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Special Rereview
Final Determination

COMPLETION REPORT

U. S. ATOMIC ENERGY COMMISSION
CONTRACT NO. [illegible]

ENIWETOK PROVING GROUND FACILITIES

DECLASSIFIED BY WASHINGTON
DECLASSIFICATION TEAM, WEEKS OF
JULY 10 & JULY 17, 1972
CECIL PEARSON

VOL. III
CONSTRUCTION

PROPERTY OF
U. S. GOVERNMENT

HOLMES & NARVER, INC.

LOS ANGELES, CALIFORNIA

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H.F.C. 2-12-[illegible]

Reviewer Class. Date
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September 1951

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SHN-1497

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COMPLETION REPORT

U. S. ATOMIC ENERGY COMMISSION
CONTRACT NO. AT-(29-1)-507

ENIWETOK
PROVING GROUND FACILITIES

VOL. III

CONSTRUCTION

HOLMES & NARVER, INC.
LOS ANGELES, CALIFORNIA

1 September 1951

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~~CONFIDENTIAL~~

per H&N 5/7/57

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COMPLETION REPORT

ENIWETOK PROVING GROUND FACILITIES

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CONSTRUCTION

CHAPTER 6.1

INTRODUCTION

The scope of the construction work performed by Holmes & Narver, Inc. in connection with the development of the Eniwetok Proving Ground during the period between January 1, 1949 and July 1, 1951, involved a total cost of approximately $25,000,000. It embraced the construction of extensive base facilities, scientific structures, and special facilities needed in connection with scientific structures and special military structures used for test purposes. This construction was carried out at fifteen locations throughout Eniwetok Atoll which were separated by from one to twenty-two miles of water.

The approach to the establishment of a construction plan for this Project contemplated primarily the problems peculiar to construction in overseas areas. This type of construction usually (for reasons which appear herein after) involves a very high labor cost with consequent necessity, on the part of those charged with construction responsibility, for attention to economies which may be realized by prefabrication and careful organization, special attention to scheduling, and particular attention to factors necessary to maintain high morale during the construction period. It should be noted in connection with the last point that during this overseas project (in contrast to ordinary overseas work) the obligation of the contractor did not cease at the end of the working day, but rather that attention was required twenty-four hours of each day to the health, morale, and general welfare of the overseas employees. The conventional approach to an overseas project, moreover, was, in the case of this project, modified by the following special conditions:

1. No basic facilities were available to support an immediate move of a substantial number of men to carry out construction activities.

2. No local labor market existed, nor a local supply of materials.

3. At the outset, a radioactivity hazard existed which had to be removed before substantial numbers of people could be introduced.

4. The separation of various units of work by water created a transportation handicap requiring the establishment of a water transportation system for both supplies and men.

5. Stringent security regulations existed for this Project.

In the light of the noted conditions which affect overseas construction in general, and those special conditions particularly applicable to the Proving Ground development, plans for construction established predetermined phases to permit a gradual build-up of on-site personnel. This build-up was related to the special problems existing at the site and was also in phase with the planned availability of working drawings, and the availability of materials and supplies as governed by the availability of funds with which to initiate procurement.

In spite of the apparently long period of time allowed for construction when the initial planning was done in the latter part of 1948, the schedule established for the construction of the base facilities then contemplated was relatively tight, in keeping with a philosophy of limiting overseas manpower to a minimum. This was done in order to leave a maximum amount of time for the construction of scientific structures and stations since the extent of this portion of the development program was quite indefinite.

Expansion of the required base facilities would of necessity affect planning, as would the expansion of requirements for scientific structures and stations. However, if the plan were sufficiently flexible, the non-availability of funds in the early phases of construction, the increases in required base facilities, and the construction effort which would be related to actual test structures might cause temporary set-backs, but would not cause irreparable delays in the over-all completion in time for test operations in the early part of 1951. Developments through 1949 and 1950 indicate that the plan was sufficiently flexible. The expansion of activities from the arrival of the first small group to initiate a beachhead to the peak which came late in 1950 was continuously progressive. Factors which retarded progress were quickly noted and remedial efforts were effective.

The details and progress of the constructon activities carried out under Job 3 of Contract AT-(29-1)-507 are reported hereinafter under three main headings: Beachhead Establishment, Construction of Base Facilities and Scientific Structures, and Construction for the Military Structures Program. Each of the sections is intended to portray the interrelationship of all of the factors affecting the work; the significant decisions made in connection with construction and the reasons for those decisions; and, lastly, details of the scope of the construction effort, together with relevant statistics.

CHAPTER 6.2

BEACHHEAD ESTABLISHMENT

The period of time designated Phase I of operations at the site, covering approximately six months from January to June 1949, was devoted to the establishment of a beachhead by engineering and construction forces. It will be recalled that the Reconnaissance Report, in view of the time scale for the entire Project as contemplated at the beginning of 1949, had established a construction plan, chosen in the interest of economy, which avoided building a construction camp. In keeping with this basic premise, Phase I operations were designed to enable relatively few people to move to the Atoll without imposing an undue burden on the garrison forces and to rehabilitate, in only barest essentials, existing structures and facilities on Eniwetok Island to the extent necessary to support the group required for initiating construction of the Parry Island base facilities. As noted during the reconnaissance survey, the garrison, in view of the limitations of personnel, supplies, equipment, and housing, was in a position to support a group of not more than 30 visitors. Within such limitations, therefore, personnel chosen to carry out Phase I operations at the Proving Ground were selected on the basis of versatility and necessity for the capabilities they possessed.

The objectives established for the group were broadly:

1. To inaugurate working relations with the military garrison at Eniwetok and with its support and command center at Kwajalein.

2. To test in actual operation the arrangements made for supply and logistic support required for civilian construction operations at the site.

3. To complete such field surveys, topography, and hydrography as required for detailed planning and designing being done concurrently at the Engineering Division design office in Los Angeles.

4. To conduct further tests on existing submarine cables to determine the rate of deterioration of these expensive and vital items and to establish the utility of each cable for future operations.

5. To carry out clean-up and blading operations in an effort to reduce the intensity level of radioactivity at the detonation sites employed during Operation Sandstone. It was necessary that the intensity level be reduced to a point which would permit extensive operations over long periods of time without hazard to personnel.

6. To rehabilitate, to the barest minimum extent, facilities for housing and feeding construction forces and for warehousing

and servicing materials and equipment required by anticipated construction operations to be carried out in the later phases of the program.

WORKING RELATIONS WITH THE MILITARY

It had been arranged in early meetings at Cincpac that the garrison forces at Eniwetok would support Phase I operations by the following services:

1. Providing subsistence and housing space.
2. Stevedoring and off-loading of the small quantities of supplies which would be required by H & N group during the Phase I period.
3. Operating intra-island small boats.
4. Operating liaison type planes within the Atoll.
5. Providing radio communication with Hawaii and the Mainland.
6. Providing auxiliary services including mail handling, PX facilities, movies, and the like.

On the basis of these arrangements the first contigent of H & N forces left Los Angeles on February 2, 1949. Included in the group, which totaled 9, were the Acting Resident Manager, a Construction Foreman, Chief of Surveys, Instrumentman, Chief Electrical Engineer, an Electrician, a Carpenter, a Heavy Equipment Mechanic, and a Heavy Equipment Operator. The group was accompanied by two Radiological Safety Monitors from the Los Alamos Scientific Laboratory.

Upon arrival at Kwajalein, meetings were arranged with the Commanding Officer, and such items as the cashing of Holmes & Narver checks, the ownership of POL supplies stored at Eniwetok, and the ownership of miscellaneous equipment, material, and supplies at Eniwetok were discussed. The high plane of cooperation was immediately evident and a satisfactory solution of all details was accomplished.

In view of the nonexistence of records covering POL supplies and material,equipment, and other supplies located at Eniwetok, the assumption was made that all of this property should be utilized by the AEC contractor in the furtherence of the program.

At Eniwetok, in keeping with the earlier undertaking at Cincpac, arrangements were made by the garrison to house the H & N group in a modified two-story quonset structure which proved to be habitable and adequate for the purpose with only minor repairs.

Subsistence was also provided; but, because Eniwetok Atoll was not a direct military supply line, the food served there was not as tasty as might be desired. The burden placed upon the garrison by even the small initial beachhead was reflected in the preparation of the food as well as in the service and conditions of utensils and table.

However, no conflict with the military establishment on this score was evident and excellent working relations between the garrison personnel and the "pioneer" group were soon established. Both groups attempted cooperatively to find the solution of problems as they arose. Thus, for example, the recruitment of camp attendants was expedited and the arrival of two men in this classification with the second H & N contingent on Feb. 14, 1949, helped the mess-barracks problem materially. During the off-loading substantially all other activities at the Jobsite were stopped.

Reports of the inability of the garrison to support even the limited number of H & N personnel were forwarded to the Home Office in order that the build-up of the garrison forces to planned levels might be expedited through Atomic Energy Commission channels; but, although augmentation of the garrison did take place during Phase I operations, it was evident that an all-out effort would have to be made to establish, at an early date, facilities for the subsistence and housing of H & N forces.

SUPPLY LINE AND LOGISTIC SUPPORT

Shipments to Eniwetok during this period were, normally, by way of Kwajalein. That is, materials destined for Eniwetok Atoll were transshipped at Kwajalein to LST's operating on approximately a weekly schedule.

As noted above, the supply line to Eniwetok was a spur of a main line which originated at San Francisco and passed through Oahu and Kwajalein. Plans had been made for direct freight service to Eniwetok which would eliminate the transshipment at Kwajalein; however, it was not until April 15, 1949, that the USS GRAFFIAS arrived at Eniwetok with the first shipment of H & N materials and supplies, together with routine supplies for the garrison. Arrangements had also been made for air freight shipments to Eniwetok, but, in this line of supply as well, transshipment at Kwajalein was necessary and a shuttle plane was operated between Kwajalein and Eniwetok on a somewhat haphazard schedule. Thus, it was not unusual that air freight shipments and mail accumulated at Kwajalein for considerable periods of time during the early part of Phase I. The schedule of this plane service was ultimately improved through efforts of the AEC, and semi-weekly service was achieved.

Refrigerator ship service to Eniwetok was initiated during the Phase I period. The first shipment of refrigerated cargo arrived at Eniwetok on May 19, 1949; thereafter, a regular monthly schedule was maintained.

SURVEYS

Upon arrival at the site, arrangements were immediately made by survey personnel to expedite the flow of survey data to Los Angeles.

In order to permit site planning to move ahead on schedule, data for contour maps and the location of high-tide lines on Parry, Runit, Aomon, and Engebi were first obtained. Survey personnel commuted from the base camp at Eniwetok Island to each of the other locations by M-boat or L-5 aircraft as available. The time consumed in moving personnel and equipment around the Atoll in these early days and the shortage of personnel contributed to the difficulty of the task. However, within two weeks from the date of arrival at Eniwetok, the initial increment of survey information needed for design by the Engineering Division at Los Angeles was mailed.

The schedule established for the accomplishment of the surveys required during Phase I operations was ambitious and was based upon the use of a number of survey crews. Unfortunately, problems connected with housing and messing additional personnel, which are discussed elsewhere in this chapter, prevented the accomplishment of all of the work scheduled for the period. However, by dint of long hours in the field, the major portions of the data required for design during this period were delivered on time.

All usable existing structures on the Atoll were located. The hydrography for the Rojoa Causeway and for all piers planned for the Atoll was accomplished. Reconnaissance was carried out for the triangulation which was to be performed during later phases of the program. This reconnaissance included the location of monuments established by the BOWDITCH and Sandstone surveys. In addition to these activities, the survey group carried out various odds and ends of work such as staking the sites of minor construction required for the interim camp at Eniwetok, the location of the POL facilities on Eniwetok, preliminary staking for initial construction on airstrips, and other items of high priority work.

One of the more unusual assignments involved crosssectioning the crater areas around the Sandstone detonation points. The details of the procedures used and of the data obtained appear elsewhere in this report and in the files of the operation.

CABLE TESTING

Cable testing similar to that carried out during the reconnaissance survey in 1948 was performed during February and March of 1949, and the usuable condition of the existing underwater cables and cable stored at Parry was firmly established by the data obtained. Details of the methods employed and the resulting data are given elsewhere in this report, but at this point it might be noted that the procedure involved established the copper conductivity and insulation resistance of each pair of wires in each cable. Two men were required to do the testing, and a "Megger" and a Wheatstone Bridge were used in making the required measurements. OCM transportation was provided to enable the men concerned with this task to prepare terminals for testing and to make and record the required measurements. These tests indicated, in general, that the 750,000 linear feet of existing submarine control and signal cable tested would be usable for operations in 1951.

In addition to performing tests on installed submarine cable, action was taken during the beachhead operation to locate, test, and properly warehouse surplus submarine cable and signal cable not installed, but remaining at the Jobsite from Operation Sandstone. A total of 137,000 feet of this cable was tested and found to be in good condition. Because much of it had been left on reels and exposed to the elements, arrangements were made for inside storage of the entire surplus supply. It might be noted that all of this existing cable was subsequently installed to meet the growing requirements encountered.

DECONTAMINATION ACTIVITIES

On February 20, 1949, after the arrival of additional heavy equipment operators, and the rehabilitation of the equipment made available at Eniwetok, an attempt was made to reduce the radioactivity level on Engebi by a simple grading operation.

A representative of the AEC on matters of radiological safety supervised these trials. The initial grading operations created a dust cloud and it was considered possible that radioactive particles might well be included in the cloud, thus creating an additional hazard to personnel involved in the operation. Further trials were conducted during which a fire hose was employed to wet down the area being graded. Inasmuch as the area on which work was being performed had previously been paved with asphalt, penetration of the water to the hazard-forming sand beneath the surface was incomplete when this method of "watering down" was employed. As a consequence, no improvement over the first trials was evident.

Activities on decontamination were halted, and consideration was given to other possible schemes. For example, it had been suggested that a hydraulic dredge could be employed and the highly contaminated crater areas remaining from Operation Sandstone could be covered with uncontaminated materials dredged from the lagoon. The possibilities of this plan were pursued to the extent that the closest available dredge was located. However, when the situation was analyzed, it was determined that the available dredging equipment would need extensive repairs and that it would arrive at the Atoll so late as to seriously interfere with established schedules for construction activities. In addition, it was questionable as to whether or not the dredge could be successfully negotiated through the coral-studded lagoon waters adjacent to the islands. The availability of sufficient sand to complete the operation was another factor which was seriously questioned.

When the situation appeared to have reached a stalemate; the suggestion was made by H & N personnel engaged in the decontamination operation at the site that prior to and during scarifying, grading, transporting, and filling operations, the use of continuous and prolonged spraying by overhead irrigation equipment might alleviate the hazardous condition. This proposal required simple, low cost, portable equipment including pumping equipment, quick-coupling aluminum pipe line, and "Rain Bird" type sprinklers distributed along the pipe line.

It was believed that the spray from the sprinklers would be of sufficient density to penetrate the spaces between the pavement segments and completely moisten the underlying dry sand. It was further proposed that in employing this technique the wet pavement could be scarified, removed, and deposited in the deep portion of the crater and thereafter covered by uncontaminated materials.

A token quantity of the equipment and materials required for a trial of these suggested procedures was shipped to the Jobsite and, at the end of May 1949, in the presence of radiological survey experts called in by the AEC as consultants on the problem, trials were performed. It was immediately apparent that the proposal was sound, and the methods outlined were followed in the later accomplishment of the decontamination of the crater areas.

Other decontamination activities included the removal of the steel stumps and the foundations for the Sandstone towers, and the gathering and dumping of all debris remaining on the Sandstone experiment islands. Metal fragments within a 1000 foot radius of the old zero points were found to be contaminated to a considerable degree, and their removal involved picking up the pieces individually and ultimately dumping them at sea.

All personnel engaged in decontamination operations wore adequate protective clothing and equipment (such as goggles and masks) when required. Film badge dosimeters were worn and care was taken to avoid exposure beyond tolerance dosage. Lectures by the radiological safety monitors were of considerable importance for indoctrination purposes and in avoiding unjustified fears of the hazards involved, thus materially expediting the accomplishment of the work.

ESTABLISHMENT OF CAMP AND WAREHOUSING FACILITIES

It was hoped that the advance field forces would be able to establish a base camp on Parry Island capable of being expanded to accommodate the additional personnel required to construct the base facilities planned for that island. In keeping with the philosophy that no construction camp, per se, would be established, it was originally thought that some of the existing facilities on Parry Island could be rehabilitated to a sufficient extent to serve as an interim camp until the semi-permanent barracks and mess hall included in the the base facilities plan for the island could be completed.

Upon examination of the existing quonset buildings on Parry and careful consideration of the factors limiting transportation between Eniwetok and Parry, communication problems, and the personnel and material required for the rather extensive rehabilitation and repairs which were necessary, it appeared to be more economical to reactivate a portion of the existing facilities on Eniwetok Island as an interim base camp from which construction operations could be expanded. Warehousing space on Parry was available and, as a consequence, no change was necessary in the plan which provided for initial shipments of material and equipment required for Parry construction being off-loaded and stored on Parry Island. In view of (1) the limitations on personnel, (2) the shortage of materials for specific features of construction due to the small amount of funds allocated to the Project during this period, and (3) the time required for procurement and transport of these materials to the Jobsite, the plan to set up the initial camp on Eniwetok appeared to be justified. As a result, as much effort as possible with the small group on hand was devoted to the rehabilitation of existing buildings at the northerly end of Eniwetok Island.

Quonset buildings at the area were converted into barracks through the employment of a small amount of labor and a small amount of locally available material. The building previously used during Operation Sandstone as the Air Task Group mess hall was repaired and rehabilitated. Two existing ranges were overhauled, repaired, and placed in operative condition, as was a walk-in refrigerator which had previously been surveyed. Power and lighting were made operable and the facility generally cleaned up. The early procurement and timely arrival of surplus messware and kitchen equipment from the AEC Hanford installation permitted the early activation of an independent mess.

For frozen and chilled storage of perishable foodstuffs, a large battery of unused reefers located near the south end of Eniwetok was repaired and reconditioned. The storage space available was shared with the military garrison. In the accomplishment of this task many parts required for the refrigeration units were salvaged from junk heaps or cannibalized from inoperative units which had not yet been surveyed.

