 3/60/2400 V	303
Nan	3	150 KW 3/60/2400 V	450
	2	122 KW 3/60/2400	244
	1	101 KW 3/60/2400	101
Total			795
Fox	2	75 KW 3/60/220	150
Tare	2	75 KW 3/60/220 V	150
Gene	2	75 KW 3/60/220 V	150

For reasons of economy, electrical power distribution at Elmer and Fred was through overhead lines. Between these two sites, two submarine lines (each capable of carrying the load) were provided for continuous service in case of the failure of one line. For the transfer of power over the submarine cables the generated 2400 volts were first stepped up to 4,160 volts at Elmer and then stepped down to 2,400 volts at Fred. At Ursula, 4,160 volts and at Nan and Yvonne 2,400 volt circuits were used; these were stepped down to operating voltages of 208/117 by conveniently located transformers.

Complete operating and production records covering the fixed installations were maintained and reported monthly to the AEC. There were no serious power outages during the critical test operational period. One of the 1000 KW alternators on Elmer shorted and burned out in early June 1956, and had to be sent to Honolulu for rewinding. The remaining three generators were able to meet all demands at that time. The daily average of KW hours produced at the fixed installations is shown in Table 4-12.

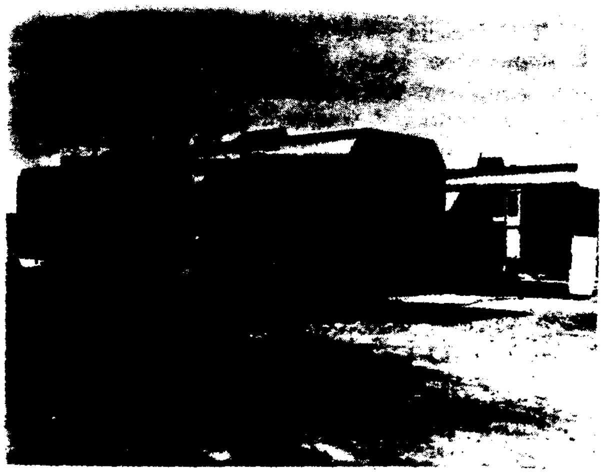


Figure 4-18. 600 KW Generators - Under Load Test

SITE	STA.NO.	KW	VOLTS	PHASE	TYPE	QTY.	GEN.NO.
ABLE	130.01	2	115	1	GAS	2	G346 & 349
	131.01	2	115	1	GAS	2	G347 & 348
	560.01	20	120/208	3	DIESEL	2	G384 & 385
	1519	5	120	1	GAS	1	G265
	1519	5	120	1	GAS	1	G266
BARGE	10	15	120/208	3	DIESEL	2	G335 & 337
	11	15	120/208	3	DIESEL	2	G336 & 338
	12	15	120/208	3	DIESEL	2	G339 & 340
	13	15	120/208	3	DIESEL	2	G364 & 368
	14	15	120/208	3	DIESEL	2	G363 & 365
	15	15	120/208	3	DIESEL	2	
	16	15	120/208	3	DIESEL	2	
CHARLIE	312.01	10	120/208	3	GAS	1	G430
	312.02	10	120/208	3	GAS	1	G433
	312.03	10	120/208	3	GAS	1	G431
	1319	30	120/208	3	DIESEL	2	G477 & 476
	7412	10	120/208	3	GAS	1	G426
DOG	75.01	3	120	1	GAS	1	G205
	75.01	3	120	1	GAS	1	G206
	75.01	3	120	1	GAS	1	G207
	312.04	25	208/220	3	DIESEL	1	G232
	1320	100	208/220	3	* DIESEL	2	G449 & 450
	1831.01	10	208/220	3	GAS	1	G423
	1831.02	10	208/220	3	GAS	1	G424
GEORGE	76	3	120	1	GAS	1	G212
	76	3	120	1	GAS	1	G214
	811.01	75	120/208	3	DIESEL	2	G454 & 455
	1528	30	120/208	3	* DIESEL	1	G180
	1528	30	120/208	3	* DIESEL	1	G181
	1830	40	120/208	3	* DIESEL	2	G470 & 471
	913	10	120/208	3	GAS	2	G429 & 268
HOW	75.02	3	120	1	GAS	1	G210
	75.02	3	120	1	GAS	1	G211
	560.03	20	120/208	3	DIESEL	2	G386 & 387
	811.02	75	120/208	3	DIESEL	2	G458 & 459
	1516	30	120/208	3	DIESEL	1	G418
	1516	30	120/208	3	DIESEL	1	G419
	261.01	5	120	1	GAS	1	G190
	261.01	5	120	1	GAS	1	G195

* = INDOOR

Table 4-9. Scientific Generator Requirements - Bikini Atoll

SITE	STA.NO.	KW	VOLTS	PHASE	TYPE	QTY.	GEN.NO.
NAN	BLDG.						
	500	150	2400/4160	3	DIESEL	3	G439, 440, 443
	411.01	5	120	1	GAS	1	G222
	560.04	20	120/208	3	DIESEL	2	G388 & 389
	911	3	120	1	GAS	1	G186
	911	3	120	1	GAS	1	G187
	70	5	120/208	3	DIESEL	1	G452
	262.01	10	120/208	3	GAS	2	
OBOE	74.01	3	120	1	GAS	1	G184
	3110	10	120/208	3	GAS	1	
PETER	2300	35	120/208	3	* DIESEL	2	G394 & 395
	AIRSTRIP GUARD SHACK	3	120	1	GAS	1	G218
ROGER	PROJ 23	2	115	1	GAS	1	
SUGAR	2200	100	120/208	3	DIESEL	1	G397
	2200	35	120/208	3	DIESEL	1	G421
	2200	10	120/208	3	DIESEL	1	G370
	73.06	3	120	1	GAS	1	G215
TARE	22	50	120/208	3	DIESEL	1	G422
	22	25	120/208	3	DIESEL	1	G420
	7411.09	10	120/208	3	GAS	1	G425
UNCLE	73.07	5	120	1	GAS	1	G259
	73.07	3	120	1	GAS	1	G274
	110	10	120/240	1	GAS	1	G198
	131.02	2	115	1	GAS	2	G356 & 357
WILLIAM	560.05	20	120/208	3	DIESEL	2	G390 & 391
	1515	30	120/208	3	DIESEL	1	G406
	1515	30	120/208	3	DIESEL	1	G411
FLOATING CAMPS	LCT 362	30	120/208	3	DIESEL	2	G465 & 467
	LCT 363	30	120/208	3	DIESEL	2	G409 & 41
	LCT 373	30	120/208	3	DIESEL	2	G460 & 46[illegible]
	LCT 374	30	120/208	3	DIESEL	2	G461 & 464
	LCT 375	30	120/208	3	DIESEL	2	G463 & 4[illegible]

* = INDOOR

Table 4-9. Scientific Generator Requirements - Bikini Atoll - continued

SITE	STA.NO.	KW	VOLTS	PHASE	TYPE	QTY.	GEN.NO.
FRED	NEAR BLDG. 649	150	2400/4160	3	DIESEL	2	G344 & 444
	NEAR BLDG. 649	600	2400/4160	3	DIESEL	1	G334
ELMER	BLDG. 334	10	120/208	3	GAS	1	G428
DAVID	410.01	5	120	1	GAS	1	G226
	410.01	5	120	1	GAS	1	G221
	POWER PLANT	75	120/208	3	DIESEL	1	G362
	BLDG. 165	10	120/208	3	GAS	1	
BRUCE	1630	25	120/208	3	DIESEL	2	G473 & 474
	7420	30	120/208	3	DIESEL	1	G407
	7420	30	120/208	3	DIESEL	1	G414
YVONNE	131.04	2	115	1	GAS	2	G350 & 351
	1524	150	2400/4160	3	DIESEL	2	G402 & 403
	Y-75	150	2400/4160	3	* DIESEL	4	G342, 399, 400 & 401
WILMA	1513	30	120/208	3	DIESEL	1	G416
	1513	10	120/208	3	GAS	1	G438
URSULA	U-108	150	2400/4160	3	* DIESEL	1	G343
SALLY	2201	10	120/208	3	* DIESEL	1	G369
	2201	35	120/208	3	* DIESEL	1	G396
RUBY	2221.04	5	120/240	1	GAS	1	G267
PEARL	4	150	2400/4160	3	DIESEL	2	G345 & 398
	4	10	120/208	3	GAS	1	
JANET	5	100	480	3	DIESEL	2	G447 & 448
	72.01	5	120	1	GAS	1	G263
	1317	75	120/208	3	* DIESEL	1	G457

* = INDOOR

Table 4-10. Scientific Generator Requirements - Eniwetok Atoll (Continued on next page.)