Three abandoned 75-kw diesel engine generator units located on the island were made operable and were entered on the property lists of the AEC. These units were moved to a central location within the contemplated camp area, and a lean-to shelter was constructed for protection from the weather. Twelve small water distillation units which had been used during Operation Sandstone were also located on the island. These units had not been operated since the early summer of 1948 and had deteriorated badly. A considerable store of spare parts for these units was discovered in a warehouse on Eniwetok, and these, with the addition of some critical parts supplied by airlift from the West Coast, permitted rehabilitation to be undertaken. Time was expended on this rehabilitation progress in consonance with the requirement for additional fresh water occasioned by population increases. Initially, water was distilled for use only in connection with the mess hall; brackish water for washing purposes was hauled from an existing well located adjacent to the airstrip. By mid-April 1949, the accomplishment of the campsite was in sight and permission was requested to raise the limit of the civilian population at the Atoll. Approval by all interested agencies was forthcoming, and, on June 1, 1949, one month ahead of schedule, the mess hall on Eniwetok Island was opened for operation. The beachhead forces thus became entirely selfsustaining, from the standpoint of subsistence and lodging, and in a position to cope with the augmentation program necessary for the prosecution of the remainder of the Project.

EQUIPMENT

It had been noted during the reconnaissance survey that some heavy equipment was available on Eniwetok Island; in addition, arrangements had been made with Cincpac to ship to the Atoll for use by personnel a motor patrol, a carryall scraper with an extra power unit, a portable machine shop, a portable water pump, a D-8 Caterpillar tractor with bulldozer blades, a crane with a boom and bucket, and four jeeps. This equipment arrived at the Atoll prior to the arrival of the first group of H & N personnel assigned to beachhead duty and was stored by the garrison.

During April 1949, it was learned by H & N representatives through the Division Engineer, Corps of Engineers, San Francisco, that an engineer battalion was completing work on Guam, and it was thought that a considerable amount of equipment could be procured by the AEC through the interagency transfer. Representatives were soon on their way to Guam to inspect the equipment available and to initiate the transfer. At Guam, the District Engineer insisted upon a transfer of funds far beyond that originally thought necessary in the San Francisco negotiations; but after considerable bargaining, certain items were purchased through the AEC.

While on Guam in connection with this transaction, the H & N representatives learned that the Department of the Navy had, on Guam, a considerable amount of equipment that it was willing to transfer to the AEC at no cost. While a substantial part of this equipment was in poor condition, a careful study revealed that it could be transported to Eniwetok within a very short time and that, in view of this factor, the cost of some rehabilitation would be warranted. Some of the equipment chosen for transfer was not serviceable but did contain operative parts which could readily be cannibalized and used for the repair of other pieces. In all, it was felt that a substantial pool of heavy equipment and parts could be accumulated very rapidly through this source and that the ultimate cost to the AEC of the resulting usable equipment on-site at Eniwetok would be a small fraction of the actual value. (It is noted that many of the basic pieces of equipment thus obtained from the Navy are still in use on the Atoll.) In any event, after completion of arrangements at Guam, further arrangements were made through Cincpac for the transshipment of the heavy equipment and parts from Guam to Eniwetok in connection with the shipment of six LCT's from Sasebo, Japan, to Eniwetok. This transfer actually took place with the arrival at Eniwetok of two LSD's, one on May 29, 1949, and the second on June 22, 1949.

Upon the arrival of the LCT's and the heavy equipment from Guam, heavy equipment mechanics, operators, and laborers were immediately assigned to the rehabilitation and repair of those items most urgently needed. The rest of the heavy equipment was stored on Eniwetok and later moved to Parry to be rehabilitated as needed.

COMMUNICATIONS

Radio communication between Eniwetok, Oahu, and the mainland during this phase of the Project was carried out through military channels. In view of the security classification of many of the facts surrounding activities at Eniwetok, a major portion of the messages transmitted through these channels required burdensome and time-consuming cryptographic treatment.

The procedure at the Eniwetok end of this link between the beachhead group and the Los Angeles Home Office involved preparation of the message by the Resident Manager, submission of the message to the Atoll Commander, who in turn, and after approval, passed it to the Signal Officer for the accomplishment of transmission in code or in plain text as required by the classification of the information contained in the message. At the Los Angeles end of the link the procedure included the preparation of the message at the Los Angeles office, dispatch of the message by armed courier to the Naval Communications Center at Long Beach, California, and transmission from there. The courier made two trips daily and picked up all incoming messages for delivery to the designated recipient through Home Office channels. The time required for the transmission of messages from sender to recipient generally was about 48 hours, although occasionally three to four days elapsed. Delays were generally caused by the necessity for coding and decoding practically all messages and the need to recheck messages garbled during transmission.

Generally this line of communication was adequate and, in view of the fact that mail delivery was haphazard by reason of transshipment of air mail at Kwajalein, the teletype communication service helped to keep beachhead operations moving ahead.

Intra-Atoll communication was handled by the utilization of the submarine control cables installed during Operation Sandstone as a trunking facility, and by portable radio transmitters and receivers obtained through the military establishment. Field telephone instruments were installed at the Sandstone Control Station on Parry Island, within the timing stations on Runit, Aomon, and Engebi, and at the Coral Head tower in the lagoon.

These facilities were used frequently to coordinate the activities of the groups scattered through the Atoll during this phase of operations and was of material assistance in the accomplishment of the triangulation surveys performed later.

PERSONNEL

The establishment of the beachhead as originally planned called for the gradual augmentation of forces to the maximum population agreed upon (30 individuals) until the H & N forces became self-sustaining. At this time it was proposed to initiate the augmentation of overseas forces which would be carried out rapidly through the balance of 1949 to a total of slightly under 600. As already noted, the first group of nine employees was chosen for versatility. They were followed in two weeks by a second group of thirteen, including clerks, camp and mess hall attendants, heavy equipment operators, laborers, chainmen, a truck driver, and a mechanic. In the second group, the choice was made of classifications essential to the activities assigned the highest priority. For example, the recovery of property, and the inventory of same, was necessarily an immediate task. Camp attendants were essential, in view of the inability of the garrison to augment their own forces at a fast enough rate. Details of the build-up are given in Table 6.2-1, which shows the classifications of on-site employees at various dates during Phase I.

TABLE 6.2-1. PHASE I PERSONNEL AT ENIWETOK

	Feb.		Mar.	May				June				
Classification	4	18	20	10	18	21	29	1	11	18	26	29
Administrative	1	1	1	1	1	1	1	2	2	2	2	2
Engineering	3	4	4	5	5	2	7	7	7	7	7	7
Warehouse						4	4	5	5	7	13	16
Clerical		2	2	2	3	4	6	8	11	11	11	13
Kitchen & Camp		2	2	3	5	7	8	8	10	12	15	14
Maintenance & Construction	5	13	16	18	22	27	32	37	43	50	53	54
First Aid							1	1	1	1	1	2
Total	9	22	25	29	36	50	59	68	79	90	102	106

It will be noted from the chart that support of the garrison forces by H & N personnel was initiated at an early date and continued until the H & N interim mess hall on Eniwetok Island was opened on June 1. Thus, in effect, from a very early date, except for the actual occupation of the mess hall, the subsistence and lodging of H & N personnel was substantially carried by H & N forces. This contribution by H & N forces to their own support materially assisted in establishing the good working relationships with garrison personnel which were maintained at a very high level throughout the beachhead period.

The establishment of the Resident Manager took place during this period as had been originally planned and, to assist him in camp operations during ensuing construction, a Camp Manager arrived at the site on May 15, 1949. The opening of the mess hall already noted and the consequent establishment of the beachhead group as a self-sufficient unit from the standpoint of messing and housing permitted the arrival of personnel earlier than scheduled in the Reconnaissance Report and materially expedited the completion of most of the features of work contemplated during the Phase I period. Unfortunately, because of the nonavailability of authorization to initiate large scale procurement during the latter part of the fiscal year, the hoped-for expeditious start of construction of base facilities on Parry Island was delayed in spite of the fact that personnel were available on site for the work.

SUMMARY

The accomplishments during the beachhead period may be summarized as follows:

1. Working relations were established with the military garrison on Eniwetok and with agencies on Kwajalein.

2. The shortcomings of logistic support were determined and recommendations were made which in a short time resulted in material improvement.

3. Considerable survey information was obtained for design of high priority construction and for the minor construction required in the establishment of the beachhead camp.

4. Submarine cables were checked, and excess cable was also checked and moved to suitable storage.

5. An interim camp was established and H & N forces became self-sufficient from the standpoint of subsistence and lodging. The camp facilities included a distillation plant capable of proding approximately 3000 gallons of fresh water per day; a power generation plant; a mess hall, including all equipment and plumbing; barracks space, including latrines, for approximately 200 persons; and a refrigerated storage plant. All this was accomlished by rehabilitation of abandoned equipment. Other facilities, such as a first aid room, office space, warehousing, recreation facilities, and the like, were achieved through the rehabilitation of structures and areas existing on the island.

6. A method was evolved for a decontamination of crater areas on the shot islands and a considerable amount of decontamination work was accomplished.

7. Sufficient equipment was rehabilitated to support immediate and near-future construction activities.

8. Interim repairs were completed on piers at the various islands and on the light plane airstrips. The clean-up of shot islands, including the removal of debris some decontamination by blading, and the demolition of unsafe structures on Parry, was performed during this period.

CHAPTER 6.3

OBJECTIVES AND COST CONSIDERATIONS

The objectives of the portion of the construction program which followed the establishment of the beachhead were outlined in the Reconnaissance Report of January 7, 1949, and are substantially as follows:

Phase II - July, 1949 to December, 1949

1. Maintain Eniwetok garrison utilities and transportation.
2. Build construction camp on Parry Island with self-contained utilities.
3. Rebuilt piers on Eniwetok, Parry, Runit, Aomon, Engebi, and reopen approach channels.
4. Build pier and shoot channel, Bogallua, if fourth site is to be used.
5. Open quarries.
6. Provide cable landing protection.
7. Provide temporary inter-island communication (existing cable, plus added line to Bogallua).
8. Start procurement.
9. Transport of material and construction workers.

Phase III - December, 1949 to December, 1950

1. Complete temporary type 150-man camp on Bogallua, Engebi, Rojoa, and Runit. (Utilities and temporary power, concrete slabs.)
2. Construct causeway, Biijiri to Rojoa.
3. Set up crusher, batch plant, paving mix machine.
4. Lay cables.
5. Erect towers.
6. Rehabilitate warehouse space, Parry.
7. Construct permanent utilities.
8. Construct permanent Reefer plant.

9. Pave Airstrips.

10. Ship total bill of materials.

11. Complete concrete construction and permanent buildings.

12. Purchase boats and vehicles for operating phase.

13. Establish communication facilities.

14. Pave roads and areas.

These objectives remained substantially the same throughout the period covered in this report and were realized. However, the quantities contemplated at the time of the Reconnaissance Report were greatly exceeded in the ultimate scope of work accomplished. Characteristic of the quantities involved in the construction effort as finally accomplished are the following:

UTILITIES

General Trenching	100,655 lin. ft.
Sanitary Sewer Lines	39,580 lin. ft.
Water Lines	103,570 lin. ft.
Water Distillation Facilities	Capacity 262,000 gal. per day.
Water Storage	Capacity 220,000 gal.
Power Generation Facilities	28 generators, cap.555 kw
Overhead Power Distribution	271,000 lin. ft.
Underground Power Distribution	101,750 lin. ft.
Submarine Power Cable	26,200 lin. ft.
Transformer Installations	295
Poles for Electrical Distribution	445
Telephone & Public Address Overhead Lines	475,240 lin. ft.
Submarine Telephone Cable	598,500 lin. ft.
Submarine & Underground Control & Signal Cable	1,889,900 lin. ft.
Submarine & Underground Fuel Lines	8,160 lin. ft.
Piers and Ramps	11

BUILDINGS & STRUCTURES

Military Structures	26
	83,300 sq. ft.
Towers	6 75 - ft.
	2 200 - ft.
	2 300 - ft.
Scientific Stations	More than 700
Base Facilities	
Aluminum Buildings, etc.	440,550 sq. ft.
Tents	198,844 sq. ft.

MISCELLANEOUS

Blading & Shaping	892,700 sq yd
Asphalt Paving	381,180 sq yd
Concrete	
Coral Concrete	27,265 cu yd
Limonite Concrete	1,210 cu yd
Steel	
Reinforcing Steel	1,240 tons
Structural Steel	1,760 tons
Forms	164,915 sq ft
Material & Supplies handled	53,620 tons (approx.)

In the construction of an installation of the magnitude indicated by the above statistics, the fact that a substantial amount of effort had to be directed to the construction and operation of facilities which would not only support the main construction effort but would also be integral parts of the Proving Ground facilities, required special consideration and planning. The philosphy of the planning of the Proving Ground development was to minimize duplication as much as possible by building facilities which would be ultimately required by the test operation activities in such a sequence that they could, to a maximum degree, accommodate the construction activity. The particular elements of the construction activities program which were in this dual-purpose category were numerous, and those of high priority included housing and messing facilities, utilities, sewers, communications, transportation facilities (including airplane landing strips and piers) and a boat pool for off loading ships and for the movement of men and supplies around the atoll.

In this construction project, there were a number of special conditions which resulted in increased construction costs over comparable costs for domestic construction. These included the following:

1. The inability of deep sea vessels to approach supply bases involved more than normal rehandling and lightering of all cargo.
2. An extended period of time was necessary between the requisitioning of materials and the actual delivery of these materials at the Jobsite.
3. Communication between the Jobsite and the Continental United States was difficult and was handicapped by security requirements.
4. Mail deliveries involved some irregularities and uncertainty.
5. Shipment of materials was required to be within the procedure and schedules of MATS and MSTS and space allowances for trans-

portation were in competition with other military agencies, a factor which after the inception of the Korean War became critical.

6. The weather conditions at the Atoll were characterized by frequent rain squalls which affected intra-Atoll transportation and, at times, certain phases of construction such as tower erection and paving.

7. Radical changes in the scope of work, combined with the long time required for procurement and shipment of many major items, affected construction schedules and at times changed the orderly progression of construction on items of high priority.

8. The wide geographic separation of the Project site from scientific groups and from the H & N design group militated against complete organizational efficiency and cooperation.

9. Unusually close tolerances required in construction were beyond the normal construction experience of most manual personnel and required, in many cases, a re-education of personnel in order to effect successful installation.

10. During earlier phases of the project the radiological hazard which existed limited the working hours of the personnel, and also created a psychological barrier to efficient operations until an educational program and the actual completion of decontamination alleviated the situation.

11. In early phases of the project the procurement of supplies was not initiated on schedule because of a temporary shortage of funds during the latter part of fiscal year 1949.

12. Additions to the scope of work involved the use of coral for aggregate far in excess of the quantities originally contemplated and involved the exploitation of quarries in locations such as submerged reefs. Furthermore, some construction involved high strength and density specifications which required special attention in view of the enforced employment of coral aggregate.

13. By reason of the condition of much of the construction equipment when received, the unusual operating conditions under which it had to be used, and climatic factors involving rapid corrosion, the problem of equipment maintenance was much more complex than usual.

As pointed out in Section 12, Estimating, cost estimates in connection with the construction at Eniwetok Atoll were first developed for inclusion in the Reconnaissance Report. The procedure used at that time was based upon the determination of domestic unit costs for each feature of construction: material, labor, equipment, and transportation. To the domestic costs thus determined, there were added the costs attendant upon the performance of services at Eniwetok Atoll. Upon the completion of the Reconnaissance Report Estimate, it was found that the cost of construction at Eniwetok was a factor of 1.966 greater than the costs of performing comparable services on the West Coast of the United States, and this multiplier was used in the development of subsequent cost estimates.

The total estimated cost of construction, including costs of design engineering and fees, was $32,466,371. From this total, deductions were made for government-furnished water transportation, government-furnished equipment, and government-furnished labor for construction on Eniwetok Atoll, in the amounts of $1,819,196, $1,819,000, and $2,390,765 respectively. Thus, the net total estimated construction cost (including engineering costs and fees) was $26,437,410. The actual cost of construction performed by H & N at Eniwetok Atoll as of June 30, 1951 was $24,714,932, including the cost of all engineering services and allocable fees.

If one divides the net estimate as given above by the factor 1.966, thus reversing the estimating process used in developing estimated construction costs at Eniwetok, to arrive at an estimated domestic cost of construction for comparable facilities constructed in a comparable manner, (i.e., using the same proportions of government-furnished equipment, transportation, and labor), the resultant estimated domestic cost is $13,442,523. Division of the actual cost of construction at Eniwetok by the estimated domestic cost thus arrived at ($24,714,932 divided by $13,442,523) results in a factor of 1.838.

An alternative multiplying factor can be arrived at by assuming that the contingency factor used in the preparation of those estimates which were not based on definitive criteria should not be included in the preparation of an estimate of cost of comparable domestic construction. Such an assumption would appear to be justified on the basis that communications, timely procurement of materials and transportation of them to the jobsite, and recruitment of labor present only relatively minor problems in a domestic construction job. On the basis of such an assumption, therefore, the net estimated cost of domestic construction of $13,442,523 should be reduced by ten per cent to eliminate contingency allowances, thus yielding an estimated domestic cost of $12,098,271.

Comparison of this latter figure with the total actual cost of construction at Eniwetok results in a multiplying factor of 2.043. On the basis of these computations it will be seen that an average multiplying factor can be said to lie between 1.8 and 2.1. It should be remembered that such an average multiplying factor applies to the program of work performed and is not applicable to specific, specialized structures erected at Eniwetok or to construction work involving the employment of extraordinary techniques, equipment, or material.

CHAPTER 6.4

ORGANIZATION AND PERSONNEL

At the outset of the project, to arrive at basic and realistic cost estimates, it was necessary to set up tentative manpower schedules and organizational structures. At this time, in view of the scope and nature of the construction work to be performed, it was visualized that a force of 600 men would be required at the Project site to accomplish construction and render the services required to support construction. In addition, a small group in Los Angeles would render supporting services including liaison with the AEC on all operational and construction matters, liaison with the H & N Engineering and Fiscal Divisions, and services connected with procurment, expediting, and logistics. To organizationally effectuate this plan, the complete responsibility for activities relating to all phases of the work being performed by H & N, other than design engineering and fiscal, was established in the Operations Division. This Division, under the supervision of the Chief of Operations, comprised two main subdivisions in order to provide adequate supervisory authority to cover activities at the Jobsite and to assure adequate Home Office supporting services.