SITE	STA.NO.	KW	VOLTS	PHASE	TYPE	QTY.	GEN.NO.
IRENE	73.04	3	120	1	GAS	1	G185
	POWER PLANT	150	2400/4160	3	DIESEL	2	G441 & 442
MACK	1514	25	120/208	3	DIESEL	1	G451
	1514	10	120/208	3	GAS	1	G434
ALICE	1541	5	120	1	GAS	1	G223

Table 4-10. Scientific Generator Requirements - Eniwetok Atoll - continued

SITE	STA.NO.	KW	VOLTS	PHASE	TYPE	QTY.	GEN.NO.
WOTHO	562.01	25	120/208	3	DIESEL	2	G231 & 233
	562.02	30	208/220	3	DIESEL	1	G408
	562.02	30	208/220	3	DIESEL	1	G415
	CAMP	15	120/240	1	DIESEL	2	G313 & 314
RONG-ERIK	563.01	25	208/220	3	DIESEL	1	G243
	563.01	25	208/220	3	DIESEL	1	G230
	CAMP	15	120/240	1	DIESEL	4	G327, 328, 329 & 330
KUSAIE	CAMP	15	120/240	1	DIESEL	5	G317, 323, 32[illegible], 331, & 332
KAPIN-GAMA-RANGI	CAMP	15	120/240	1	DIESEL	5	G318, 319, 3[illegible] 321 & 322
TARAWA	CAMP	15	120/208	1	DIESEL	5	G312, 315, [illegible]6 324 & 325
UTERIK	CAMP	15	120/208	3	GAS	1	G383
	CAMP	50	120/208	3	* DIESEL	1	G150
UJELANG	CAMP	15	120/208	3	GAS	1	G376
	CAMP	50	120/208	3	* DIESEL	1	G152

* = INDOOR

Table 4-11. Generator Requirements Off-Atolls

DAILY AVERAGE of KW HOURS PRODUCED at FIXED INSTALLATIONS

DATE		ELMER	FRED	DAVID	YVONNE	URSULA	NAN
1954	JUL.	35,633	3,583				
	AUG	39,166					
	SEP	37,620					
	OCT	38,983					
	NOV	38,920					
	DEC	36,700					
1955	JAN	39,616					
	FEB	36,500					
	MAR	38,600					2,360
	APR	39,520					2,820
	MAY	40,166					3,608
	JUN	42,790					3,670
	JUL	43,916					4,016
	AUG	44,050					4,375
	SEP	44,680				1,300	4,550
	OCT	41,267	4,833			1,483	4,358
	NOV	37,140	10,120			1,600	4,720
	DEC	37,616	9,117	809		1,530	4,600
1956	JAN	40,167	10,883	736		1,467	4,742
	FEB	39,450	11,412	854		1,675	5,087
	MAR	46,166	15,000	803	1,034	1,867	6,000
	APR	54,077	19,376	767	5,964	2,960	7,130
	MAY	59,820	20,800	780	4,220	1,900	6,420
	JUN	59,000	21,500	800			5,040

Table 4-12. Daily Average of KW Hours Produced at Fixed Installations

SECTION 4
FRESH WATER DISTILLATION AND DISTRIBUTION

The evaluation of the requirements for fresh water distillation units was based on the anticipated peak populations to be supported at each camp site. On 30 March 1955, a purchase order was awarded for the acquisition of six 200 gph units which were necessary to meet the then known requirements. On 7 July 1955, this order was increased to 11 such units, four of which were required for the off-atoll weather stations. The evaluation of fresh water requirements had to be reviewed periodically because of the changing number of persons expected to participate in REDWING. On 15 August 1955, anticipated requirements had increased and a 600 gph unit was ordered. On 15 October, the over-all forecasted peak population was discussed in a conference at JTF-7 Headquarters in Washington and, as a result of the conference, it was determined that additional distillation plant capacities would be required at Elmer and Fred. A 2100 gph unit was located that was being assembled for export to a foreign country. The fabricator of this unit was willing to divert it, and a purchase order was awarded for its acquisition on 14 November. This unit was installed on Elmer and activated as the

Figure 4-19. Distillation Plant - Nan

period of peak demand approached. With the acquisition of the 2100 gph unit, two of the 600 gph units previously assigned to Elmer were transferred to Fred. Table .... indicates the distribution of all units at the Proving Ground in April 1955 when all camps were in operation.

Because of the large influx of personnel at Elmer due to the evacuation of the northern islands in Eniwetok Atoll, it became necessary to increase the Elmer plant capacity. Units were available from the rolled-up camps. During the month of June, consumption at Elmer averaged 142,331 gallons per day. To meet this demand, one additional 600 gph unit and seven 200 gph units were installed. This installation provided a plant consisting of one 2100 gph unit, eight 600 gph units, and seven 200 gph units with a total daily rated capacity of 199, 200 gallons. With a firm capacity based on 75 per cent of rated capacity, the plant capacity at this time was 149,400 gallons.

The average daily per capita consumption at each camp is shown in Table 4-14.

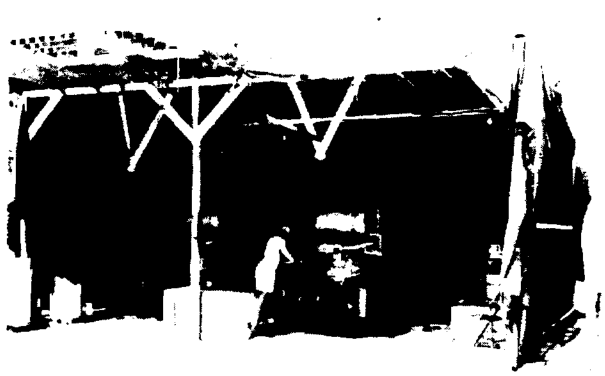


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Figure 4-21. Beachhead Distillation Plant

Figure 4-20. Fresh and Salt Water Pipe - Being Installed

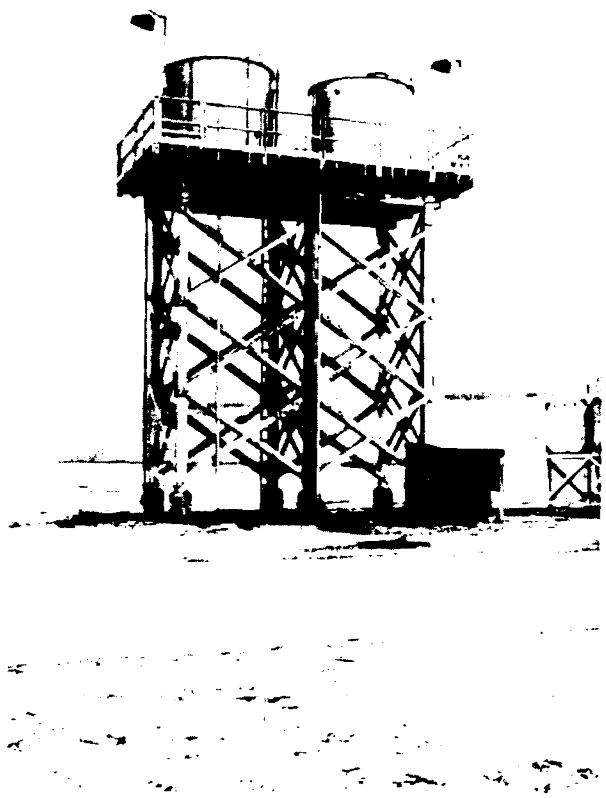


Figure 4-22. Typical Off-Island Water Tower

DISTRIBUTION of DISTILLATION UNITS

ENIWETOK ATOLL

Site	No. Units	Rated Capacity	Prime Mover	Type Unit	Rated Capacity	Firm Capacity
Elmer	1	600 gph	Diesel Engine	Portable	14,400	10,560
	6	600 gph	Induction Motor	Stationary	86,400	63,360
	1	2100 gph	Diesel Engine	Stationary	50,400	48,000
Fred	7	600 gph	Diesel Engine	Portable	100,800	73,920
	8	600 gph	Induction Motor	Stationary	115,200	84,380
David	1	200 gph	Diesel Engine	Portable	4,800	3,264
Yvonne	6	150 gph	Gas Engine	Portable	21,600	16,128
Ursula	3	200 gph	Diesel Engine	Portable	14,400	9,762
Gene	2	200 gph	Diesel Engine	Portable	9,600	6,528
BIKINI ATOLL						
Nan	2	600 gph	Diesel Engine	Portable	28,800	21,120
	5	150 gph	Gas Engine	Portable	18,000	13,440
Fox	2	200 gph	Diesel Engine	Portable	9,600	6,528
	1	150 gph	Gas Engine	Portable	3,600	2,688
Tare	2	200 gph	Diesel Engine	Portable	9,600	6,528

OFF-ATOLL SITES

Site	No. Units	Rated Capacity	Prime Mover	Type Unit	Capacity / Day	
					Rated	Actual
Wotho	2	150 gph	Gas Engine	Portable	7,200	5,376
Ujelang	1	150 gph	Gas Engine	Portable	3,600	2,688
Uterik	1	150 gph	Gas Engine	Portable	3,600	2,688
WEATHER STATIONS						
Rongerik	1	200 gph	Diesel Engine	Portable	4,800	3,264
Kusaie	1	200 gph	Diesel Engine	Portable	4,800	3,264
Tarawa	1	200 gph	Diesel Engine	Portable	4,800	3,264
Kapingamarangi	1	200 gph	Diesel Engine	Portable	4,800	3,264

Table 4-13. Distribution of Distillation Units

FRESH WATER CONSUMPTION PER CAPITA

ENIWETOK ATOLL

DATE		ELMER POP.	ELMER CONS.	FRED POP.	FRED CONS.	YVONNE POP.	YVONNE CONS.	URSULA POP.	URSULA CONS.	GENE POP.	GENE CONS.
1954	Jul	658	61	1048	61						
	Aug	605	58	1034	69						
	Sep	564	61	1005	66						
	Oct	569	60	1012	86						
	Nov	600	58	988	75						
	Dec	537	68	910	66						
1955	Jan	624	64	909	77						
	Feb	591	51	864	88						
	Mar	567	56	911	81						
	Apr	636	58	914	75						
	May	632	66	894	80	46	45	52	46		
	Jun	769	68	859	86	56	49	59	63		
	Jul	763	68	949	73	36	51	97	50		
	Aug	834	72	982	62	51	41	67	84	94	27
	Sep	828	60	1064	66	55	43	107	53	101	30
	Oct	1012	54	1225	57	103	32	107	53	98	38
	Nov	1055	59	1304	62	132	39	133	47	61	54
	Dec	1008	59	1391	56	216	37	115	49	61	56
1956	Jan	1198	53	1653	66	304	34	134	45	77	58
	Feb	1306	56	2021	58	346	35	152	42	95	51
	Mar	1661	53	3331	41	379	39	203	45	157	43
	Apr	2246	50	3441	44	254	54	228	49	157	42
	May	2559	52	3412	47	135	41				
	Jun	2530	56	3048	49						

Table 4-14. Daily Fresh Water Consumption per Capita (Continued on next page.)

(CONTINUED)

BIKINI ATOLL

DATE	NAN POP.	CONS.	FOX POP.	CONS.	TARE POP.	CONS.
1954 Dec	140	26				
1955 Jan	164	28				
Feb	192	28				
Mar	176	37				
Apr	197	40				
May	201	36				
Jun	190	37	64	36		
Jul	213	37	64	39	60	33
Aug	221	37	40	55	70	33
Sep	233	43	35	50	49	54
Oct	243	39	60	44	59	39
Nov	252	47	83	42	87	43
Dec	257	44	125	42	72	51
1956 Jan	303	39	163	40	85	42
Feb	543	36	175	39	101	41
Mar	605	38	202	41	164	37
Apr	778	34	241	34	175	40
May	916	30				
Jun	707	40				

Table 4-14. Daily Fresh Water Consumption per Capita - continued

FRESH WATER STORAGE FACILITIES GROUND and TOWER

SITE	TOWER STORAGE TANKS	GROUND STORAGE TANKS
Elmer	21,000 gal.	250,000 gal.
Fred	21,000 gal.	210,000 gal.
David	4,200 gal.	4,200 gal.
Yvonne	4,200 gal.	21,000 gal.
Ursula	4,200 gal.	21,000 gal.
Gene	4,200 gal.	21,000 gal.
Nan	4,200 gal.	84,000 gal.
Fox	4,200 gal.	21,000 gal.
Tare	4,200 gal.	21,000 gal.
Wotho	1,100 gal.	1,100 gal.
Ujelang	1,100 gal.	1,100 gal.
Uterik	1,100 gal.	1,100 gal.
Rongerik	1,100 gal.	1,100 gal.
Kusaie	1,100 gal.	1,100 gal.
Kapingamarangi	1,100 gal.	1,100 gal.
Tarawa	1,100 gal.	1,100 gal.

Table 4-15. Fresh Water Storage Facilities - Ground and Tower

Figure 4-23. Redwood Stave Fresh Water Storage Tanks

SECTION 5
LAND TRANSPORTATION

The vehicles available for land transportation were allocated for specific use and to key personnel at the various sites according to their respective requirements. A motor pool at Elmer was operated which controlled the assignment of vehicles for short-term usage. This pool was combined with that of TG 7.1 during the operational phase. A representative from each unit was assigned to administer his interests in dispatching and controlling the vehicles in the pool. Daily bus service was furnished at Elmer with the route passing the main installations. Five 2½-ton personnel carriers were used for transporting personnel to and from the Fred airport. Schedules of these personnel carriers were adjusted daily in accordance with plane arrivals and departures.

The servicing of all vehicles on Elmer was under the control of the Holmes & Narver Motor Pool Dispatcher. Lubrication service was effected at intervals ranging from two to three weeks.

The distribution of light vehicles under custody of the Contractor during the period of peak activity is shown in Table 4-16.

DISTRIBUTION OF LIGHT ROLLING STOCK

SITE	JEEP	PICKUP	POWER WAGON	WC-PC	HM TRUCKS	SCOOTERS	BUS-AMBULANCE	TOTALS
Elmer	45	7	20	20	23	5	4	124
Fred	7	1	5	3	8	2	0	26
Gene	3	0	1	1	3	0	0	8
Ursula	4	0	2	2	3	0	0	11
Yvonne	4	0	1	1	6	0	0	12
Fox	2	0	3	4	2	0	0	11
Nan	14	0	4	5	5	1	2	31
Tare	3	0	0	5	2	0	0	10
TOTAL	82	8	36	41	52	8	6	233

Table 4-16. Distribution of Light Rolling Stock

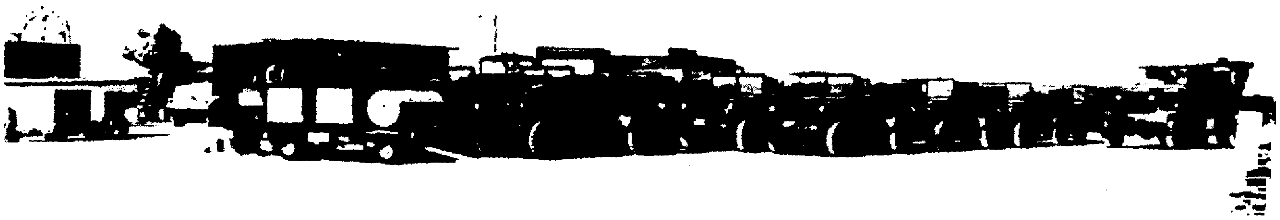


Figure 4-24. Vehicles Awaiting Interatoll Shipment

SECTION 6
AIR TRANSPORTATION

Air transportation within the Proving Ground was provided by elements of the U. S. Air Force and U. S. Navy. Interatoll transportation was provided between Bikini and Eniwetok Atolls through the establishment of a shuttle service by C-47 planes. The Peter-Oboe airstrip was used until 15 March 1955 when the airstrip on Nan was placed in service. At first, schedules called for two flights per week but this was augmented as the tempo of work increased until during the operational phase, schedules called for two flights per day seven days a week. Passenger scheduling was handled by one Personnel Supervisor at each of sites Elmer and Nan. Passenger traffic was heaviest during the week ending 29 April 1956. The daily movement of H&N passengers during that week is shown in the following table:

PASSENGER TRAFFIC - ENIWETOK - BIKINI

	TO NAN	TO FRED
Monday	31	38
Tuesday	17	24
Wednesday	26	26
Thursday	46	81
Friday	13	22
Saturday	5	24
Sunday	9	11

Air transportation to off-atolls was arranged on an as-needed basis. Generally, amphibious-type planes were used, although in several instances land planes were flown to Tarawa and Majuro where landing fields were available. For the control of air freight and passengers on off-atoll flights, the Superintendent of Supply was delegated the authority to act as Transportation Control Agent. Passengers varied in number from 2 to 6 per trip. The number of off-atoll trips made during the month of April 1956 was as follows: Uterik 3; Kusaie 5; Rongerik 6; Tarawa 3; Kapingamarangi 3; Ujelang 2, and Wotho 3.