The Jobsite and Home Office subdivisions were organized along the functional lines shown in Figures 6.4-1 and 6.4-2 in order to permit the application of maximum effort to construction and related activities.

It was anticipated in this early planning that, as service and maintenance functions (as compared to actual construction activities) became more numerous, such functions would be departmentalized in the Jobsite organization in order to avoid distortion of construction costs. It might be noted here, as well, that the establishment of a Material Take-Off Section within the Construction Department, and a Construction Estimating Section was not established initially in the interest of economy. These functions at this stage of the project could readily and economically be performed by the Home Office Engineering Division. Furthermore, this type of organizational division afforded the advantage that procurement could be initiated on many items required for construction long before final plans and drawings were complete, thus materially reducing the normal time between inception of a project and delivery of critical procurement items such as generators, stills, structural aluminum, and the like.

The mobilization of the originally planned Jobsite force of 600 was planned to take place rapidly after the establishment of the beachhead. As the scope of work was increased and it became necessary to augment these forces, orginzational changes were required to assure continuous and augmented supporting services as well as adequate staff supervision and control on all phases of the construction effort.

The first of these changes took place in January 1950 and involved the transfer of material take-off responsibility from the Engineering Division to the Construction Department. The reasons for this change

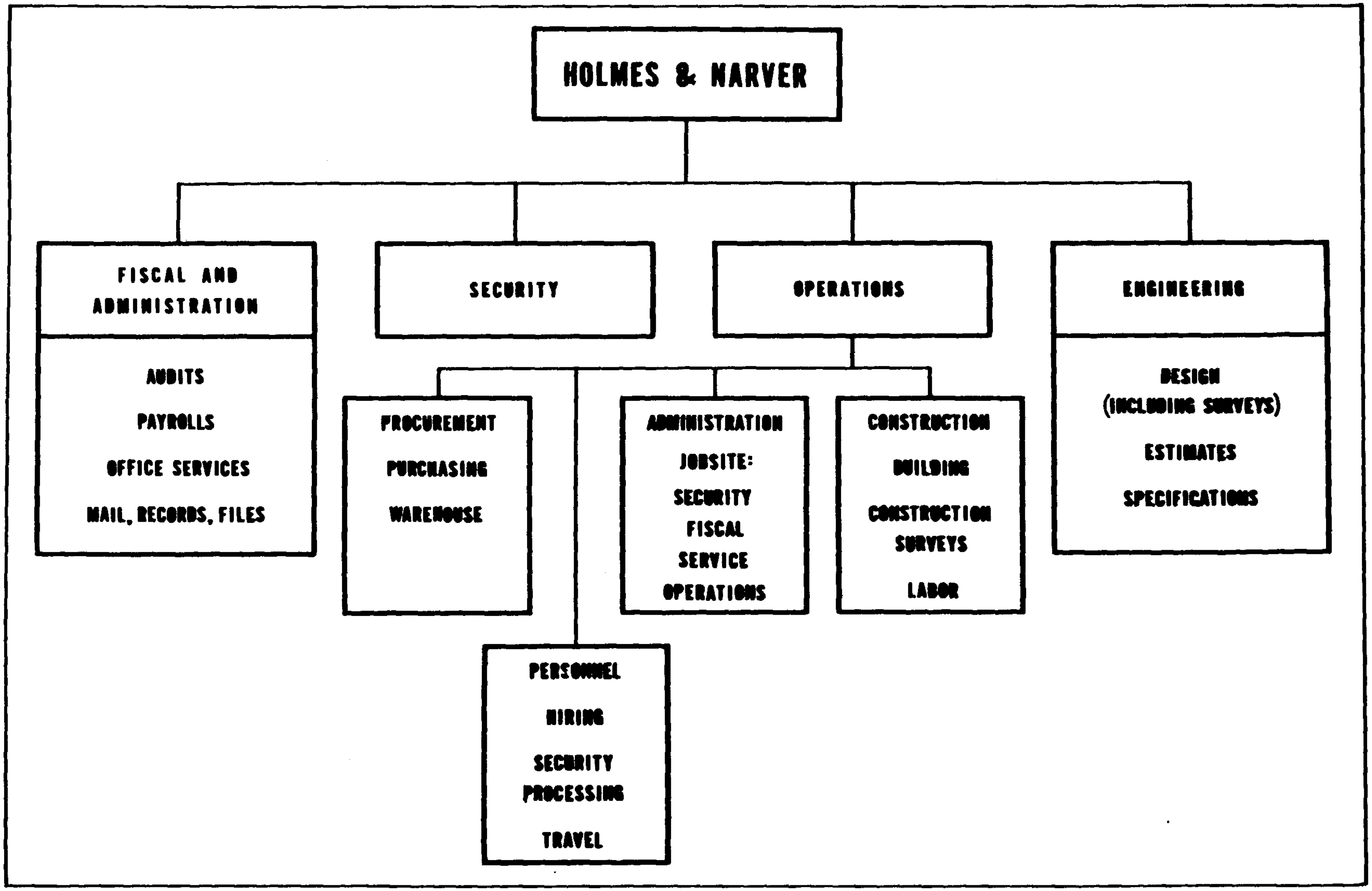


Figure 6.4-1 Home Office Organization

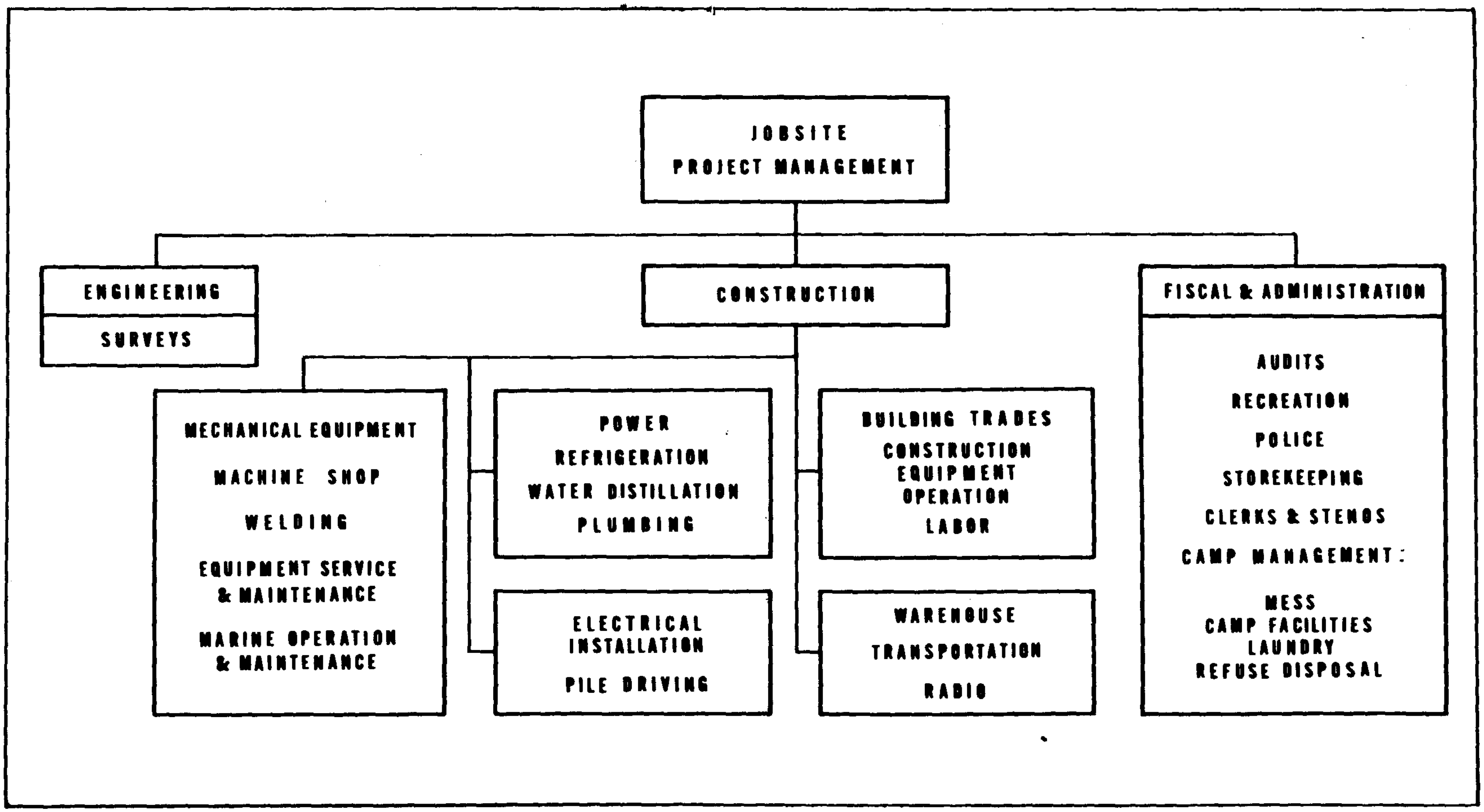


Figure 6.4-2 Jobsite Organization

were two-fold. In the first place, procurement of materials for the planned base facilities had been accomplished and the need for engineering requisitions prior to completion of design no longer existed. In the second place, the assignment to H & N of construction responsibility for the elements of the Military Structures Program required adherence to usual construction organization practice in view of the fact that architect-engineer services had been performed by other agencies.

Later, in May 1950, the operation of camps at various sites became a sizable activity and a new division called the Service Operations Division was formed. It should be noted that the formation of this division was completely in accordance with plans formulated at the time of the submission of the original Reconnaissance Report in January of 1949.

Upon the formation of the Service Operations Division, the functions of operating power plants, water plants, maintenance, motor pools and mechanical shops were transferred from the Construction Department to this new division and the responsibility for all such services placed under one head. In addition, the greatly expanded activity of the Marine Department taken in connection with the proposed enlargement in the number of craft in operation made it advisable in order to properly support the expanding construction effort, to place the responsibility for operation and maintenance of all marine craft under one head, that of the Port Captain, and to place the function under the Service Operations Division. The inauguration of the Service Operations Division, coming as it did at a time when construction on Parry was substantially complete in addition to being functionally sound, marked the inception of work under Job No. 4 of the Contract and served, as noted above, to prevent the distortion of construction costs. The physical changes in organization made at the site to accommodate the increasing development of the Project consisted of the progressive subdivision of the basic organization by creating area managers in subsidiary sites other than Parry Island, under whose direction were comparable construction units with supporting services continuing to be supplied through the established base organization. The basic organization was also necessarily modified to accomodate liaison with numerous other agencies as they became operative at the site and with the military construction program on Eniwetok Island. A chart of the orgainzation as it existed during the latter part of 1950 and through the operational phase in 1951 is shown in Figure 6.4-3.

Prompted by successive increases in the scope of work, and increase in the numbers of classifications of personnel and in the numbers of persons in these various classifications took place as the job progressed. The accelerating scope of the acitivity is apparent in the tabulation of construction personnel mobilization which is shown in Figure 6.4-4. Due to fluctuations in the recruiting effort and the security screening, arrivals of personnel at the Jobsite were not always in consonance with an efficient balance of construction categories and actual requirements. As a consequence, minor rescheduling was required as well as the infrequent necessity for working certain individuals out of classification.

Of greater significance in connection with the cost of construction are the salient facts that, as is the case in practically every overseas

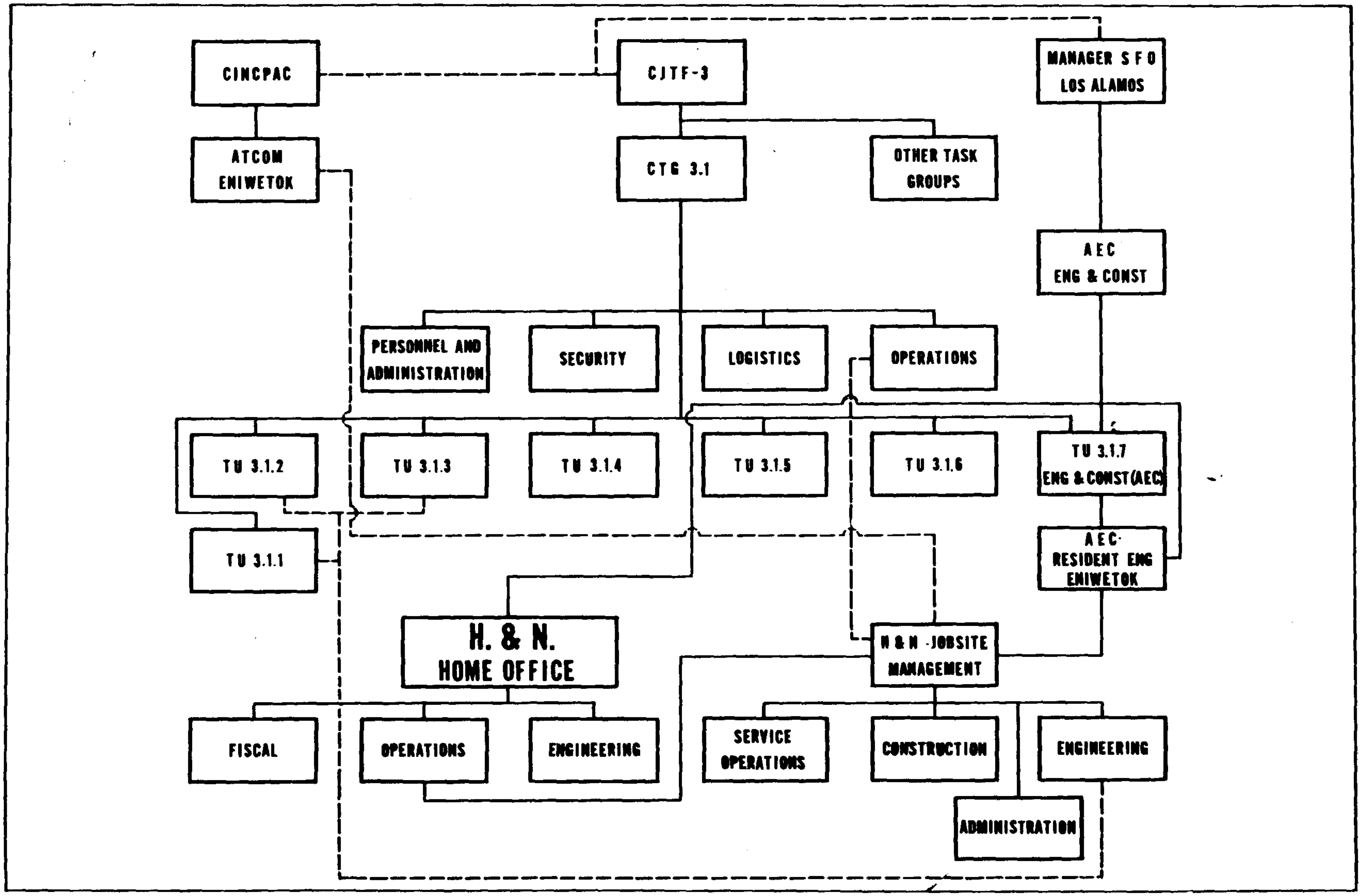


Figure 6.4-3 Liaison Chart, March 1951 through June 1951

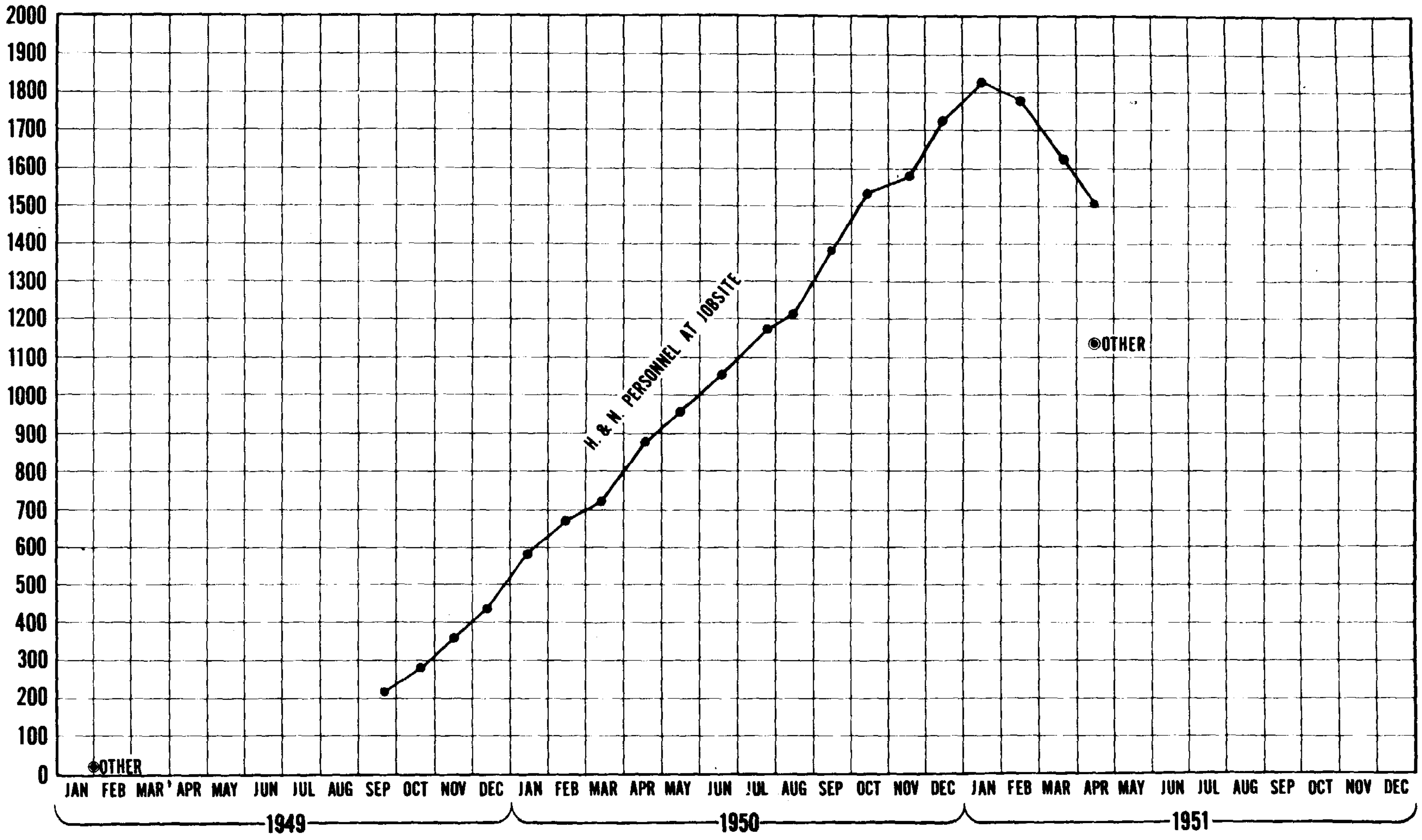


Figure 6.4-4 Holmes and Narver Personnel at Jobsite

construction job, many applicants for work in all categories were barely average in competence, and in addition the time required for security clearance effectively reduced the opportunity to hire only personnel of proved experience. Furthermore, and of equal importance, the wage scales established in many categories prevented the employment of seasoned craftsmen. This was the case in connection with the recruitment of bricklayers whose services were required in connection with the Military Structures Program.