Intra-atoll air transportation was provided by helicopters and small liaison planes of the L-20 type. During the early stages of the Operation these aircraft were provided on an as-needed basis. When the work increased in tempo, regularly scheduled flights were established within each atoll. These trips were supplemented by special flights where needed. During the operational phase, the Contractor maintained a passenger control agent (Dispatcher) at sites Elmer, Tilda, and Yvonne in Eniwetok Atoll and at sites Fox, Nan, and Tare in Bikini Atoll. These dispatchers were responsible for control of both TG 7.5 and TG 7.1 traffic.

A voice radio circuit was provided in each Atoll for communications between dispatchers. To facilitate movement of TG 7.1 personnel, a direct telephone line was provided between the TG 7.1 Administration Office and the Dispatcher at Elmer. Passenger traffic during the week ending 29 April, a week of intense activity, is indicated in the following table:

	NUMBER OF FLIGHTS		PASSENGERS CARRIED	
	ENIWETOK	BIKINI	ENIWETOK	BIKINI
H-19	22	419	31	1023
L-20	710	80	1282	214
HRS	-	272	-	680

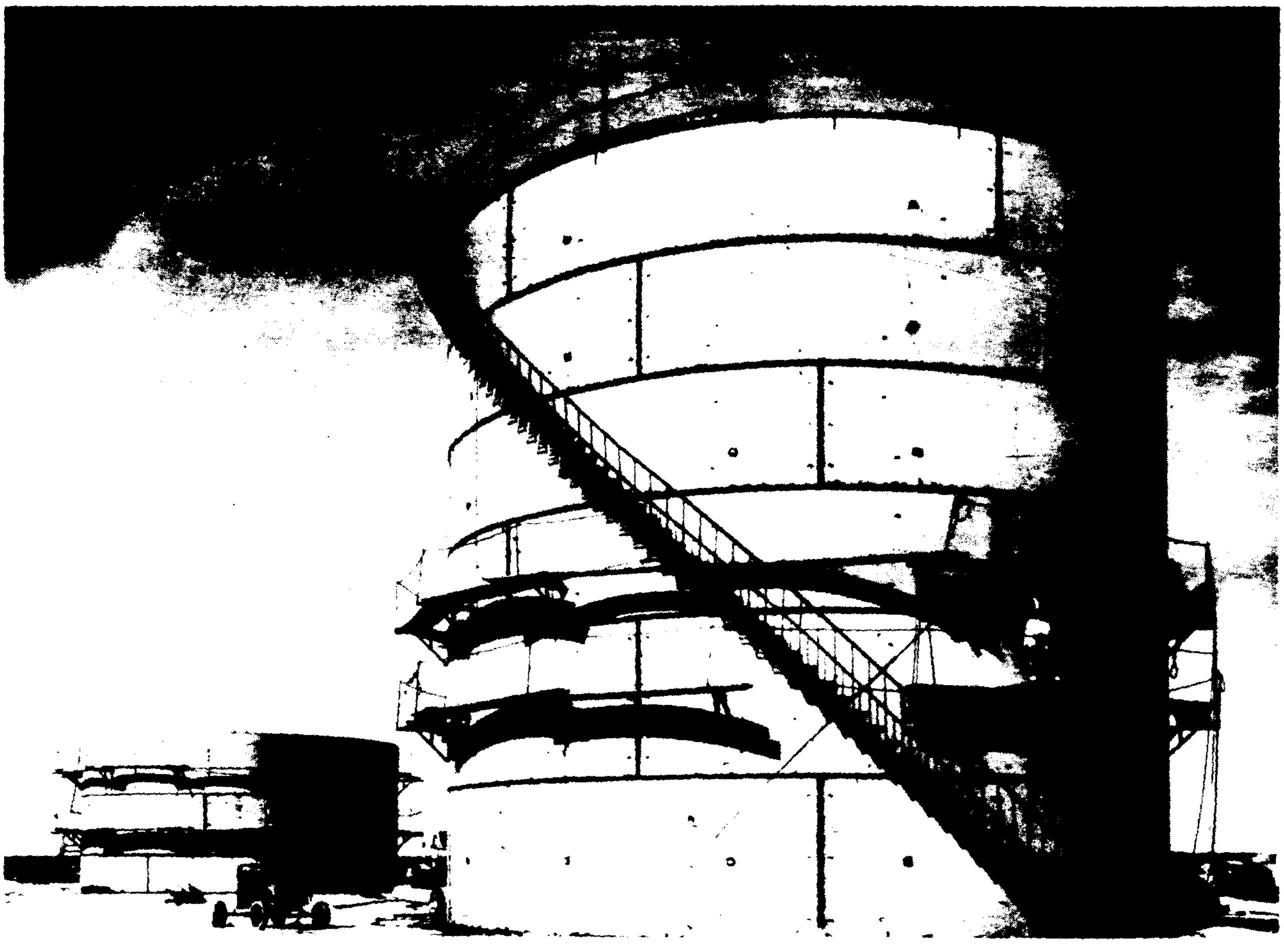


Figure 4-25. Replacing POL Tanks

Figure 4-26. LST Mole at End of Operation

CHAPTER V
MAINTENANCE

SECTION I
MAINTENANCE

The maintenance of all base facilities except for fixed communication facilities on Fred and David, JTF-7 communication facilities on Elmer, and military-owned equipment, were a responsibility of Holmes & Narver under Job 3 of the contract with the Atomic Energy Commission. Routine recurring maintenance was authorized through continuous maintenance work orders effective for the fiscal year. The continuous maintenance work orders covered each category of base facilities and structures as follows: (1) construction equipment; (2) buildings and structures; (3) other equipment, including land and marine transportation, camp, and office equipment, etc.; (4) land improvements such as airstrips, roads, and recreation areas; (5) utility systems, including electrical and water distribution lines, sewers, and POL distribution lines; (6) batch plant; (7) and aggregate plant equipment. For accounting purposes, work order numbers were assigned to the various components of each category in accordance with the chart of accounts. Maintenance that could not be considered routine and the cost of which was in excess of $1,000.00 was authorized by a specific maintenance work order. Specific maintenance work orders were also used when accumulated costs of an item were needed for study purposes or because of funding considerations. Included in the latter case was work chargeable to the Atcom maintenance fund; repair of equipment installed in the Army PX, Officers Club or NCO Club (the payment for which was made from unappropriated funds); and repairs to Navy boat pool craft and Bio-Med equipment.

For the purpose of organizational efficiency, the maintenance of marine, water distillation, and power generator plant equipment was a function of the Service Operations Division; all other maintenance was a function of the Construction - Maintenance Division. Routine maintenance authorized by continuous work orders was initiated upon the authority of the Division Head responsible for the work involved.

The tropical atmosphere, high humidity, and salt spray prevalent in the Proving Ground were conducive to rapid corrosion and deterioration of all ferrous metals. Cleaning, sandblasting, and painting of such metal surfaces were necessary at frequencies varying from six to twelve months. During the interim and build-up periods this work was placed on a scheduled basis.

Maintenance of aluminum buildings was confined to the repairs of roofing and siding caused by accidental, or storm damage; weatherproofing along the bottoms of structures; and operational repairs to doors, windows, shutter-arms, and plumbing and electrical fixtures. Maintenance requirements for Butler-type buildings were similar to the above with the added necessity of preserving steel components. Metal shelves in the warehouses on Elmer required cleaning and repainting at approximate six-month intervals. This work provided a backlog for the employment of stevedores when their services were not required for handling cargo. Maintenance of the old style tents was confined to the patching of canvas, which deteriorated rapidly. The new style tents created more of a maintenance problem than the old type because they were not equipped with flies. These new tents leaked considerably during heavy rains; mastic applied to the canvas as a remedial measure did not satisfactorily alleviate this condition. Tents with outer flies appear to be the only solution to this problem.

Maintenance requirements were particularly heavy for such equipment as cranes, trucks, trailers, and tractors used for constructing the man-made islands and causeways. This equipment deteriorated rapidly since it was operated in sea water ranging from two to five feet in depth. Preventive measures included spraying the equipment with diesel oil and greasing movable parts as many as 4 times a day. At the end of each working day the oil cases were drained, flushed, and refilled with new oil. Even with the most thorough preventive measures salt water action seriously reduced the life of traction mechanisms. Because of these conditions older equipment was used. A liberal supply of spare parts was essential to prevent deadlining the equipment.

Upon completion of CASTLE, a major overhaul program was scheduled so as to have all marine craft in good operating condition for the next Operation. This plan involved the complete overhaul of 22 LCMs and 5 LCUs. As the craft could be deactivated after CASTLE, all machinery was removed for shop overhaul. All deteriorated or damaged hull parts

Figure 5-1. Typical Shot-Island Vehicle Repair Shop

were replaced, and the boats were sandblasted and painted. The machinery of all deactivated craft was mothballed and not replaced in the boats until required for service. When additional craft were acquired, they were inspected, overhauled if necessary, and modified to meet Jobsite requirements. Of the nine LCUs acquired, five were outfitted for use as houseboats.

Throughout REDWING, periodic inspections of the hull and mechanical parts of marine craft were made. The conditions under which landing craft had to operate were hazardous with respect to propellers, shafting, underwater bearings, and bottoms. Operating crews were required to keep a constant check and inform the dispatchers in case of required maintenance. A record of operating hours was maintained and the general overhaul of an engine was undertaken after approximately 3,500 running hours. Spare engines in good operating condition were kept available as replacements for units that required general overhauling. The scaling, scraping, and painting of hulls was a continuous operation.

The drydock (AFDL-5) was returned to Pearl Harbor for bottom cleaning and general overhaul in November 1954 and was returned to Jobsite in April 1955. During its absence from Jobsite, the scientific barge outfitting slip was used to perform work above the waterline on such craft as barges and LCUs.

All diving operations were performed by volunteers who could definitely prove previous training and experience. Divers were required to pass physical examinations and were re-examined quarterly. A total of 225 shallow water and 12 deep dives was required. These operations were necessary for repairing or installing submarine POL lines, inspecting water intakes and outfalls, recovering anchors, inspecting the ground tackle of moorings, and repairing submarine cables.

Due to the runway and parking apron deterioration resulting from intense use during Operation CASTLE, an improvement program for the Fred Airfield was authorized in July 1954. The early approval of this work, which involved the asphalt paving of approximately 300,000 square yards of airfield apron and the seal coating of 114,000 square yards of runway, permitted its accomplishment during a period of minimum air traffic. This work has been previously discussed in this report under Permanent Base Construction. The other airstrips in the Proving Ground were rehabilitated under the authority of construction work orders. Maintenance consisted of sweeping the runway on occasion and repainting the markers as requested by the Air Force.

Maintenance of the deep water pier primarily involved repairing damage to the catwalks caused by ships while docking. Due to the continuous need for this dock during the Operation, certain repairs involving the replacement of the dolphin and fender piling and repairs to the catwalk were postponed until the completion of REDWING. The earth-filled piers on Elmer and Fred were used extensively and required continuing repairs because of erosion from wave and current action.

Figure 5-2. Diver Emerging

The earth ramps used by the LSTs at Elmer and Nan required bulldozing with the arrival of each ship. Road maintenance consisted of the occasional use of the motor patrol equipment, especially after heavy storms, in order to maintain the surface. A water truck was used to allay dust during prolonged rainless periods. As a result of the fall-out caused by the Tewa event, all the base camp areas affected were decontaminated by grading. This work had to be accomplished both mechanically and manually in order to bring the radioactivity to acceptable levels.

The major shops for repairing refrigeration, power-generating, and water-distillation equipment were located at Elmer. All such equipment was thoroughly checked through the major shops before shipment to an off-island camp. Maintenance of this equipment at temporary camps consisted of routine servicing and incidental trouble shooting.

An unusual maintenance requirement developed due to the accidental shorting of one of the 1000 KW generators in the CMR plant. The rewinding of this generator could not be accomplished with the facilities available at Jobsite, and it was therefore shipped to Honolulu where the work was performed under a purchase order contract.

The steel tanks installed during Operation GREENHOUSE for storing salt and fresh water at Elmer and Fred had to be replaced prior to CASTLE and again for REDWING. Because of the relatively short life of steel tanks and their high maintenance costs, they were replaced with tanks made of redwood staves. At first, considerable leakage occurred at the seams of the wooden tanks; however, most of the leakage was eliminated by using seal coat. Due to operational requirements which did not permit removing the tanks from service, the completion of this repair work had to be postponed until the end of the Operation.