Such problems, however, did have certain beneficial aspects. Competent supervisory personnel had been employed. Thus, while a substantial amount of construction required the application of unusual practices to conform to specified tolerances and strengths, close supervision of the work was essential and resulted in rapid training of somewhat less experienced personnel to follow the required techniques.

CHAPTER 6.5

PROCEDURES

Construction drawings prepared by the H & N Engineering Division, upon approval for construction and authorization to proceed, were distributed simultaneously to the Operations Division and to the Jobsite Engineering Department for transfer to the Jobsite Construction Department. Bills of materials and engineering requisitions for materials either preceded the transfer of drawings, as in the case of high priority or long term procurement items, or accompanied the drawings, thus initiating procurement activities.

Upon arrival of the drawings at the Jobsite Engineering Department, necessary recording was accomplished and a check was made to ascertain that required specifications were on hand in sufficient detail to govern construction and to form the basis for the inspection and testing services to be performed by the Engineering Department. Upon the completions of these preliminary steps, the drawings and all pertinent specification information were sent to the Construction Department.

SCHEDULING

At this point scheduling of the particular structure for construction within the broad scheduling pattern was initiated. In this step, the interplay of all of the factors affecting construction required recognition. The availability of the required materials at the Jobsite, the availability of manpower in required categories, any special equipment required, movement of materials within the Atoll, deadline dates for completion - all these had to be considered in order to assure orderly progress within the over-all program. This assurance was achieved through the coordination effected in regular staff and Construction Department meetings. It should be remembered in this connection that after the middle of 1950, the receipt of drawings approved for construction was continuous. The addition of scientific stations occurred almost daily and scheduling in the light of such conditions was a matter which required continuous surveillance in order to prevent delays in planned operational activities.

After a workable schedule for construction was established for a particular feature of the program, plans were distributed to the construction group operating at the specified locations. Within the group a breakdown of the plans was made to the categories of construction effort required. Thus, for example, foundation drawings were given to the structural steel section, the carpentry section, and the concrete section; electrical drawings were distributed to the electrical section to permit prefabrication where possible, or assembly of materials and installation. Construction efforts followed in due course.

The Inspection and Statistical Sections of the Engineering Department followed construction progress to assure conformance with plans and specifications and to report progress of construction by daily reports. In addition, area superintendents regularly reported progress on each structure and station.

Such a procedure is normal for a construction project. Its application in the case of the Eniwetok project was somewhat more complex in view of the difficulties encountered in having most, if not all, required materials on hand before initiation of construction on any particular building, structure or station. This material situation was the result of a series of events extending in time from June 1949 through March of 1951 which must be borne in mind in order to appreciate the impact on construction costs of a 5,000-mile supply line. In May and June, 1949 when early and intensive procurement of basic construction materials should have been accomplished, funds were not available. As a result, the flow of such materials to the Jobsite began in September 1949 instead of July and thus imposed a 60-day delay.

The planned schedule of construction of base facilities placed Eniwetok Island as an area to be completed toward the end of fiscal year 1950 and the procurement of materials for that site was accordingly established for the latter part of 1949 and the early part of 1950, which appeared reasonable in the light of the above mentioned, unanticipated, nonavailability of funds. However, when arrangements were made in the fall of 1949 for a Military Construction Battalion to perform the major portion of the construction required for Eniwetok Island, the planned procurement schedule had to be pushed ahead. In respect to some items this was possible but, initially, the diversion of a considerable amount of materials intended for other locations was required in order to maximize the utilization of the military forces.

The diversion thus required introduced scheduling problems which became more pronounced when hostilities in Korea started and resulted in a 60-day hiatus in shipping schedules. The Construction Battalion was alerted for movement to the Far East and a high priority given to the work on Eniwetok in order to permit movement at the earliest possible date. As a result, further diversions of materials to Eniwetok Island construction were required in order to meet this new and unforeseen priority. Likewise, the war and the attendant absence of shipping space for 60 days caused frequent reshuffling of forces in order to apply efforts effectively in view of the materials on hand.

Thus it was that, at the time construction of scientific stations was to begin (i.e., in July and August of 1950), the materials situation was inordinately light. Work had not stopped and it must be emphasized that no "stand-by" time was ever incurred during the project because of material shortages. On the other hand, construction personnel had to be redeployed and moved from site to site in order to utilize available manpower effectively in consonance with the materials on hand.

With the arrival in early September 1950 of the first ship following the suspension of shipping during July and August, the situation was eased and scheduling of construction was approaching a normal pattern. However, this approach could not be complete in view of the fact that the requirements for scientific stations increased almost daily. In addition, complex structures were introduced at very late dates and involved considerable amounts of highly specialized fabrication. An outstanding example of such a requirement was the enormous steel casting specified late in 1950 for Station 121. Obviously, the foundations for the station could be completed immediately, and were, after some changes, discussed hereinafter. But completion of the station had to be delayed until procurement and delivery of the castings could be effected.

The above events, coupled with the disadvantages inherent in following to a late date the requisitioning procedures used in initial procurement (which are discussed in somewhat more detail in the following subsection), accounted for the somewhat excessive amount of time spent in scheduling construction on this project. However, it is apparent that for the most part this effort was expended as a result of items which were added to the original scope of work or items on which the priority of construction was changed during the course of the project, and to this extent the attendant costs were not or should not have been unforeseen.

CONSTRUCTION REPORTS

In July 1959, Holmes & Narver was directed by the AEC to submit, on the 25th of each month, a progress chart for construction on the project. This chart was expected to contain separate bars for various increments of the construction project, showing the predicted progress for each month until completion and the actual progress attained from the commencement of work until the reporting date each month. The division of the total project into appropriate items was left to the judgment of the Contractor. Each item was expected to be weighted in accordance with the ratio of the estimated workload required for that item to the total construction workload for the entire project as it was designed at that time. The report was also expected to contain a composite curve of predicted progress derived from the weighted progress of all items, and a composite curve of actual progress derived in the same manner.

During the early phases of the project, a single chart was submitted each month in accordance with these requirements. As the project progressed it became necessary to revise the form of the chart periodically because of (1) increases in the scope of work which had the effect of varying the weighted values of certain items in proportion to others, and which on occasion required revised estimates as to progress and as to the completion date; (2) change in policy regarding construction work on Eniwetok Island, which required a revision of weighted values of all items and which indicated a need for a separate report on progress for this particular item for a period of time; (3) successive revisions in policy regarding the use of Bogallua Island which caused stoppages and recommencement of work on that island, with revisions in weighted values incident to each such revision; (4) the addition of the Military Structures Program, which indicated the need for a separate report on this particular project, although it was also incorporated in the composite progress chart as a part of the basic Contract as modified and, consequently, caused a radical revision in all weighted values and in the estimated monthly progress and estimated completion date of each; (5) the addition of the Scientific Structures Program which similarly indicated the need for a separate progress chart for this particular project; and (6) various other specific additions which were made, including the Loran Station, work on Piiraai, Bokonaarappu, Teiteiripucchi, and Coral Head, and the shipment of spare towers, each of which had to be integrated into the composite progress chart and which caused revisions in weighted values.

A progressive account of development of each of the three principal charts will be described in the following paragraphs.

Basic Construction Chart. The basic construction chart was initially designed to indicate progress by site locations, except that the items of towers and communications were included as separate items inasmuch as each of them comprised work on several different locations. Weights were assigned to each item in accordance with the estimated number of man hours expected to be required in proportion to the total man hours estimated for the entire project.

The initial weighted values and estimates continued unchanged until November 1949, at which time H & N was advised by AEC that a Military Construction Battalion would perform the major portion of the construction work on Eniwetok Island. Therefore, Holmes & Narver was directed to discontinue construction work on that location except on certain items of work and for the provision of certain technical supervisors and operation of utilities. This change in procedure had the effect of reducing the weighted value of Eniwetok Island, as a result of which all work on Eniwetok, hitherto shown under two separate items, was combined into one item. At the same time, the concept of the project was revised by AEC to the extent that Bogallua Island was included as a test site involving the expected construction of a tower and other facilities on that site. It will be noted that weighted values of certain items were revised between the October and November reporting dates incident to these revisions in plans.

Between the reporting dates of December 1949 and January 1950, it was decided by AEC to discontinue work on Bogallua Island. Some work had already been accomplished on this site; therefore, the weighted value was reduced to unity, and it was considered to be completed insofar as further activity at that time could be foreseen. Other revisions which had the effect of increasing the scope of work on various items required a reassessment of weighted values. A new estimate of predicted progress was made at this time, utilizing the knowledge gained from experience during the first six months of construction work. Between the reporting dates of April and May 1950, it was decided to submit a separate progress chart for Eniwetok Island. Therefore, this item was deleted from the basic chart, and the weighted values of all other items were changed proportionately.

Between the reporting dates of June and July 1950, the progress chart was completely revised to represent all items as shown in Modification 7 of the Contract. This revision provided for the inclusion of items on Coral Head, Tower-Site Southeast of Runit, Piiraai, Bokonaarappu, and Teiteiripucchi, the Military Structures Program No. 3, Military Program No. 8.2, the Shipment and Storage of Spare Towers, and the Loran Station. Eniwetok Island was re-inserted and it was again decided by AEC to reactivate the planned development of Bogallua Island. These major revisions in the scope of work necessitated a complete revision in estimates of progress and in estimated completion dates, as well as a revision in the weighted values of each item. It will be noted that the weighted value reassigned to Eniwetok was considerably greater than that assigned during the period from October 1949 to June 1950. Despite the fact that much of the work at this location was performed by the Construction Battalion, its weighted value was assessed to conform exactly to the relative magnitude of work and to coordinate the percentages of completion as reported on this chart with those submitted by other H & N departments in accordance with various AEC requirements.

Between the reporting dates of July and August 1950, it was decided by AEC to cancel further work on Bogallua Island. This necessitated a minor revision of all weighted values.

Except for an extension in the estimated completion date from December 31, 1950, to March 15, 1951, caused by: (1) the insertion of the E program; (2) the diversion of large numbers of construction forces to work on the Military and Scientific Structures Program; and (3) the diversion of forces to the support of operational activities, no changes were made in the basic construction chart after August, 1950.

Military Structures Construction Chart. A chart for reporting the estimated and actual progress of construction of the Military Structures Program was designed in a manner similar to that for the basic construction program, except that it contained 26 items, each representing a separate structure. Each structure was carefully analyzed as to the estimated man hours expected to be required for completion. The initial chart on this program was submitted in April 1950. No significant changes were made in the weighted values throughout the progress of construction. The principal feature of interest is indicated in the lag in actual progress of construction during the period from July 25 to September 25, 1951. This was due almost entirely to the breakdown of logistic support during this period which is discussed above in this section. The logistic derangement during this period prevented the receipt of many essential items of material which had the effect of retarding progress on many of the Military Structures by 30 to 60 days. It will be noted that the curve of actual progress parallels very closely the original predicted curve except for the 60-day period from July 25 to September 25. This retardation of progress had the effect of extending the final completion date from December 25, 1950 to February 25, 1951.

Scientific Structures Construction Chart. A chart for reporting the estimated and actual progress of construction of the Scientific Structures Program was designed in a manner similar to the basic construction chart and the Military Structures Chart. It was difficult to devise a means of breaking down this program into component parts inasmuch as there were approximately 700 stations of extreme variations in size. It was therefore decided to present the breakdown in terms of nineteen categories of using agencies; one additional item listed as "All Users" represented those jobs which were required to implement the entire Scientific Program, such as additions to the Test Site Power Plants.

In deriving the value of the percentage of progress of each category for use on this chart, it was necessary to maintain records in the Home Office and to receive weekly reports from the Jobsite on the progress of

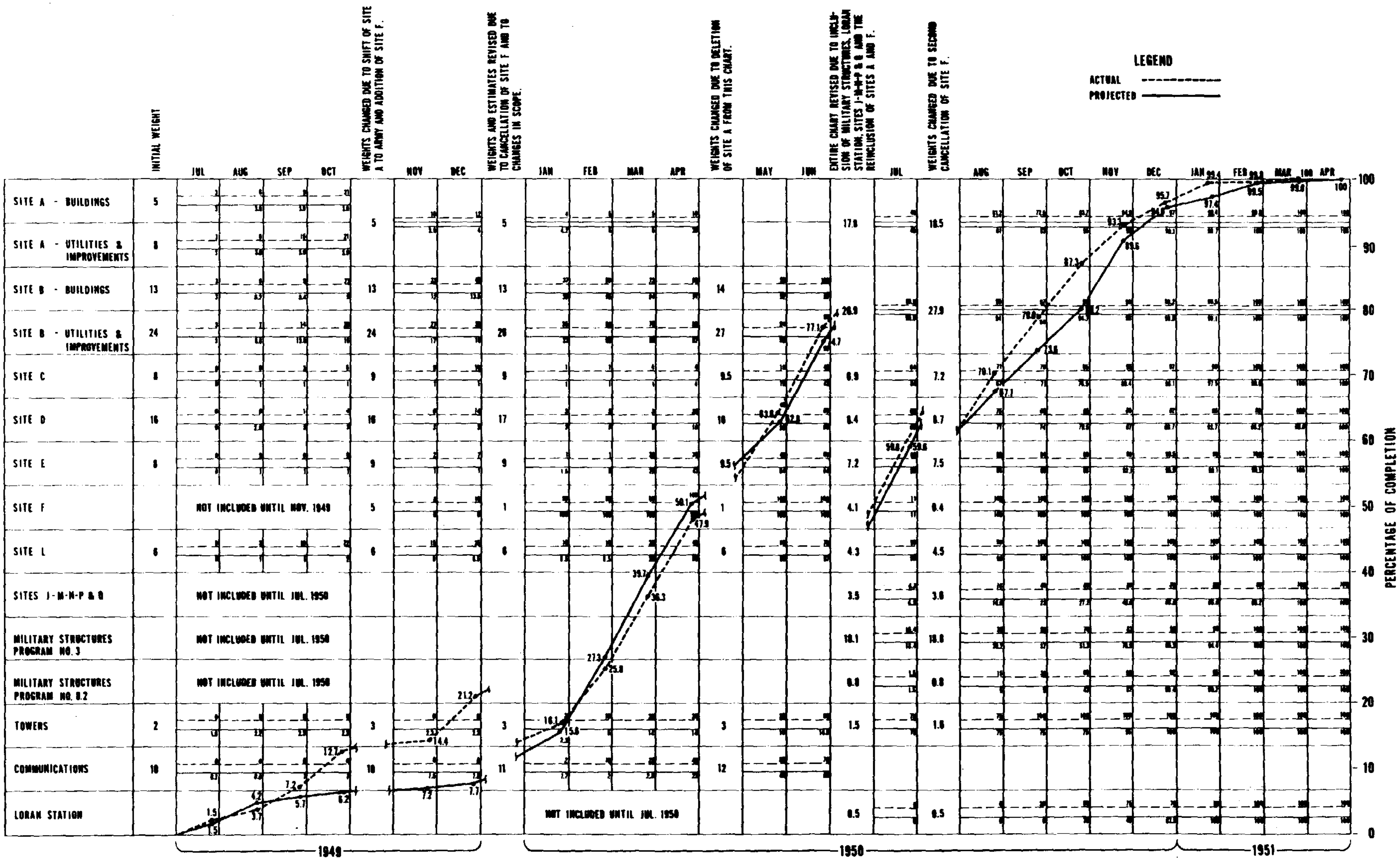


Figure 6.5-1 Consolidation of Progress Charts, Construction Period

each of the seven hundred separate stations, each of which was assigned a weighted value among the total number of stations designed for that user.

There were no significant revisions in this report from the date it was originally submitted on July 25, 1950, until completion on April 15, 1951. There was a lag in actual progress during the month of November, 1950, due to revisions in locations and in design details which were still being received at that time. In certain instances, stations were relocated after a substantial amount of construction had been completed; this not only required a new start from the beginning on that particular station, but it also required the removal of such work as had already been accomplished. Changes in design details precluded the timely procurement and delivery of certain important items of material.

Consolidated Chart. Figure 6.5-1 is a consolidation of the progress charts submitted during and at the close of the construction portion of the program. This chart indicates the five major scheduling changes which took place during the two year construction program.

MATERIAL TAKE-OFF AND CONTROL

As noted hereinabove, one of the advantages of an architect-engineer-construction type of contract for a project such as the development of the Eniwetok Proving Ground is inherent in the procedure thus made possible whereby procurement of critical and "long delivery" items can be initiated at an early stage of design. As a consequence, initially, the responsibility for material take-off and requisitioning for procurement resided in the H & N Engineering Division. Long term procurement items, including, for example, large generators and water distillation units, were requisitioned on the basis of purchase order specifications prepared by the Engineering Division and procurement was initiated as soon as funds were available. On other and more standard items not considered to be in short supply, requisitions were prepared after design had progressed to the bill of material stage. Auxiliary items, such as forming lumber and materials, were requisitioned on a stockpile basis.