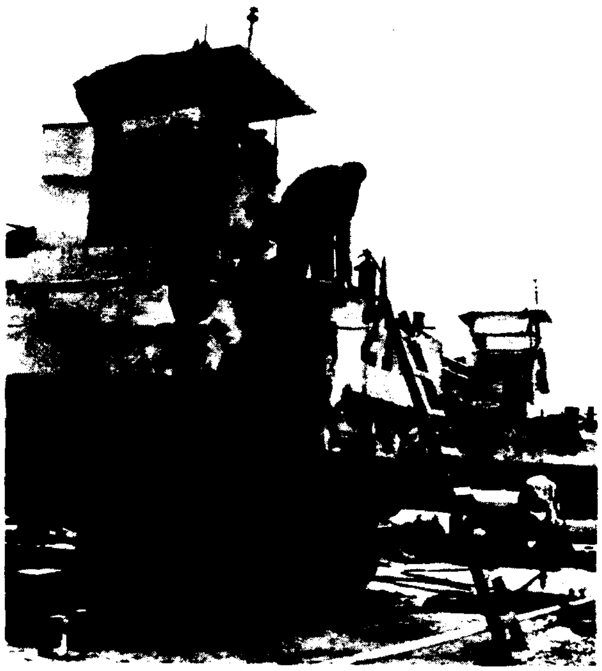


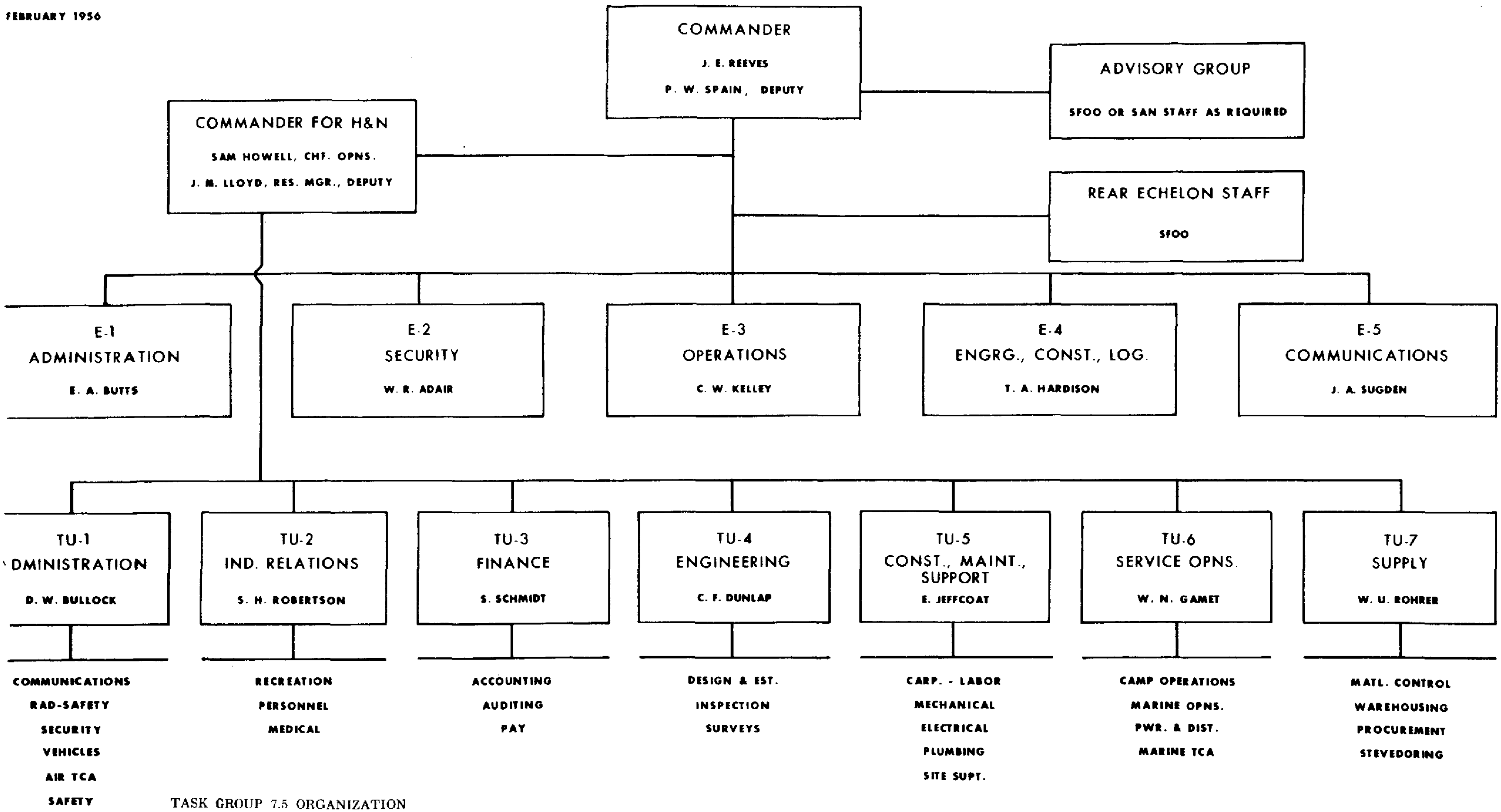
Figure 5-3. Paint Spraying-Marine Craft

Maintenance, though continuous throughout each Operation, will be intensified now that REDWING has been completed. Due to the magnitude of REDWING, equipment and facilities could not always be spared for routine work, and personnel normally engaged in servicing were assigned to higher priority jobs during the peak of activities; consequently, a considerable maintenance backlog has developed which must be accomplished shortly in order to offset deterioration economically. This accummulation of routine maintenance plus the usual post-operational equipment servicing and preservation will be a much greater job than previously experienced.

Figure 5-4. Berm Used for Protecting Equipment From Inundation - Nan

Figure 5-5. Post-Shot Damage Survey Team

FEBRUARY 1956



TASK GROUP 7.5 ORGANIZATION

CHAPTER VI
TEST OPERATIONS AND ROLL-UP

SECTION I
TEST OPERATIONS AND ROLL-UP

On 15 April 1956, the operational phase of REDWING commenced when the Commander of JTF-7 assumed control of all operational activities in the Forward Area. On 25 April 1956, a directive was issued covering preparations for the initial event (LaCrosse), which was to be executed two days in advance of the scheduled target date of 1 May 1956. All scientific stations and facilities were readied by this new target date; however, the test was not held until 5 May 1956 due to weather and other technical considerations. The schedule of the 17 events in the REDWING Operation is indicated in Figure 1-4 Chapter I. The last detonation occurred on 21 July 1956, and CJTF-7 relinquished operational control of the Forward Area on 10 August 1956.

To ensure adequate support to the various agencies involved in the test operations, the Contractor was responsible for the performance of the following tasks: (1) complete the construction of scientific structures and facilities which were held in abeyance until the execution of certain events; (2) provide support personnel, material, and equipment to assist in instrumentation and the recovery of scientific data; (3) adjust camp facilities and services according to the fluctuating population; (4) take measures for minimizing the effects of blasts, thermal energy, inundation, and radioactive contamination for the facilities, equipment, and supplies under Contractor custody, and provide like services for other participating agencies as approved by the AEC; (5) return surplus equipment, construction and materials to Elmer; (6) evacuate personnel from designated sites according to plan and at specified times, and maintain an accurate muster account on a continuous basis; (7) arrange for the evacuation and protection of pets; (8) employ proper measures to safeguard classified material from the evacuated sites; (9) ensure a continuous unattended operation of designated utilities for the various detonations; (10) arrange for rapid re-entry and re-establishment of the vital services at each evacuated site taking into consideration possible shot postponements and Rad-Safe requirements; (11) maintain the capability for operation from bases afloat, including the use of houseboats; (12) and establish safety precautions for glare, fall-out or shock waves and the alert signals used for possible evacuation.

Support services rendered during REDWING consisted of supplying materials or labor and equipment to perform whatever work was required by test participants in preparing facilities for the various events. In general, the work involved was of minor magnitude, but because each detail of the complex test technique was important, the men, equipment, fabrication, and materials furnished were a high priority concern of Management. The services were authorized by a work order directive from the Manager, EBO, at the request of a participating agency. These directives covered supplying construction equipment, skilled workers, shop repair and fabrication, post-test recovery and damage repair surveys, decontamination, button-up services for stations not participating in a scheduled event, and packing, crating, and shipping. Support services pyramided considerably in contrast to previous Operations due to the increased scope of the over-all test program and the services involved in "buttoning-up" various stations for protection against fall-out, blast, and inundation to ensure readiness for succeeding events.

Approximately one month prior to the initial event, a planning guide was issued which covered the proposed condition of readiness for each camp in successive events. This guide designated whether the camps were to be rolled-up, or left intact but evacuated, and also covered the disposition of personnel and equipment. A requirement of CJTF-7 from each Task Group was the preparation and submission of a check list covering duties to be performed for each event during the period of D−5 through D+3. These check lists covered major events and indicated when facilities could be secured and equipment moved, and which utilities were to be serviced for operation during shot time. The lists served as a guide to ensure that the activities of all participating units during that period were compatible with available support and consistent with authorized Rad-Safe procedures. From these lists, summaries were prepared of special helicopter and boat missions, support requirements, trailer and vehicle evacuation schedules, and communication checks. The summaries facilitated the planning for and the execution of the duties assigned the Contractor for placing all facilities in a state of readiness for each detonation.

Measures taken for protecting personnel, equipment, and property were governed by predictions of overpressures, thermal energy, radioactive contamination, and the extent of inundation as furnished by Task Group 7.1. Two conditions of test readiness were applicable to camps and related facilities. When damaging pressures were probable, camps and facilities were rolled-up, but when these conditions were considered remote, they were left intact. In the latter case, precautions were taken against blast, fall-out, and inundation as deemed advisable for each event. Test readiness measures relative to scientific facilities varied according to User request and were governed by whether or not a station participated in an event.

Camp roll-up was generally scheduled to commence on D−5 day and be completed by noon of D−1 day. Roll-up consisted of the removal of all equipment, materials, and supplies considered worthy of saving for shipment to Elmer from the Eniwetok Atoll camps and to Nan for subsequent transshipment to Elmer from the Bikini Atoll camps. Schedules of camp services and population forecasts covering the period of D−5 through D−1 day facilitated planning and execution of the tasks involved. Roll-up was accomplished according to these camp service schedules and in phase with personnel reductions at each site, with provisions for serving food continually through an early lunch period on D−1 day. Practically all of the expendable structures were left standing at shot-island camps. This procedure was considered more economical than dismantling the buildings, transporting the salvable materials to a main base, and processing them for future use.

For the first event (LaCrosse) this planning contemplated only the roll-up of the Yvonne camp and evacuating personnel to Elmer from the northern camps in Eniwetok Atoll. The Gene and Ursula camps were to be left in a condition for rapid re-entry. As a result of the widespread radioactive contamination of all islands north of Yvonne caused by the LaCrosse event, the Gene and Ursula camps were uninhabitable for 24-hour occupancy and were subsequently rolled-up. The Yvonne camp had been rolled-up prior to the detonation, and since this area was not contaminated, limited facilities were re-established. Some blast damage occurred in this area; however, repairs were effected for

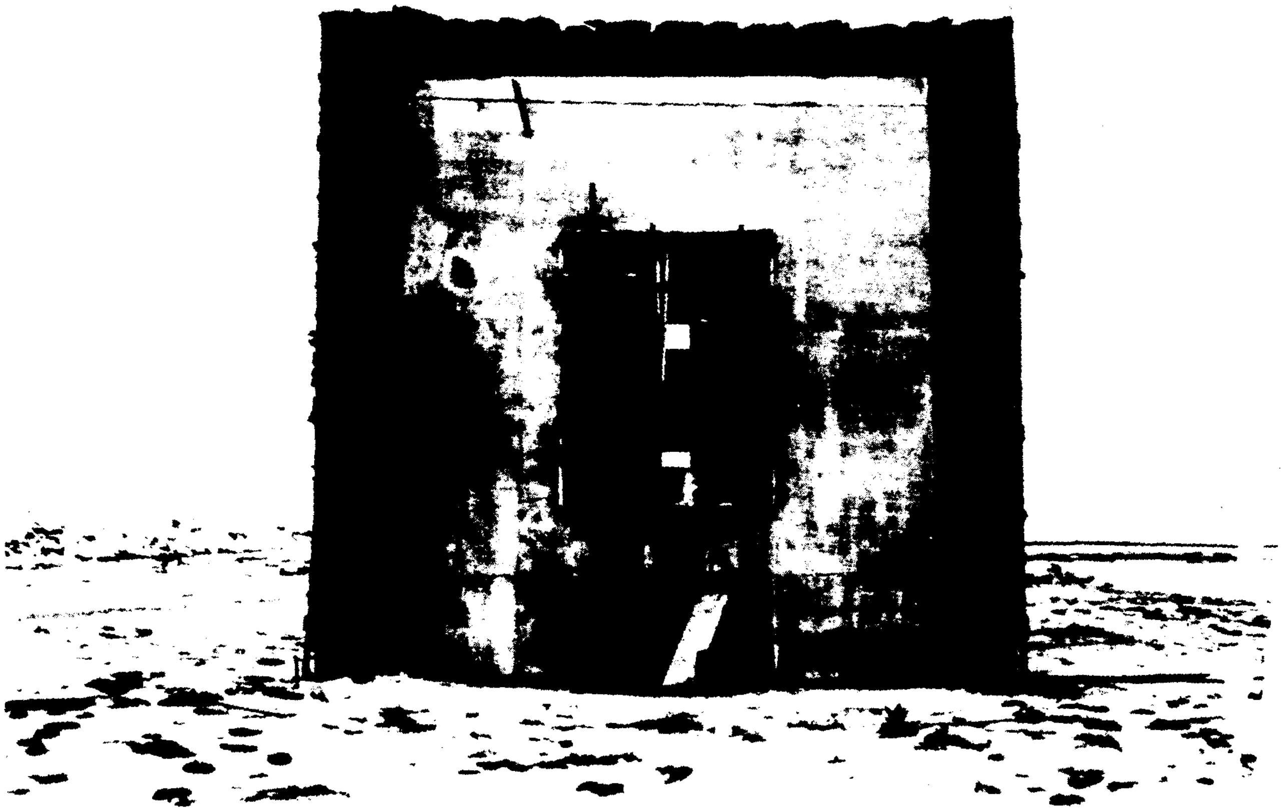


Figure 6-1. Use of Sandbags For Blast Protection

the expected short-term occupancy only. To support scientific groups in the Ursula Complex who were required to work at odd hours, limited camp facilities were established on a barge (Station 12), which was towed to and moored off this site. The Fox and Tare camps were rolled-up prior to the Cherokee and Zuni events, respectively.

Prior to the Cherokee event, the possibility of pressures damaging the remaining Bikini Camps (Nan and Tare) was considered remote. The windows and doors of buildings were left open; the sides of all tents were rolled-up; and furniture was moved to the center of tents. The fuel tanks of the power plants were covered with earth. The water towers and generator sheds were guyed with steel cables, using heavy mobile equipment as anchors. Because of size, the mess hall at Nan was shored both internally and externally, and the side panels were removed. Mess hall supplies, utensils, and critical items of equipment were covered with tarpaulins. Marine craft were anchored or buoyed off Nan with the exception of three LCMs, 11 DUKWs and the fuel and decontamination barges, which were evacuated to sea.

The protective measures employed for each detonation were similar to those accomplished for the Cherokee event with modifications as dictated by predicted effects from that particular test. For example, inundation at Nan was considered quite probable because of the Zuni event; as a protection against inundation, a large area south of the airport was cleared and surrounded by a berm about 4 feet high in which vehicles, vans, and other equipment could be placed. Critical facilities such as the power plant and Station 70 were also surrounded with berms. Protecting Nan against inundation from Zuni was accomplished before the Cherokee event inasmuch as radioactive contamination from Cherokee was possible, thus eliminating the need for performing this work in a contaminated area.

Planning for evacuation to sea from Bikini Atoll and for operations from bases afloat in case of unacceptable contamination at the camp sites was initiated early in the program. To meet requirements for bases afloat the USNS Ainsworth and the USS Curtiss were outfitted with additional communication equipment and com centers prior to their arrival in the Forward Area. Funds were made available to the USNS Ainsworth for providing mattress pads for use in troop berthing spaces. The following cabin and troop space allocations were made aboard the TG 7.3 vessels in order to accomodate Task Group TG 7.5 personnel during the evacuation of Bikini Atoll:

SHIP	CABIN	TROOP	TOTAL
Ainsworth	125	395	520
Badoeng Strait	5	20	25
Catamount	5	20	25
Curtiss	5	15	20
Estes	5	5	10
Totals	145	455	600

The muster and final accounting of all personnel scheduled to board the evacuation ships were delegated to one Personnel Supervisor at Eniwetok and Bikini Atolls, respectively, each acting under the title of TG 7.5 Evacuation Officer. Personnel were arranged in Muster Groups consisting of a Group Leader and a unit of men from the same department who were to board the ships simultaneously from the same location.

Each group varied in size and contained men with like working schedules who were assigned a specific time for assembly at a designated area. Group Leaders reported to one Muster Officer at each of the off-island sites; at Elmer, one Muster Officer was appointed for each department. When the Muster Officer was satisfied with the accountability of the men under his jurisdiction, he reported to the TG 7.3 Beachmaster stating that the group was ready for embarkation. The Beachmaster controlled the dispatching of boats that ferried between ship and shore. Upon boarding the evacuation ships, each group was checked again. The Muster Officer advised the Task Group Evacuation Officer upon satisfactory accountability, who in turn reported to the TG 7.3 Evacuation Officer on board the vessel and to the JTF-7 Evacuation Officer.

The evacuation of personnel to sea during Operation REDWING occurred at Bikini Atoll only. The capability for emergency post-shot evacuation was also maintained at Eniwetok Atoll. The evacuation plan for Eniwetok Atoll contemplated an accurate and detailed account of all personnel; airlifting employees to Honolulu who had accumulated radiation exposures above 2500 mr; provisions for emergency rations; designating assembly areas and embarkation points for each Task Group; and the allocation of berthing spaces afloat.

On 22 July 1956, preparations were made to evacuate the main base camps in Eniwetok Atoll because of the fall-out from the last event of the test series. The fall-out ceased after levels of 110 mr had been reached. The raising of the maximum permissible exposure (as discussed under Radiological Safety in this report), combined with effective decontamination measures, eliminated the need for evacuation of Eniwetok Atoll. A chronological schedule of the evacuations and re-entries at Bikini Atoll is shown in Table 6-1.

As a result of the experience with the loss of personal effects after the Bravo event of CASTLE, all employees required to evacuate a camp in this Operation were instructed to mail excess belongings stateside or forward them to Elmer for safekeeping. It was emphasized that the Atomic Energy Commission would not recognize individual claims for personal effects or equipment abandoned in an evacuated camp and consequently lost or damaged.

The re-entry plans for the evacuated sites covered measures to be taken in case of postponement, and for reoccupation consistent with safety from radiological hazards. The plans designated key employees by name and the duties assigned to re-entry personnel for checking operating units and rapidly establishing utility services. These first re-entry personnel were scheduled for evacuation by the Badoeng Strait, from which helicopters provided transportation to all the critical sites. In order to render emergency assistance for the Cherokee event, one Contractor Assistant Resident Manager and three utility servicemen remained in Station 70 at Nan along with the firing party.

In anticipation of the need for supporting scientific personnel who were required to work at odd hours in contaminated areas, five LCUs' were outfitted as houseboats. A houseboat operating manual was prepared, covering controls, safety and service. During evacuation periods these boats were moored off Nan, completely stocked and maintained in a state of readiness for early service after each detonation.