Upon the accomplishment of procurement on all of the above categories of required material and equipment, wherever possible in shipments to the Jobsite specific items were earmarked for designated structures. Records of stockpile items, such as forming lumber, cement, and the like, reflected scheduled usage at the site. The phasing of shipments under the bill of material type of requisitioning followed was not in consonance at all times with the manpower availability and potential at the Atoll. As a result, in order to assure continued progress on essential structures, earmarkings of specific items were ignored and, for a short period of time at the end of 1949, the desired degree of material control was not maintained.

The solution of the difficulty was evident when reference was made to original planning. The transfer of material take-off functions to the Construction Department had been envisaged although the exact time at which this would occur had not been established in view of the anticipated expansion of the Scientific Structures Program. The breakdown in control was evidence that the critical date for the accomplishment of the change in take-off responsibility had passed.

Furthermore, at the same time (late December 1949), the addition of the Military Structures Program to the scope of H & N's construction work made it necessary that material take-off be accomplished in the normal manner for cases in which architect-engineer services are performed by a different organization from that performing the construction.

Thus, it was in January 1950 that the Material Take-Off Section was transferred to the Construction Department of the Operations Division. The prime responsibility of the section continued to be the preparation of all breakdowns of materials called for by construction drawings forwarded to the Jobsite, and of all auxiliary materials needed to perform the construction according to the specified technique~~s~~.

The breakdown in material control has been noted above in this section and the complete resolution of the resultant inventory variance is discussed in Section 11, Fiscal. In order to guard against recurrence, strict measures were instituted for Jobsite warehouse control in accordance with established procedures and steps were taken to augment the flow of information concerning materials and supplies to the Jobsite. Minor revisions in control procedures were effected at this time (January 1950) and these are incorporated in the procedural description in the following paragraphs.

When the material status records were taken over from Engineering Department Take-Off Section, sheets listing approximately six thousand items of material were checked by the supervisor for proper description and nomenclature. The calculations of quantities allocated against quantities purchased appearing on the material status reports were checked and transferred to new 5 x 8 inch looseleaf stock cards. The verified balances were posted from the existing material status report to the stock cards which were bound in plain canvas binders in classified groups, each in alphabetical sequence. The stock card was designed to show the requisition number and date; purchase order number and date; quantity on requisition; quantity on purchase orders; quantity allocated; building number; site; and balance unallocated. This stock card not only reflected quantities available for allocation but was a key follow-up reference for requisition or purchase order. This record was also used extensively as a commodity reference on calls from other departments.

A separate set of stock records was set up for all materials requisitioned for maintenance purposes by the Home Office Construction Department and the Jobsite forces.

As subsequent bills of material were prepared from take-off, the stock cards were checked for available quantities. If the supply was not sufficient, an engineer's requisition was prepared for procurement. Entry was then made on the bill of material velum, indicating either supply from stock or requisition number. The items on bills of material were posted to the stock card for an immediate record of allocations.

After posting, the bills of material were bound in canvas ringbinders segregated by site location and in building number sequence.

Immediately upon preparation, one copy of each engineer requisition was forwarded to Jobsite for recording on stock record and material control cards. One copy, posted to the Home Office stock cards, established immediate reference and reconciliation with bill of material allocations. After posting, an individual follow-up folder was prepared and the requisition inserted for compilation of all purchase, expediting, inspection and shipping data to the point of shiploading at Oakland. When all items were delivered complete to Oakland Naval Supply Center, the follow-up history reflected all action, including cargo lot number, name of ship, and date of sailing.

This function represented a tremendous volume of document check-out, including the requisition, purchase order, delivery tickets, Oakland receiving reports, and Navy ocean manifest. The entire follow-up operation, including correlation with the Purchasing Department, Los Angeles Warehouse, and the Oakland Office, was performed by personnel of the section who, in addition answered all Jobsite inquiries on the shipping status of all materials.

When a requisition follow-up folder became complete, it was filed according to construction classification and structure group.

A daily report summary was prepared showing materials arriving at Oakland. This included their description, purchase order and lot number, weight and cube, loading priority and Navy ocean manifest number. This report was sent to the Jobsite following the bills of material, the requisition, and the purchase order for the purpose of keeping Jobsite informed for scheduling and material control. This report reflected accumulative weight and cube up to time of ship departure. Cargo left at dockside after ship departure represented the material appearing on the opening report for the next ship sailing.

In addition to the above, a progress report of fabricated items was published periodically, depending on the loading and sailing dates of a cargo ship, so that the information shown would be current when received by Jobsite management. The detail contained was as follows:

1. Building or Structure
2. Area
3. Description
4. Vendor
5. Requisition Number
6. Purchase Order Number
7. Scheduled Delivery Date
8. Progress of Fabrication
9. Oakland Arrival Date
10. Ship Schedule Date

The progress report was completely indexed and listed all previously fabricated items showing date shipped and name of vessel.

Navy ocean manifests were prepared by the Naval Supply Center at Oakland. Six copies were airmailed to Jobsite by Holmes & Narver's

Oakland Office immediately after ship departure and were normally in the hands of the warehousemen or Jobsite Material Control Section ten days prior to ship arrival. This represented the final link of control reporting and therefore fully documented all material requests and material movements sufficiently in advance to arrange for efficient handling and storage of material before its arrival at Jobsite.

Because of heavy volume purchases of basic items such as cement, reinforcing steel, and lumber, on a basis of estimated needs prior to beginning design take-off, stockpiles accumulated at Jobsite before installation of stock records or material control. In order to determine the exact status of these basic items, special survey reports for a complete tabulation were made from Home Office material control records. These reports reflected the requisition and purchase order numbers; quantity; use feature (building, site and program); date trans-shipped; and name of vessel. A complete tabulation of allocations and pertinent drawing numbers was prepared to arrive at a book balance on these items. All such surveys were forwarded to Jobsite early in 1950 to assist in complete establishment of Jobsite material control and to make it possible to take necessary steps regarding further requirements.

Jobsite receiving reports and appurtenant over-short and damage reports were reconciled with the "in-transit" account charge by the Home Office Accounting Department. However, no accounting of warehouse receipts and issues was attempted by the Home Office Material Control Section.

In addition to the primary duties outlined above, the Material Take-Off Section of the Construction Department secured the approval of the responsible architect-engineer on more than 200 shop drawings. This group handled more than 3000 different drawings relative to the project, and acted as a center for the distribution of drawings and specification information for the Military Structures Program. More than usual work load and more than usual care was involved in the material take-off for the Military Structures Program both because of the nature of the materials and accessories and also because of the unusual construction practices followed. An example of this was Building No. 4 of Structure 3.1.1 where the ratio of tons of reinforcing steel to cubic yards of concrete was approximately 1.63, nearly 220 per cent greater than the ratio of the same materials for a typical industrial reinforced concrete structure of comparable dimensions. Furthermore, a structure such as that designated as 3.1.1, incorporating materials of radically different composition integrated into the same wall or other element, involved unusual considerations of forming and erection sequence. These problems are normally a concern of the Material Take-Off Section in order that the construction will be adequately supplied both as to method and basic materials.

Auxiliary services provided by the Material Take-Off Section included special studies pertaining to proposed procedures and special phases of construction. Sketches were often prepared for clarification of the more technical and difficult construction requirements. Correct application procedure for the fibre glass sealing strips used in the Army and Air

Force Military Structures Program was one instance in which such sketches were very helpful. Also complete records of all mail and laboratory reports for the Military Structures Program were kept.

As indicated above, in the early stages of the Project requisitions were originated by the Engineering Division as a duplicate material listing of that appearing on the bills of material. Revisions which followed usually concerned minor additions and the resulting requisitions contained a variety of items usually in small quantities. These requisitions, originating in various Engineering Departments (e.g., Electrical, Mechanical, Structural, etc.), were forwarded directly to the Procurement Department for purchase and subsequent shipment to the Jobsite. This practice would not, in all cases, provide adequate service to the construction forces in that it failed to assure adequate warehouse stocks of common items. This deficiency was taken care of by the issuance of bulk item requisitions covering such items as forming lumber, reinforcing steel, cement, pipe, and the like.

As the scope of material requirements became better realized, long range planning had indicated that the above method of requisitioning while economical in the early stages of construction was incommensurate with the anticipated volume of materials to be procured. An unnecessary amount of paper work for all departments could be foreseen and more important, a lack of economy inherent in the purchase of small quantities of material could be predicted. Greater economy would conceivably be achieved by purchasing many more construction items in lot quantities.

Thus, when the Military Structures Program came into being in January of 1950, steps were taken to transfer this function to the Construction Department. It is seen above that the materials take-off function was transferred to the Construction Department at this time to prepare adequate complete take-offs on all drawings approved for construction. The Requisition Section was now established in the Construction Department with the responsibility of collating requirements originating from the Materials Take-Off Section and issuing consolidated requisitions representing appropriate quantities.

A general outline of the procedure followed by the Requisitioning Section is given below.

Bills of Material.

A. Screening

1. Check for correct description of items.
2. Check for complete information in title block.
3. Check with Material Control Section to determine availability of previously stockpiled items.
4. Requisition items not previously ordered and enter under appropriate columns requisition numbers and

exact quantities required. Quantities for items known to exist in present stockpile may be entered under column headed "stockpile."

B. Printing

1. Two copies of "Requisition for prints," together with original bill of material, are submitted to the Blueprint Department.

2. Quantities of prints and transparencies to be ordered are as follows:

   a. Nine prints each of all bills for Eniwetok.

   b. Nine prints each of all bills for Scientific Structures for all locations.

   c. Seven prints each of all bills other than those for Scientific Structures and for locations other than Eniwetok.

   d. One transparency of all bills.

C. Distribution

1. Four prints and one transparency of all bills are transmitted by memorandum to the Jobsite Resident Manager through the Project Manager.

2. One print of all bills, together with a copy of above memorandum is transmitted to the Procurement Director.

3. One print of all bills is sent to originating Department.

4. One print of all bills is given to Material Control Section for recording and subsequent filing for Construction Department use.

5. Two extra copies of Eniwetok prints are given to the Department Head for transmittal to:

   a. Construction Battalion representative at Oakland.

   b. Construction Battalion representative at Jobsite.

6. Two extra copies of bills for Scientific Structures are transmitted by memorandum to the Jobsite Construction Manager through the Project Manager.

7. Original vellum is retained in Construction Department files.

Requisitions.

A. Sources of material to be requisitioned

   1. Bills of material

   2. Engineering memorandums

   3. Engineering messages (teletypes)

   4. Department Head's direction

B. Requisitioning procedure

   1. Rough draft on "requisition work sheet" is made by Requisitioning Section and submitted to the Superintendent of Construction or his designee for preliminary approval.

   2. Upon approval requisition is typed to include: one white copy (original), one blue copy, one pink copy, one green copy and four yellow copies. Two extra copies (color optional) are added for requisitions requiring expediting and/or inspection.

   3. Typed requisitions are proofread, initialed by originator, and submitted to the Department Head and to the Superintendent of Construction for final approval.

C. Distribution

   1. White (original) and blue copies to Director of Procurement. Requisitions for fabricated parts are accompanied by sufficient prints and/or specifications to supply all bidders. Blue copies are later returned to Construction Department with purchase order numbers noted thereon and will then become permanent record copy.

   2. Green copy with work sheet attached is retained in Department Head's file.

   3. Pink copy and four yellow copies are furnished to Material Control Section for distribution to field.

   4. Two extra copies (when required) are sent to the Inspection Department.

The requisition procedure above outlined, originally established at the inception of the Military Structures Program, proved very practical and efficient. The requisition section of the Home Office Construction Department was soon asked to handle the entire flow of Engineering Department bills of material requests. All requisitioning in connection with all phases of the construction program was performed by this section throughout the balance of the project.

CHAPTER 6.6

CONSTRUCTION OF BASE FACILITIES AND SCIENTIFIC STATIONS

The accomplishment of construction at the Eniwetok Proving Ground covers a span of time from early 1949 through the construction of the towers and facilities required for the "E-Plus" Program during the period between the second and third shot. For purposes of discussion, the construction activities are considered here by six-month periods.

JULY 1949 TO JANUARY 1950

The construction performed during the beachhead period in the early part of 1949 was concerned mainly with the preparation of areas for effective occupancy by the augmented forces which were to follow the beachhead group. The categories of the construction effort during this early period included: cleanup and salvage; development of interim power and water supply systems; rehabilitation of existing buildings for interim housing and base facilities; preparation of island approaches, inter-island transportation, and communication; and the solution of the decontamination technique problem. The accomplishments during this period formed the foundation for the greater construction effort which followed.

As has been noted elsewhere (See Volume 1, Section 4, Contract History.), the funds available for the Project prior to July 1, 1949 were very limited. As a consequence, no backlog of materials for Phase II and subsequent construction operations could be accumulated. Concurrently with the allotment of funds at the close of fiscal year 1949, material procurement and manpower mobilization could be prosecuted vigorously at the Home Office. Pending the reflection of this effort at the Jobsite, construction activities comprised in the main, the completion of the airstrips on Parry, Runit, Aomon, and Engebi Islands, the decontamination of the shot areas, the rehabilitation of piers and boat landings at the various operations islands, and the preparation of foundations for the permanent buildings to be erected on Parry Island.

At this time the mobilization of manpower proceeded more rapidly than the procurement and shipment of materials to the Jobsite. As a result, in the early part of September 1949, approximately 200 Holmes & Narver personnel were on duty at Eniwetok. The limited housing facilities on Eniwetok Island were filled and it was not considered economical to expand the Eniwetok interim camp to any greater extent. It had been expected that aluminum buildings for permanent construction on Parry Island would be available at the end of the beachhead period to provide housing facilities on Parry Island. When it became apparent that only a small increment of aluminum buildings was scheduled for delivery early in October 1949, a decision was made to activate Parry Island as a camp on an interim basis to take the overflow from Eniwetok. A minimum amount of work was performed in the rehabilitation of old quonset structures existing on Parry Island, and portable generators and water stills were installed. A minimum field kitchen was also established for mess purposes.

A quarry was immediately opened and foundations were prepared for the aluminum buildings for which the aluminum was scheduled to arrive in early October. Inasmuch as Parry Island was ultimately to be used as a supply and maintenance center, the vital features of warehouse and shop space were developed by the rehabilitation of some large quonset structures which had been included in the planned construction for this period.

Considerable site grading was called for on Parry Island and this work was done by the Parry Island contingent during the latter part of the summer of 1949. The actual accomplishment of grading operations on Parry Island involved, in addition to the removal of derelict structures, the clean-up of the northern half of the island and the removal therefrom of large quantities of junked equipment and materiel of all types. Earthmoving equipment, M-boats, engines, generators, Navy cube-shaped containers, ammunition trailers, and vehicles of all types had been abandoned after the war and left to the corrosive action of the elements. More than a thousand tons of this junk was dragged from the dump area and either loaded aboard barges for dumping at sea or moved to the lagoon side of the island to form a barrier against tidal action. More than thirty abandoned unrepairable small craft such as M-boats, whale boats, and AVR types were towed out to sea and dynamited.

During this clean-up considerable quantities of material were found which were still in usable condition and a salvage yard was established. Corrugated steel sheathing, pipe, packaged POL supplies, a few jeeps and weapons carriers, portable refrigerators, and earthmoving equipment formed the bulk of the salvage, and practically all was later utilized in the construction program.

As various portions of the island were cleared of debris, blading operations began and were followed immediately by the application of a stabilizing layer of crushed coral which was to cover the main living and working areas and roads. Successive rolling and wetting of this crushed coral base resulted in a well stabilized surface which, with further compaction and wetting, would provide low cost roads which would require only periodic dust palliative applications.

Concurrently with the grading activity on Parry Island, decontamination grading on the experiment islands was completed using the "Rainmaker" technique described above in connection with beachhead operations.

The first shipment of aluminum buildings arrived at the Atoll on October 6, 1949. This shipment included parts for 16 buildings, 10 of which were erected by the middle of December. Four 36-man barracks were occupied on Parry Island in December.

Inclusion of the Bio-Medical Program had been agreed upon prior to July 1, 1949, and on that date Work Authorization No. 2 authorized the activation of Japtan Island as an animal colony, laboratory, and camp for the personnel engaged in that program. The complete construction of limited facilities for the breeding of mice was required by December 1,1949. Site plans for this island were received at Eniwetok early in October and

Paved Airstrip on Runit, July 1950, Showing Paved Turn-around Areas. Temporary Construction Camp at Left.

Semi-Permanent Campsite on South End of Runit, Showing Camp
Under Construction. Beached LCM'S from World War II Were
Later Removed to Clear Area for Scientific Stations.

the grading of roads and building site areas was initiated immediately. By the end of October 1949, foundations, floor slabs, and footings were poured, and the erection of such aluminum buildings as could be diverted from the Parry requirement was initiated. Temporary utility hookups were established for Bio-Medical personnel before the arrival of animals on December 1, 1949.

With the arrival of aluminum at the Jobsite, the Project passed from the mobilization stage into the active construction stage. From this time on, the tempo of the work increased at Parry and the operational islands to the north. Thus, as of December 15, 1949, construction of 17 buildings was under way or completed on Parry Island; 2 aluminum buildings for the mouse colony were completed on Japtan Island; the sewer system on Parry Island (including the outfall line) was complete, and buildings were being hooked into the system. Airstrips were completed on Parry, Runit, Aomon, and Engebi; the personnel pier on Parry was complete; and the cargo pier largely complete. New piling had been driven for the Eniwetok pier; grading operations on the Parry sites and on Japtan were almost complete; and roads had been staked on these two islands and were under construction. POL facilities on Parry Island were under construction, and four large tanks had been installed. Almost 6,000 tons of materials and supplies in various categories had been received at the Jobsite, but the establishment of warehouse stocks of all required supplies, materials, and aids to construction had not yet been accomplished. Thus, 100 per cent completion of any particular item of construction was deferred. It might be noted in this connection that of the many morale problems which could affect an overseas construction project of this type, such as poor housing facilities, poor food, complaints about mail deliveries, complaints about climate or recreational facilities, complaints about wages or work classifications, failure to mail paychecks to designated recipients, fulfillment of allotments, etc., the only one which appeared to be serious at this stage of the construction effort was concerned with the desire of the men to be able to work with more adequate supplies, that is, to follow through without a break on the construction of a particular building to completion.