As the first target date approached and the work load decreased men surplus to the needs of the Operation were returned stateside. Reduction in personnel had to be cautiously approached. Men required to work in contaminated areas might receive the limit of permissible exposure necessitating their evacuation, and their replacements had to be available. The capability of providing construction and support services for events to take place in either Atoll had to be maintained.

For technical reasons, changes were made in the schedule of events. The Huron (Station 10) and the Apache (Station 12) events were re-scheduled to take place in the Mike crater west of Gene. Station 10 had actually been positioned in its originally scheduled location off Fox; all personnel had been evacuated to sea for this detonation and the count-down had reached minus two minutes when it was cancelled. The site of the Tewa detonation was changed from off Fox to a position between Charlie and Dog, and the Pawnee event was deleted from the program. The changes in site locations of Zero stations required modifications or additions to participating stations. An example was the reactivation of Station 1611, with the addition of a collimating wall for the Huron event rescheduled to the Mike crater. Station 1611 had been stripped of User equipment and had been partially mothballed. In the earthmoving operations required to establish a clear line of sight from Station 10 to Station 1611, radioactive levels of 2.5 roentgens were encountered. To keep from overexposing the operators involved with the earth moving, the seats of the equipment used were lead-shielded.

Most of the work sites were contaminated from the various test detonations. In order to keep from overexposing personnel, a greater number of men with a wider variety in job classifications were needed than would ordinarily be required. Illustrative of this was the repair of a break in an underground power cable at Yvonne resulting from the Erie event. The area was so highly contaminated that the work had to be accomplished in 15-minute shifts to limit the dosage of each person involved to 2.5 rs. The work group actually effecting the repairs consisted of a DUKW operator, Rad-Safe monitor, laborers, and electricians. Such a break in an uncontaminated area would normally require two or three men to effect repairs.

The fact that the forward base at Nan re mained uncontaminated throughout the tes period greatly facilitated operations in Bikin Atoll. Considerable damage was incurred t buildings and facilities along the lagoon beac as a result of inundation at the time of th Navajo event. A number of buildings were d stroyed, several transformers were shorted, co siderable shore line erosion occurred, and de fish and silt were deposited in the inundat area. Temporary repairs and clean-up w effected as necessary in order to continue w test operations.

A damage survey was made after each onation for reporting purposes and for de mining the repairs required for the facilities ticipating in succeeding events. Informatior damage incurred is not included in this re as post-shot damage reports have been forwa to the Atomic Energy Commission.

EVACUATION AND RE-ENTRY SCHEDULE

BIKINI ATOLL

EVAC. NO.	EVENT	TOTAL PERSONNEL TG 7.5 EVACUATED	EVACUATION START HOUR	EVACUATION START DATE	EVACUATION COMPLETION HOUR	EVACUATION COMPLETION DATE	EVACUATION DTG REPORT HOUR	EVACUATION DTG REPORT DATE	RE-ENTRY START HOUR	RE-ENTRY START DATE	RE-ENTRY COMPLETION HOUR	RE-ENTRY COMPLETION DATE	REMARKS
1	CHEROKEE	560	1000	5/10	*2000	5/10	NO REPORT		1000	5/11	1200	5/11	*Event postponed 2000 hours on 5/10. Only essential personnel for operation of Nan returned to shore. 166 remained afloat.
2	CHEROKEE	529	1100	5/16	2005	5/16	2010	5/16	1000	5/17	1130	5/17	Event postponed. Essential personnel for refueling, etc. sent ashore. Balance remained afloat.
3	CHEROKEE	528	1400	5/17	2130	5/17	2137	5/17	1030	5/18	1400	5/18	Event postponed. Essential personnel for operation of Nan sent ashore. 140 left afloat.
4	CHEROKEE	505	1100	5/20	1950	5/20	1957	5/20	1100	5/21	1245	5/21	27 (Tare) personnel remained afloat.
5	ZUNI	494	1100	5/27	2000	5/27	2008	5/27	1100	5/28	1400	5/28	53 (Tare) personnel remained afloat 24 hours pending phase-out scheduling, etc. to site Elmer.
6	FLATHEAD	418	1600	6/11	2305	6/11	2310	6/11	1000	6/12	1140	6/12	
7	DAKOTA	399	1700	6/17	2000	6/17	2024	6/17	0900	6/18	1030	6/18	Event postponed.
8	DAKOTA	393	1800	6/18	*2000	6/18	NO REPORT		2000 ***0730	6/18 6/19	**2045 0830	6/18 6/19	*Event postponed 2000 hours. **Balance of personnel returned ashore. ***Balance of personnel returned ashore morning of 6/19.
9	DAKOTA	388	1800	6/21	2025	6/21	2032	6/21	0900	6/22	1045	6/22	Event postponed.
10	DAKOTA	386	1700	6/25	0010	6/26	0016	6/26	1000	6/26	1130	6/26	
11	HURON	371	1700	7/1	2050	7/1	2056	7/2	0900	7/2	1030	7/2	Event postponed. Subsequently cancelled this site and transferred to site Elmer.
12	NAVAJO	**354	1800	7/8	*2100	7/8	NO REPORT		2100	7/8	2200	7/8	*Event postponed 2100 hours. Only partial evacuation scheduled prior to 2100 hours. Those evacuated were returned ashore by 2200 hours on same night.
13	NAVAJO	352	2000	7/10	0225	7/11	0231	7/11	*1000	7/11	1430	7/11	*Essential personnel for clean-up and repair only. Balance started re-entry 1230 hours.
14	TEWA	332	1910	7/20	0225	7/21	0033	7/21	0900	7/21	1015	7/21	

Table 6-1. Evacuation and Re-entry Schedule - Bikini Atoll

The term "roll-up" is applied to the recovery of all equipment and materials in excess to the needs of any site or at the close of test operations, and putting same in such a state of repair and preservation that only minimum maintenance will be necessary until reuse is required. For record purposes, the work connected with roll-up was placed in two categories: (1) construction and camp equipment; (2) equipment in scientific stations.

Roll-up commenced when heavy construction neared its end. After serving its purpose, equipment was returned to the main base at Elmer where it was scheduled for overhaul, including sandblasting, painting, and application of other preservatives before being placed in storage. Roll-up of camp facilities proceeded as a parallel operation along with the preparation of various sites for scheduled test events as previously noted. With the exception of a few buildings that could be removed bodily, expendable buildings at shot-island camps were not salvaged.

Roll-up of the equipment in scientific stations will be accomplished by preserving equipment in place whenever feasible. This is a change in the method used at the end of Operation CASTLE when the equipment was dismantled and shipped to Elmer for processing and storage. Some damage was incurred in the dismantling and shipping, and in some cases items lost their identity with respect to a specific station. To eliminate these unsatisfactory conditions, preservation processing will be accomplished in place and will include cleaning, painting, and the application of preservatives and weatherproof covering. All stations will be cleaned and enclosures will be sealed with weatherproof paper. Only such equipment as motors, electrical generators, and certain electronic items requiring dehumidified storage will be returned to Elmer. All items will be properly tagged to identify them with the specific station from which removed. Periodic inspections are planned after test operations, and maintenance will be undertaken as necessary to keep equipment in good condition.

Roll-up of off-atoll installations was effected as transportation could be made available. Roll-up of each site was completed as follows: Kapingamarangi 27 July; Ujelang 31 July; Kusaie 26 July; Tarawa 29 July; Uterik 5 August; Wotho 6 August; and Rongerik 7 August.

The post-test roll-up in Bikini Atoll was completed by 15 August 1956 and the Nan camp was evacuated on that date. Prior to this evacuation, all wooden buildings were painted with one coat of aluminum paint. Limited camp and construction equipment was left at this site for the use of maintenance crews that will be sent to Bikini Atoll when transportation is available. Included in the equipment left at Nan was one Osgood crane, a surveyed tractor, two surveyed trucks, a 30 KW generator, one small distillation unit, an M-boat, and a DUKW. The limited facilities left at Nan will eliminate the need for frequent water transportation since crews can be airlifted and self sustaining for the anticipated short periods of the maintenance calls. The successful integration of User agency requirements wih the mechanics of personnel assignment, transportation, radiological safety, and evacuation was made possible by the cooperative spirit exhibited by the various components of the Joint Task Force. Through mutual application and cooperation, problems that arose were adequately resolved and Operation REDWING proceeded to a successful conclusion.

THE END