With respect to the details of construction, no major problems were encountered. A certain amount of experimentation was necessary in the use of coral aggregate and in the preparation of a design mix suitable for the type of construction being carried out at this time. Due to variations in the moisture content of the coral aggregate used for concrete, some slight difficulties were encountered in maintaining consistency. At the initial stages of this effort and prior to the installation of a complete rock crushing and grading plant, aggregate gradations were not in accord with most desirable practice, but careful supervision of batching operations prevented any real difficulty from arising. In order to expedite the floor slab operations on Japtan Island experiments in the use of salt water in the coral concrete were carried out, and satisfactory results were obtained. Such practice also enabled the construction forces to conserve the fresh water and brackish water supply. This practice effected substantial economies.

Erection of the aluminum buildings followed predetermined, planned techniques. The first aluminum building on Parry Island was constructed in the presence of a representative of the Pacific Iron and Steel Company, the fabricators of the aluminum building, and minor assembly problems which occurred were noted and carried back to the fabricating organization for correction. Inasmuch as the erection of aluminum buildings was a major portion of the construction of permanent facilities at the Proving Ground, careful attention was given to the development of a smooth and efficient erection sequence. To accomplish this, an assembly yard was set up and a maximum number of parts were preassembled prior to placing on the foundation. To obviate painstaking layout of anchor bolts in the slabs during the pouring of the foundation slab, buildings were secured to the slabs by means of anchor bolts shot through the base members and into the concrete through the use of an explosive technique.

Preassembled ribs were connected to the base members, and crossbracings between ribs were next installed through the employment of a scaffold mounted on a dolly. The light weight of the members contributed to the progress and reduced the number of men needed for the various operations. With the skeleton well started, sheathing was begun, the roof being done first in order to provide shelter from the sun and frequent rain squalls.

The rectangular aluminum buildings presented no serious problems. However, in order to be in a position to fabricate necessary additional parts, particularly for transitions between buildings set in T, H, or E-shapes, a sheet metal shop was established on Parry early in the construction program. This shop later performed all prefabrication of ductwork needed for dehumidification and air conditioning installations. For the aluminum building program, its contribution was great. Flashing, gutters. special side pieces for window openings, and many other parts were fashioned at the shop and materially expedited this portion of the program.

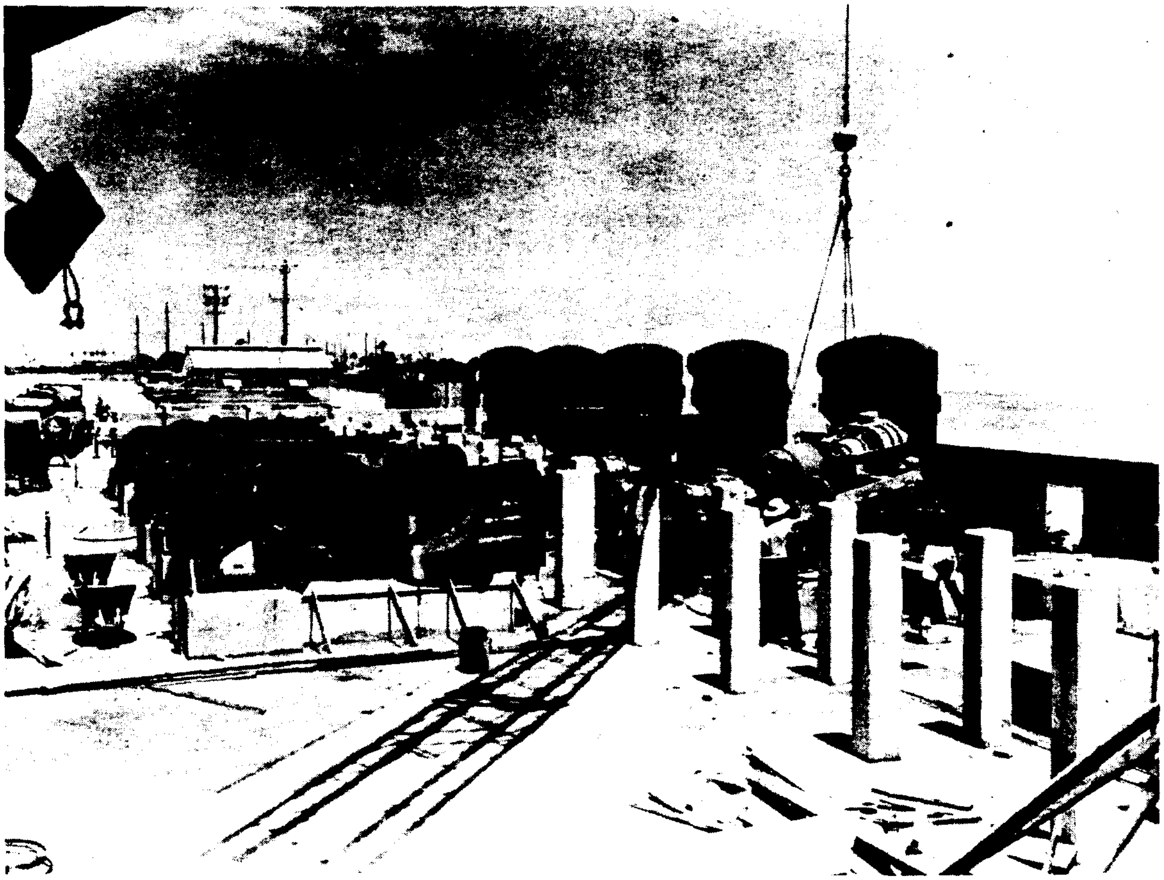
In all 428,092 square feet of aluminum buildings for living and office space were erected, and 12,458 square feet were erected on high concrete foundation walls to provide the height required in the power houses on Parry and Eniwetok Islands. Installation of wiring, plumbing, and installed equipment presented no unusual problems in most cases. Sealing those aluminum buildings which were to be dehumidified or air conditioned was accomplished in accordance with specifications by the employment of a plastic film built up by a spraying technique substantially identical with that used by the military forces in cocooning ships and equipment. This operation was carried out after all wiring, plumbing, and duct work had been installed in the area to be sealed.

The first aluminum building erected was a 36-man barracks (Building No. 101) and assembly operations were begun on October 10, 1949. On October 17, after the utilization of some 600 manhours, the structure was complete, except for the latrine section. The time consumed compared favorably with the experience of the fabricating plant using skilled technicians and mechanics. Throughout the course of the Project, as experience was gained in the assembly of this type of structure and crews became more adept in the techniques involved, the time required for completion was reduced. On occasion, the work had to be scheduled to fit the arrival of materials and often resulted in having several buildings partially finished waiting for some particular part.

Air Eliminators & Oil Dehydrators Being Installed in Slab for the POL Pumphouse, Parry Island.

POL Tank Farm, Parry Island, Showing Part of Tanks Installed, Pump House in Background.

General View of Center of Eniwetok Island Showing Headquarters, Post Exchange, Post Office, Hospital, & Barracks Buildings.



Pump for Water Distillation Unit Being Installed, Power House,
Eniwetok Island.

As the construction work progressed from the base camp to outlying areas, the problem of loss of manhours in the long boat ride involved received early attention. A successful initial remedy was to outfit an LCT with sufficient living facilities and messing facilities to provide for the on-site subsistence of approximately 30 men per unit. This technique was successfully employed in the decontamination grading activities which were necessary before a safe and practicable occupation of the outlying areas was possible. As early as it was feasible, secondary tent camps were established on off-lying islands to minimize the transportation problem and the unproductive manhours involved.

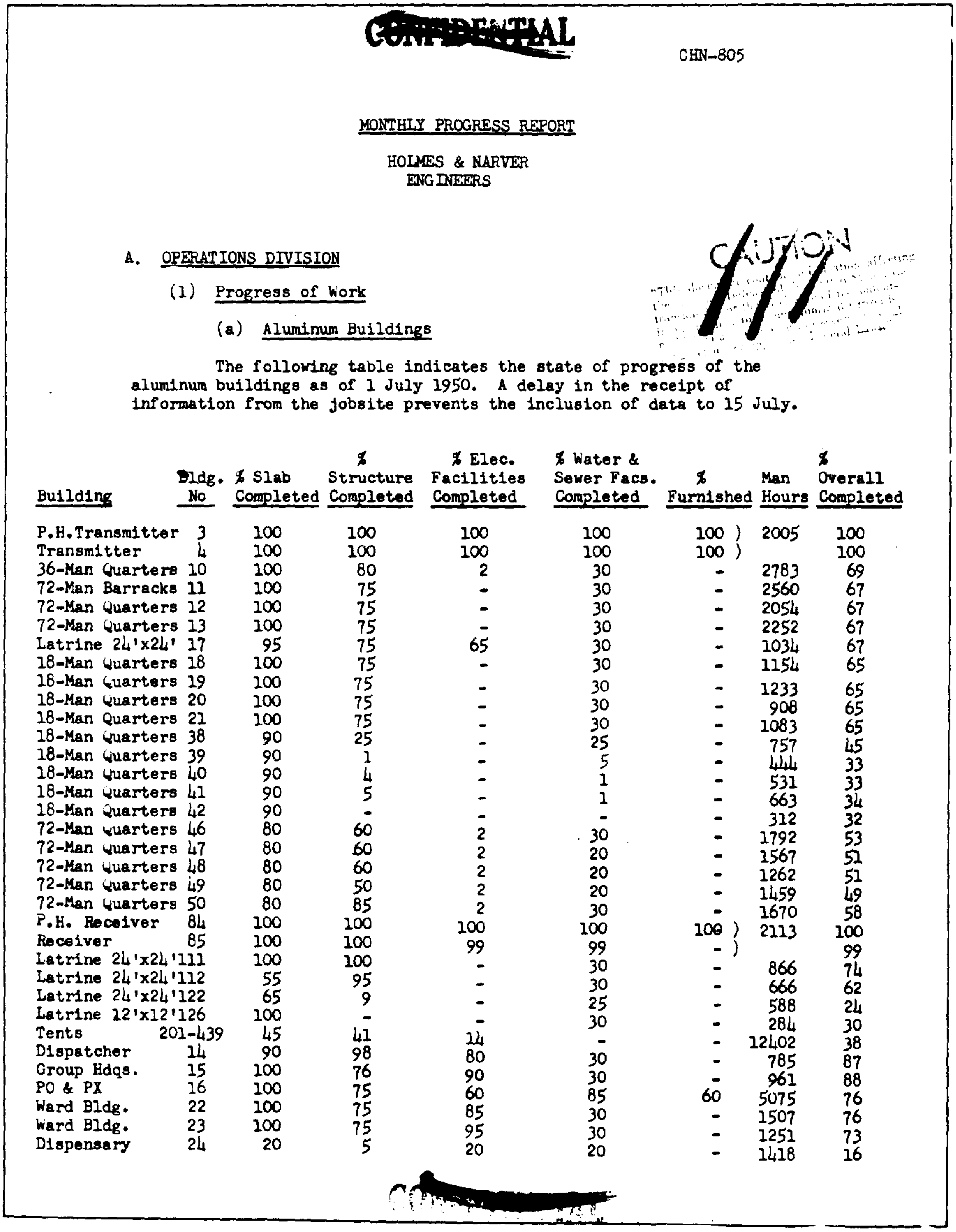
Initiated by Work Authorization 50-507-4, a high priority was given during this period to the activation of Bogallua Island, elsewhere referred to as Site "F", looking towards the accomplishment of a so-called "quick and dirty" test operation in the spring of 1950. Among the burdens this imposed on the construction schedule were the great secrecy surrounding the purpose of the Bogallua activation and the diversion it caused from regularly scheduled activities elsewhere. The effect of this diversion was similar to that created by the early activation of Japtan Island. Ultimately this work was cancelled when a decision was reached that the scientific test early in 1950 would not be held.

JANUARY 1950 TO JULY 1950

In view of the increase in scope of construction to be performed, and the planned increase in manpower thus required, the period between January 1, 1950 and July 1, 1950 was characterized by an increase in H & N personnel at the Jobsite from approximately 450 to approximately 1150. Events during this period included the arrival of a Construction Battalion to perform construction services in connection with the facilities required on Eniwetok Island; the substantial completion of the base facilities on Parry Island; the initiation of construction for the scientific programs, including the completion of the tower on Engebi; substantial amounts of foundation work for the Military Structures Program; and the establishment of major construction facilities at Runit, the Aomon Group, and Engebi.

Excavation for the Military Structures Program started in May 1950; soil investigations established in the specifications were carried out, and the necessary preparation of the excavations for forming was initiated. On Army Structure 3.1.1, some five hundred cubic yards of lean mixed concrete were placed in units 4, 5, and 7 as compacted fill for footings. Soil investigations for Navy Structure 3.2.7 revealed insufficient bearing at the originally designated location and work had to be stopped pending relocation. Navy Structures 3.2.2a and 3.2.2b were located and soil bearing tests were under way at the close of the first half of 1950. No location data had been received on Structures 3.2.1a and 3.2.1b. On the remaining structures work was pushed as rapidly as the arrival of specified materials at the site permitted.

Figure 6.6-1 presents extracts from the H & N Progress Report of July 15, 1950 showing in detail the progress of construction during the first half of 1950.



~~CONFIDENTIAL~~

CHN-805

MONTHLY PROGRESS REPORT

HOLMES & NARVER
ENGINEERS

~~CAUTION~~

A. OPERATIONS DIVISION

(1) Progress of Work

(a) Aluminum Buildings

The following table indicates the state of progress of the aluminum buildings as of 1 July 1950. A delay in the receipt of information from the jobsite prevents the inclusion of data to 15 July.

Building	Bldg. No	% Slab Completed	% Structure Completed	% Elec. Facilities Completed	% Water & Sewer Facs. Completed	% Furnished	Man Hours	% Overall Completed
P.H.Transmitter	3	100	100	100	100	100)	2005	100
Transmitter	4	100	100	100	100	100)		100
36-Man Quarters	10	100	80	2	30	-	2783	69
72-Man Barracks	11	100	75	-	30	-	2560	67
72-Man Quarters	12	100	75	-	30	-	2054	67
72-Man Quarters	13	100	75	-	30	-	2252	67
Latrine 24'x24'	17	95	75	65	30	-	1034	67
18-Man Quarters	18	100	75	-	30	-	1154	65
18-Man Quarters	19	100	75	-	30	-	1233	65
18-Man Quarters	20	100	75	-	30	-	908	65
18-Man Quarters	21	100	75	-	30	-	1083	65
18-Man Quarters	38	90	25	-	25	-	757	45
18-Man Quarters	39	90	1	-	5	-	444	33
18-Man Quarters	40	90	4	-	1	-	531	33
18-Man Quarters	41	90	5	-	1	-	663	34
18-Man Quarters	42	90	-	-	-	-	312	32
72-Man Quarters	46	80	60	2	30	-	1792	53
72-Man Quarters	47	80	60	2	20	-	1567	51
72-Man Quarters	48	80	60	2	20	-	1262	51
72-Man Quarters	49	80	50	2	20	-	1459	49
72-Man Quarters	50	80	85	2	30	-	1670	58
P.H. Receiver	84	100	100	100	100	100)	2113	100
Receiver	85	100	100	99	99	-)		99
Latrine 24'x24'	111	100	100	-	30	-	866	74
Latrine 24'x24'	112	55	95	-	30	-	666	62
Latrine 24'x24'	122	65	9	-	25	-	588	24
Latrine 12'x12'	126	100	-	-	30	-	284	30
Tents	201-439	45	41	14	-	-	12402	38
Dispatcher	14	90	98	80	30	-	785	87
Group Hdqs.	15	100	76	90	30	-	961	88
PO & PX	16	100	75	60	85	60	5075	76
Ward Bldg.	22	100	75	85	30	-	1507	76
Ward Bldg.	23	100	75	95	30	-	1251	73
Dispensary	24	20	5	20	20	-	1418	16

[redacted]

Figure 6.6-1. Extracts from H & N Progress Report of July 15, 1950

~~CONFIDENTIAL~~

SITE A (Continued)

Building	Bldg. No.	% Slab Completed	% Structure Completed	% Elec. Facilities Completed	% Water & Sewer Facs. Completed	% Furnished	Man Hours	% Overall Completed
Theatre-800 Man	30	-	95	95	-	-	2788	96
Reefer Bldg.	33	95	-	20	30	-	8910	76
Mess Hall	36	77	15	18	30	-	7306	40
Commissary	37	85	16	2	1	-	2491	59
Pow.& Water Dist.	56	80	2	16	-	-	6484	25
Hydrogen Storage	87	100	100	-	80	-	350	98
Weather Inst.Rep.	88	100	100	-	-	-	442	90
Base Operations	89	100	60	45	30	-	2593	71
Air Task Gr.Hqs.	90	100	65	40	30	-	4246	80
Crash Truck	91	100	80	85	-	-	6038	85
L-13 Operations	92	100	68	85	-	-	662	80
L-13 Maintenance	93	100	-	-	-	-	1450	40
POL Pump House	94	97	4	30	-	-	881	36
Theatre-800 Man	108	-	15	-	-	-	757	20
Elev.Wtr.Storage	121	100	100	-	-	-	2320	100
Salt Wat.PumpSta	124	100	-	10	20	-	3048	73
Bakery	35	5	-	-	8	-	292	3

SITE B

Barracks	100	100	100	100	100	100	1748	100
"	101	100	100	100	100	100	2183	100
"	102	100	100	100	100	100	1717	100
"	103	100	100	100	100	100	1955	100
"	104	100	100	100	100	100	1454	100
"	105	100	100	100	100	100	2152	100
"	106	100	100	100	100	100	1621	100
"	107	100	100	100	100	100	1957	100
"	108	100	100	100	100	100	1739	100
"	109	100	100	100	100	100	1584	100
"	110	110	100	100	100	100	1659	100
"	111	100	100	100	100	100	1086	100
"	112	100	100	100	100	100	1063	100
"	113	100	100	100	100	100	1000	100
"	114	100	100	100	100	100	1043	100
Infirmary	117	100	100	98	100	90)	3726	97
Nurses Quarters	118	100	100	98	100	90)	--	--
Barracks	119	100	100	100	100	100	974	100
"	120	100	100	100	100	100	859	100
"	121	100	100	100	100	100	815	100
"	122	100	100	100	100	100	1210	100
"	123	100	100	100	100	100	783	100
"	124	100	100	100	100	100	763	100
"	125	100	100	100	100	100	863	100
"	126	100	100	100	100	100	880	100
"	127	100	100	100	100	100	707	100
"	128	100	100	100	100	100	788	100
"	129	100	100	100	100	100	794	100
"	130	100	100	100	100	100	664	100

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~~CONFIDENTIAL~~

Figure 6.6-1. (Continued)

[redacted]

[redacted]

SITE B (Continued)

Building	Bldg. No.	% Slab Completed	% Structure Completed	% Elec. Facilities Completed	% Water & Sewer Facs. Completed	% Furnished	Man Hours	% Overall Completed
Theatre	200	100	100	100	100	100	1216	100
Mess Hall	201	100	100	100	100	100	10959	100
Bakery	202	100	100	100	100	100	1277	100
Boiler House	203	100	100	100	100	100	848	100
PX	204	100	95	98	98	90	2246	96
Fire Station	205	100	100	100	100	100	1057	100
Barracks	206	100	100	100	100	100	1314	100
H&N Ad.Bldg.	208	100	99	100	100	95	3297	99
AEC Ad. Bldg.	209	100	100	100	100	100	1936	100
Photo Lab.	210	100	98	90	45	-	2450	90
Inst. Lab.	211	100	-	-	10	-	446	25
Sample Lab.	212A	100	100	100	70	-	613	95
Sample Lab.	212B	100	100	95	50	-	434	96
Sample Lab.	212C	100	100	100	10	-	316	90
Guard Post	213	-	100	-	-	-	47	100
Guard Post	214	-	100	-	-	-	47	100
Day Room	216	100	100	100	100	100	253	100
Reefer Bldg.	217	100	100	100	100	100	4836	100
Reefer Bldg.Add.	217A	100	90	10	10	40	1533	64
T.F. Adm.Bldg.	221	100	30	-	-	-	3075	38
Day Room	222	100	100	100	100	100	626	100
Latrine	227	100	98	100	90	90	883	96
Latrine	228	100	98	100	90	90	937	96
Telemeter Bldg.	229	100	100	90	100	-	235	90
Commissary	230	100	100	100	100	-	597	100
Lab.	231	100	-	-	-	-	145	25
POL Pump House	300	100	100	100	100	100	686	100
Power&Wtr.Plant	301	100	100	100	100	100	16589	100
Laundry	302	100	100	100	100	100	2393	100
Boiler House	303	100	100	100	100	100	848	100
Warehouse	308	100	100	100	100	100	1444	100
Test Lab.	309	100	100	100	100	100	387	100
Control Bldg.	311	100	100	98	98	-	449	99
Warehouse	313	100	100	100	100	100	1260	100
Plumbing Shop	314	100	100	100	100	100	816	100
Elec. Shop	315	100	100	100	100	100	852	100
Sheet Metal Shop	316	100	100	100	100	100	877	100
Carpenter Shop	317	100	100	100	100	100	687	100
Paint Shop	318	100	100	75	100	100	441	99
Mtr Repair Shop	322	100	100	100	100	100	500	100
Rad-Safe Bldg.	323	100	100	98	95	95	2267	95
Boat Repair Shop	406	100	100	100	100	100	779	100
Telep.Shelter	408	-	-	-	-	-	-	-
Recreation Bldg.	409	100	100	100	100	100	1985	100
S.W.Pump Sta.	410	100	100	100	100	100	929	100
Latrine-Whse Area	-	100	100	100	100	100	112	100
Garbage Can Bldg.	-	100	100	100	100	100	316	100
Tents	1-50	100	[redacted]	[redacted]	100	100	2683	100

Figure 6.[redacted]1. (Continued)

[redacted]

Building	Bldg. No.	% Slab Completed	% Structure Completed	% Elec. Facilities Completed	% Water & Sewer Facs. Completed	% Furnished	Man Hours	% Overall Completed
SITE C								
Latrine	100	100	-	-	25	-)	935	28
Latrine	101	100	-	-	25	-)		28
Latrine	108	100	-	-	25	-)		28
Mess Hall	102	100	-	10	25	-	568	20
Theatre	103	100	100	98	-	-	517	99
Admin.Bldg.	105	100	-	-	25	-	243	28
Power & Wtr.Plt.	106	-	12*	2	2	-	1596	9
Repair Ship	107	100	-	-	20	-	136	27
Fire & First Aid	109	100	-	-	20	-	171	27
Grease Rack	-	100	100	-	-	-	81	100
Tests	1-50	100	45	-	-	-	1863	68
Warehouse	-	-	100	-	-	-	-	
Refreshment Tent		10	-	-	-	-	18	3
SITE D								
Latrine	102	100	-	-	20	)	829	22
Latrine	107	100	-	-	20	)		22
Mess Hall	104	100	10	10	25		750	25
Theatre	100	100	100	25	-		515	95
Admin. Bldg.	105	100	-	-	20		135	25
Power&Wtr.Plant	108	-	25*	2	5	10	4839	27
Repair Shop	106	100	-	-	--	-	388	25
Fire&First Aid	103	100	-	-	20	-	120	25
Grease Rack	-	100	100	-	-	-		100
Warehouse	-	-	-	-	-	-	-	-
Tents	1-50	100	75	-	-	-	2196	80
Refreshment Tent		10	10	-	-	-	51	8
SITE E								
Latrine	101	100	90	100	100	100)	3191	95
Latrine	107	100	90	100	100	100)		95
Latrine	108	100	90	100	100	100)		95
Mess Hall	103	100	98	95	100	88	4441	93
Theatre	109	100	100	100	100	100	182	100
Admin.Bldg.	106	100	-	-	-	-	415	18
Power&Wtr.Plant	100	-	60*	5	5	10	7934	44
Repair Shop	102	100	-	-	-	-	266	18
Fire&First Aid	104	100	-	-	-	-	51	18
Grease Rack	-							
Warehouse	-		25	-	-	-	129	
Tents	1-85	100	100	100	-	100	4120	100
Camp Extension								
Tents	87-154	100	-	-	-	-	707	40
Latrines (2)		100	-	-	20	-	468	30
Mess Hall Add.		100	90	-	20	-	1578	60
P.O.,PX,Rec.Hall		100	100	-	90	90	490	80

* All concrete structure.

[redacted]

Figure 6.6-1. (Continued)

[redacted]

SITE L

Building	Bldg. No.	% Slab Completed	% Structure Completed	% Elec. Facilities Completed	% Water & Sewer Facs. Completed	% Furnished	Man Hours	% Overall Completed
X-Ray Bldg.	1	100	100	100	100	100	757	100
Mess Hall	2	100	100	100	100	95	4454	99
36-Man Barracks	4	100	100	100	100	100	1370	100
18-Man Barracks	6	100	100	100	100	100	936	100
18-Man Barracks	7	100	100	100	100	100	854	100
S.W.Pump Sta.	8	100	100	100	100	100	1118	100
Power &Wtr.Plt.	11	100	100	99	100	100	6136	99
Laboratory	12	100	95	100	100	90	4242	98
Mouse House	13	100	100	100	100	100	1947	100
Incinerator	46			-	-	-	-	
Feed StorageBld	47	100	100	100	-	-	443	100
Booster PumpSta	48	100	100	100	100	100	1084	100
Autopsy Bldg.	49	100	100	100	100	90	1659	97
Greenhouse	50	100	100	100	-	-	127	100
Animal Runs	14-45**	100	98	100	99	-	15306	97
Grease Rack & Service Sta.			100	-	-	-	322	100
New Mouse House	-	-	-	-	-	-	-	-

** 20 Runs Completed.

[redacted]

Figure 6.6.-1. (Continued)

[redacted]

(b) Sewer System

Site A - 8320 lin. ft. of sewer pipe has been laid, of which 1360 lin. ft. is the outfall. This represents 53% completion and 8712 man-hours expended.

Site B - 14,600 lin. ft. of sewer pipe laid, representing 100% completion, with 8925 man-hours expended.

Site C - 2170 lin. ft. of sewer pipe laid, representing 90% completion and expenditure of 747 man-hours.

Site D - 1600 lin. ft. of sewer pipe laid, representing 95% completion, with an expenditure of 505 man-hours.

Site E - 8000 lin. ft. of sewer pipe laid, which constitutes 100% completion, with 1442 man-hours expended, There is also an extension of 450 feet of sewer pipe necessary because of camp expansion. So far no sewer pipe has been laid.

Site L - 5900 lin. ft. of sewer pipe has been laid, representing 100% completion, with an expenditure of 3299 man-hours.

(c) Fresh and Salt Water Systems

The following are the percent completions for the various locations:

Site A - 45%; Site B - 100%; Site C - 95%; Site D - 95%; Site E - (exclusive of camp extension, representing 400 lin. ft. each of fresh and salt water lines) - 100%; Site L - 100%.

(d) Power and Distillation Plants

The following is the status for installation of generators and distillation units for the various locations:

Site A - 5 generators, averaging 30% completion; 8 distillation units averaging 30% completion.

Site B - 5 generator units, 100%; 4 distillation units, 100% complete.

Site C - 2 generator units, not started; 3 distillation units, not started.

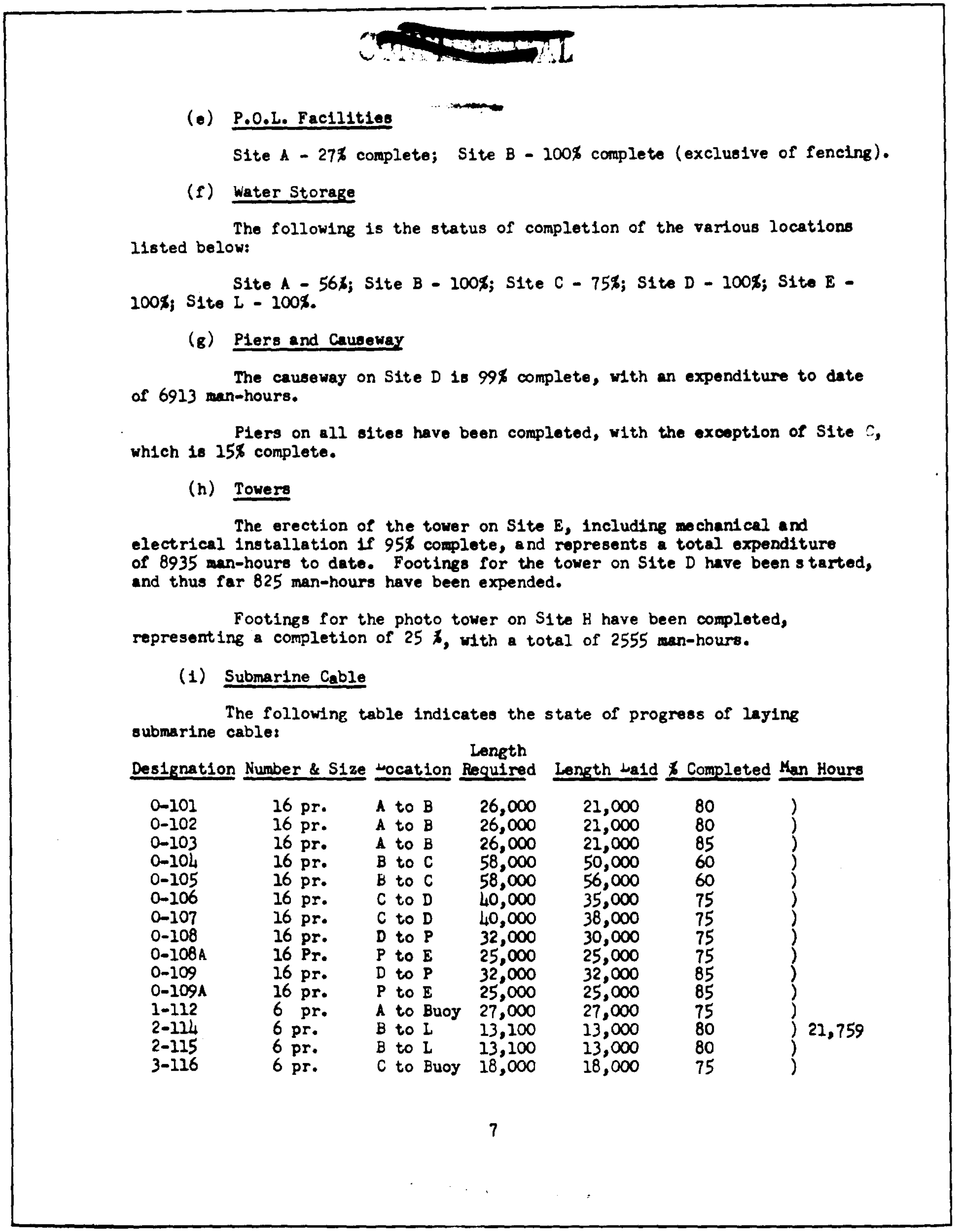
Site D - 2 generator units, just started; 3 distillation units, not started.

Site E - 3 generator units, averaging 5% completion; 3 distillation units, averaging 5% completion.

Site L - 1 generator unit, 100% complete; 4 distillation units, two of which are 100% complete. The other two are 75% complete.

[redacted]

Figure 6.6-1. (Continued)



[redacted]

(e) P.O.L. Facilities

Site A - 27% complete; Site B - 100% complete (exclusive of fencing).

(f) Water Storage

The following is the status of completion of the various locations listed below:

Site A - 56%; Site B - 100%; Site C - 75%; Site D - 100%; Site E - 100%; Site L - 100%.

(g) Piers and Causeway

The causeway on Site D is 99% complete, with an expenditure to date of 6913 man-hours.

Piers on all sites have been completed, with the exception of Site C, which is 15% complete.

(h) Towers

The erection of the tower on Site E, including mechanical and electrical installation if 95% complete, and represents a total expenditure of 8935 man-hours to date. Footings for the tower on Site D have been started, and thus far 825 man-hours have been expended.

Footings for the photo tower on Site H have been completed, representing a completion of 25 %, with a total of 2555 man-hours.

(i) Submarine Cable

The following table indicates the state of progress of laying submarine cable:

Designation	Number & Size	Location	Length Required	Length Laid	% Completed	Man Hours
0-101	16 pr.	A to B	26,000	21,000	80	)
0-102	16 pr.	A to B	26,000	21,000	80	)
0-103	16 pr.	A to B	26,000	21,000	85	)
0-104	16 pr.	B to C	58,000	50,000	60	)
0-105	16 pr.	B to C	58,000	56,000	60	)
0-106	16 pr.	C to D	40,000	35,000	75	)
0-107	16 pr.	C to D	40,000	38,000	75	)
0-108	16 pr.	D to P	32,000	30,000	75	)
0-108A	16 Pr.	P to E	25,000	25,000	75	)
0-109	16 pr.	D to P	32,000	32,000	85	)
0-109A	16 pr.	P to E	25,000	25,000	85	)
1-112	6 pr.	A to Buoy	27,000	27,000	75	)
2-114	6 pr.	B to L	13,100	13,000	80	) 21,759
2-115	6 pr.	B to L	13,100	13,000	80	)
3-116	6 pr.	C to Buoy	18,000	18,000	75	)

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Figure 6.6-1. (Continued)

[redacted]

Designation	Number & Size	Location	Length Required	Length Laid	%Completed	Man Hours
3-117	6 pr.	C to M	3,000	5,000	75	)
3-118	6 pr.	C to M	3,000	5,000	75	)
4-119	6 pr.	D to Buoy	23,000	22,000	75	)
4-120	6 pr.	D to N	12,500	12,000	80	)
4-121	6 pr.	D to N	12,500	12,000	80	)
5-124	6 pr.	E to Buoy	10,000	10,000	75	)
5-125	6 pr.	E to S	7,000	7,000	80	)
5-126	6 pr.	E to S	7,000	7,000	80	)
5-127	6 pr.	E to Q	23,000	22,000	80	)
5-128	6 pr.	E to Q	23,000	22,000	80	)
5-129	6 pr.	E to F	39,000	39,000	75	)

(j) Paving

Following is the status of progress with respect to paving:

Site C - 4000 sq. yd. of 3" paving; 1700 sq. yd. of 1½" paving. This represents 21% completion.

Site E - 3500 sq. yd. of 3" paving; 9400 sq. yd. of 1½" paving, representing 80% completion.

(2) Miscellaneous Items of Interest

14 June. A buoy was installed in the lagoon for the use of Mars planes.

22 June. Unloading was completed from the USS Whiteside, and she departed from the atoll.

1 July. USS Yancey arrived at the jobsite with 3903 M/T cargo.

6 July. One hundred and three men arrived at the jobsite, most of whom were transported on the General Butner from San Francisco and Honolulu to Kwajalein.

13 July. The USS Mispillion arrived at the jobsite with 923,471 gallons of asphalt, and the following cargo:

- 1 Water Taxi
- 1 Spare Gray Marine Engine
- 1 Derrick Drill with drill, wagon and accessories
- 1 Dewalt Power Saw, with combination saw blades
- 1 Cement testing Machine

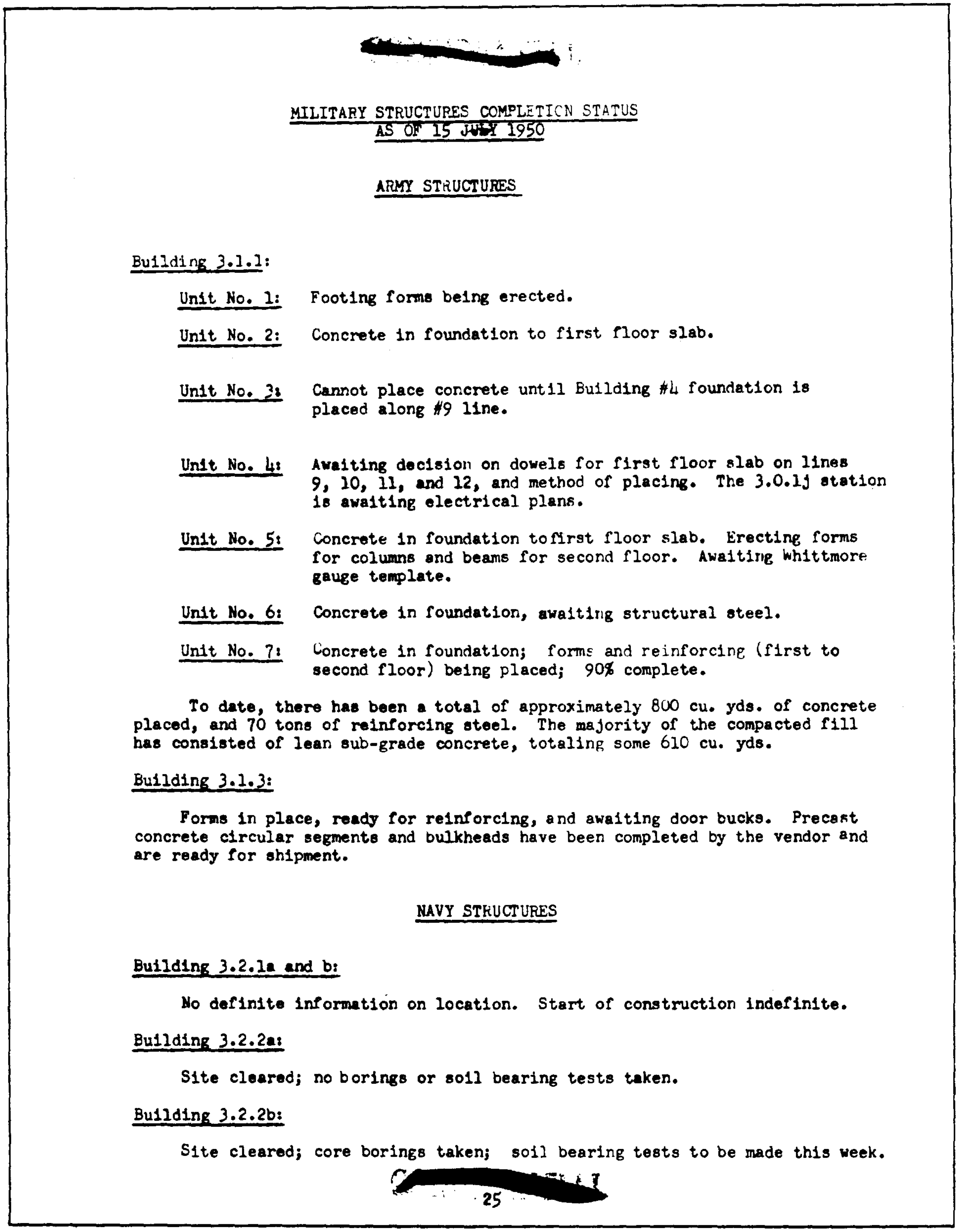
14 July. The USS Warrick arrived at the jobsite with 2650 M/T of cargo.

14 July. Dr. Hallen, who will establish dental facilities at the jobsite, departed Los Angeles.

[redacted]

[redacted]

Figure 6.6-1. (Continued)



[redacted]

MILITARY STRUCTURES COMPLETION STATUS
AS OF 15 JULY 1950

ARMY STRUCTURES

Building 3.1.1:

Unit No. 1: Footing forms being erected.

Unit No. 2: Concrete in foundation to first floor slab.

Unit No. 3: Cannot place concrete until Building #4 foundation is placed along #9 line.

Unit No. 4: Awaiting decision on dowels for first floor slab on lines 9, 10, 11, and 12, and method of placing. The 3.0.1j station is awaiting electrical plans.

Unit No. 5: Concrete in foundation tofirst floor slab. Erecting forms for columns and beams for second floor. Awaiting Whittmore gauge template.

Unit No. 6: Concrete in foundation, awaiting structural steel.

Unit No. 7: Concrete in foundation; forms and reinforcing (first to second floor) being placed; 90% complete.

To date, there has been a total of approximately 800 cu. yds. of concrete placed, and 70 tons of reinforcing steel. The majority of the compacted fill has consisted of lean sub-grade concrete, totaling some 610 cu. yds.

Building 3.1.3:

Forms in place, ready for reinforcing, and awaiting door bucks. Precast concrete circular segments and bulkheads have been completed by the vendor and are ready for shipment.

NAVY STRUCTURES

Building 3.2.1a and b:

No definite information on location. Start of construction indefinite.

Building 3.2.2a:

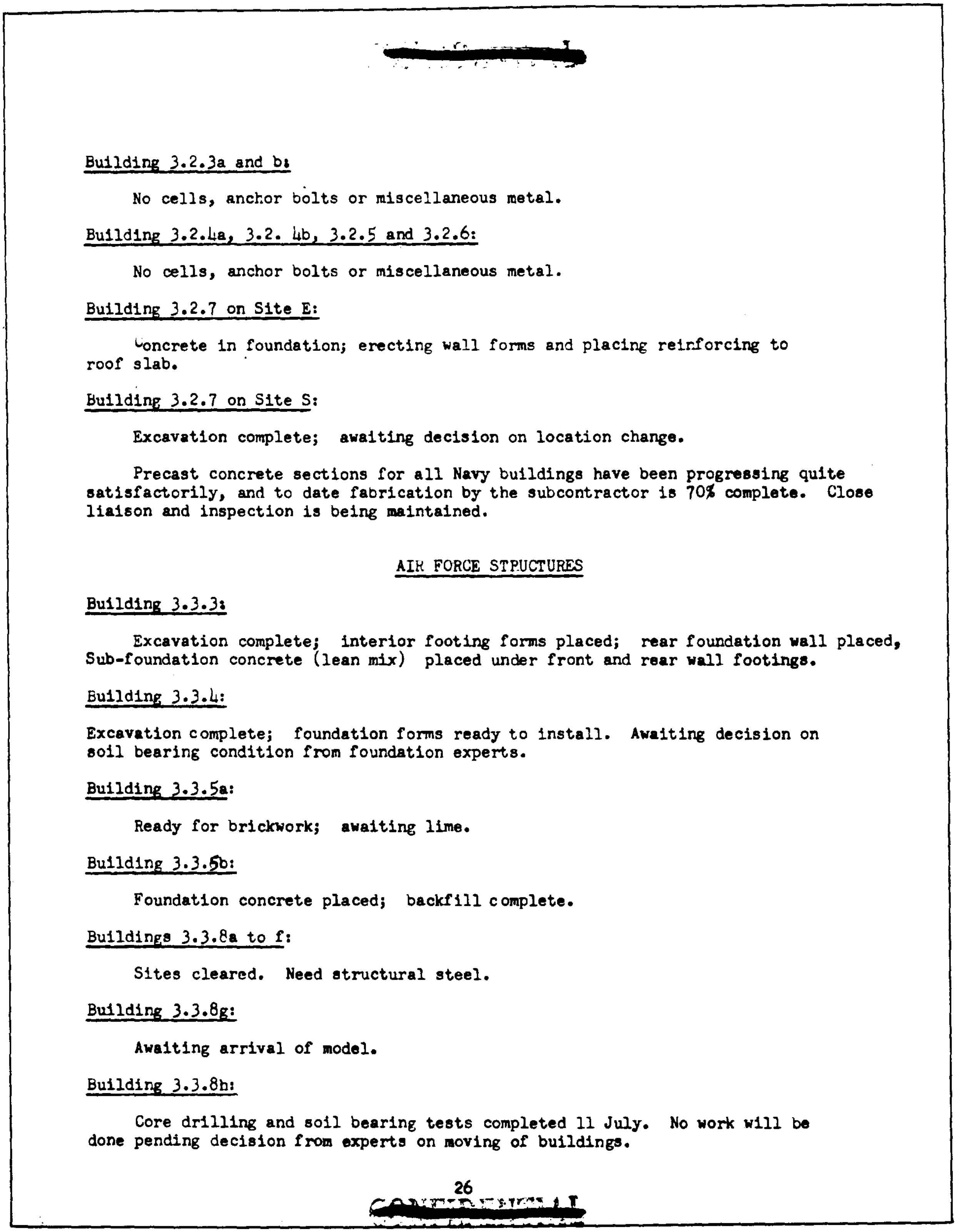
Site cleared; no borings or soil bearing tests taken.

Building 3.2.2b:

Site cleared; core borings taken; soil bearing tests to be made this week.

[redacted]

Figure 6.6-1. (Continued)



[redacted]

Building 3.2.3a and b:

No cells, anchor bolts or miscellaneous metal.

Building 3.2.4a, 3.2. 4b, 3.2.5 and 3.2.6:

No cells, anchor bolts or miscellaneous metal.

Building 3.2.7 on Site E:

Concrete in foundation; erecting wall forms and placing reinforcing to roof slab.

Building 3.2.7 on Site S:

Excavation complete; awaiting decision on location change.

Precast concrete sections for all Navy buildings have been progressing quite satisfactorily, and to date fabrication by the subcontractor is 70% complete. Close liaison and inspection is being maintained.

AIR FORCE STRUCTURES

Building 3.3.3:

Excavation complete; interior footing forms placed; rear foundation wall placed, Sub-foundation concrete (lean mix) placed under front and rear wall footings.

Building 3.3.4:

Excavation complete; foundation forms ready to install. Awaiting decision on soil bearing condition from foundation experts.

Building 3.3.5a:

Ready for brickwork; awaiting lime.

Building 3.3.5b:

Foundation concrete placed; backfill complete.

Buildings 3.3.8a to f:

Sites cleared. Need structural steel.

Building 3.3.8g:

Awaiting arrival of model.

Building 3.3.8h:

Core drilling and soil bearing tests completed 11 July. No work will be done pending decision from experts on moving of buildings.

[redacted]

Figure 6.6-1. (Continued)

During the summer and early fall of 1949, agreements were reached between the AEC and the Department of Defense for the provision of military construction forces to perform construction activities in connection with the base facilities at Eniwetok Island. The formal directives covering this aspect of the construction to be done at the Proving Ground were included in Work Authorization No. 50-507-6 dated November 3, 1949, covering the activation of Eniwetok Island. These directives included the performance of certain functions by H & N as construction representatives for the AEC, such as the procurement of all materials required except tents, furnishing, mess, and infirmary equipment, the provision of certain supervisory personnel to assist in the construction, and the rendering of inspection services.

In order to plan the working relationship between the military forces and H & N at the Jobsite and to define the responsibilities of each, a meeting was held in Washington on January 30, 1950 at which representatives of JTF-3, the 7th Engineer Brigade, including the 79th Construction Battalion, the AEC, and H & N participated. The agreements reached are set forth in the Memorandum of Agreement, presented as an exhibit at the end of this volume. Briefly stated, these agreements concerned a statement of all of the items of construction to be erected on Eniwetok Island, the responsibility of H & N to design all of the facilities and to supply working drawings to the Construction Battalion, as well as specified materials therefor. H & N was to construct certain of the designated facilities which were deemed to be beyond the capabilities of the Battalion, such as, for example, the power plants and was to provide certain categories of supervisory technicians to assist the military group in the performance of the construction services. The Brigade undertook to support H & N activities by providing stevedoring services, although the operation of all boats, tugs, barges, and lighters was to remain the responsibility of H & N, supplemented by such boats from TG3.2 as could be provided. The operation of utilities and the provision of maintenance materials was also agreed to be the responsibility of H & N.

The arrival of the Brigade fully equipped, selfsustaining and ready to perform the required services was planned for March 1, 1950, and assurances were given that sufficient construction materials would be on hand for initial construction activities. The movement of all H & N personnel from the interim camp established on Eniwetok Island to the facilities becoming available on Parry Island was also involved in the arrangements being made for the Battalion's effort at the Atoll, inasmuch as the Battalion desired to use the interim camp for its initial activities.

The period between February 15, 1950, and April 15, 1950, was replete with meetings between key personnel of the organizations concerned. Discussions were directed towards alleviation of anticipated difficulties and solution of problems which had already arisen. It was clear that an adjustment in procurement of materials by H & N would be necessary and that the flow of materials to the Jobsite had to be augmented. It was also clear that a period of readjustment at the Jobsite would be required for both the H & N forces and the Construction Battalion. The possibility of delay in the delivery of construction plans was recognized as was the possibility of delay in having sufficient materials for all the required structures on Eniwetok Island on hand at the times specified.

It should be remembered that the original planning of facilities for Eniwetok Island provided for occupancy by some 600 personnel. These plans had been expanded to provide facilities for 1800 persons. In addition, the location and details of many of the buildings and structures planned for Eniwetok Island were still to be resolved by the various using groups. However, a considerable amount of work in demolition of existing structures on Eniwetok Island, the removal of debris from site areas, and other tasks had to be performed before actual construction of the new facilities could be accomplished. It was thus the general consensus of opinion that no serious impairment of the potential of the construction troops would occur.

On February 24, 1950, by Administrative Order No. 1, JTF-3 instructed the Construction Battalion through the Commander of TG3.2 to execute its mission. These instructions included:

A. The general clean-up of the island and removal of all structures not required for the operation.

B. New construction and rehabilitation of existing housing facilities to accommodate 2560 military and civilian personnel, together with related services, such as mess hall, laundry, bakery, dispensary, and recreational facilities.

C. The extension of the existing 6400 foot runway, and the construction and installation of wharfs, POL facilities, fresh water distillation facilities, power facilities, roads, and warehouses.

It was also provided that upon the arrival of the Battalion in the forward area the Navy would provide an APL to quarter approximately half of the incoming troops.

Advance elements of the Construction Battalion reached Eniwetok on March 10, 1950, and the main group arrived by ship on March 16, 1950. The ensuing 30 days brought to light many problems which had not been completely resolved by earlier discussion. For the most part, such problems were dealt with in meetings held as the occasion demanded, between representatives of the Battalion, the AEC and H & N. In general this type of liaison was both harmonious and effective.

The fact that plans for Eniwetok Island were not available on March 15, because of revisions required by JTF-3 and conveyed to H & N through the AEC was a major cause for concern on the part of the Commander of TG3.2. This problem and others faced by the Battalion were discussed at a series of meetings held from April 19 through April 22, attended by the Commander of JTF-3, the Manager of SFOO, AEC, the Commander of TG3.2, and representatives of the staffs of these organizations and of H & N. The serious light thrown on the statement of problems by the Commander of TG3.2 at these meetings was unanticipated in view of the fact that assigned liaison representatives of TG3.2, the AEC, and H & N had established effective working relationships and had discussed them in some detail. It should be noted that the problems discussed at the April meetings were similar in nature and in import to those faced by the H & N forces since the beginning of the beachhead period and were related in part to the fact that this undertaking for the Battalion was not a normal military construction effort.

The subjects raised were discussed at some length and at the close of the meetings, the Commander of TG3.2 returned to the United States with the visiting group. On June 1, 1950, a new Commander of TG3.2 was designated. In the meantime, a routine of regular weekly meetings between representatives of TG3.2, the AEC, and H & N was established which effectively resolved such mutual problems as changes and modifications in the plans and in construction materials, allocation of materials, boat schedules, stevedoring services, and the like. The first of these meetings was held on April 24, 1950, and a spirit of genuine cooperation was achieved which played a significant part in the ultimate accomplishment at the Proving Ground.

During the period between January 1, 1950 and July 1, 1950, one of the more significant problems resolved, was concerned with the final determination of the paving material to be used in the rather extensive paving program which was planned. It will be recalled that the reconnaissance report had recommended the employment of hot-mix asphalt for all paving purposes. However, the procurement of a hot-mix plant involved an expenditure which, upon re-examination, did not appear to be justified. Furthermore, in view of the extensive amount of paving proposed for the stabilization of zero areas as well as for road work, a search for cheaper substitutes was initiated. This search resulted in the placement on Parry Island of a series of test strips in which various asphaltic materials were employed. Exposure of these test strips to the elements and to explosive forces ultimately led to the decision to employ Bitumuls in the paving mix. Shipments of substantial quantities of this material were soon dispatched to the Jobsite and paving operations were begun. The details of the experiments and the mixes employed are given in Chapter 5.22, Paving, Volume 2 of this report.

Also, during this period, in view of the anticipated requirement for large amounts of coral concrete meeting high strength specifications for the Military Structures Program, efforts were directed towards the establishment of procedures which would assure the desired results. A quarry, rock crushing equipment, an aggregate plant, and a concrete batching plant had been established on Engebi Island, and concrete testing facilities were available. Eventually, a suitable design mix was established as a result of the experimentation program. Details are given in the extracts from the H & N concrete report, presented as an exhibit at the end of this volume.

It might be noted that in addition to the requirement for high strength that the close spacing of reinforcing steel in many of the structures constructed imposed a requirement for concrete which could be poured without causing voids. Thus, beach sand was found to be too coarse, as it resulted in a harsh concrete because the fines had been washed out. A sand deposit containing suitable fine gradations was found in the lagoon

Blasting Coral Ledge on Reef to Obtain Rock for Crusher Plant.

Crusher Plant in Operation.

under twenty feet of water and was exploited through the use of a clamshell equipped crane operating on a barge. A stockpile of this sand was established at each of the operational island batch plants.

Concrete was hauled from the batch plant on Engebi, as at the other islands, in tubs and transit-mix trucks. The utilization of tubs was held to a minimum in view of the fact that excessive segregation took place when concrete was hauled in such a manner for distances in excess of half a mile.

Prior to July 1, 1950, approximately 75 per cent of the 620,000 feet of submarine cable required had been laid and checked out. This operation involved the performance of work beyond the normal activities engaged in by a construction contractor. It will be recalled that the principal difficulty reported in the laying of cable during operation Sandstone had been in keeping ships on the desired course under the prevailing winds and at the same time laying cables without paying out the cable at an excessive speed. As a result of considerable investigation and study of the methods, equipment, and manpower which might most effectively be used for cable laying, it was decided that laying from coils arranged in a figure eight pattern on a barge deck was the most feasible method. Reels were not used in order to avoid the necessity for stopping the laying operation at every 6,000 foot interval in order to pay out the splice case containing the loading coils essential to meet the communications specifications established.

No standard equipment was available for the job, and the only commercial cable ship and crew were much too large to navigate the lagoon. As a consequence, special equipment required was designed and fabricated at the Jobsite. The design took into account the three procedural problems encountered during Sandstone operations. At that time, a powered boat had been used as the laying barge, thus imposing a propeller hazard. In order to minimize this hazard, the cable had been led over the side of the barge,which resulted in flexing the cable unnecessarily and which increased cable handling difficulties. In addition, this imposed an eccentric drag on the barge and added to navigational difficulties. Lastly, the cable had been coiled in a circular pattern instead of a figure eight which created an unnecessary cable torque and increased the possibility of fouling between coils.

These procedural problems were overcome by the employment of a tug-hauled barge as the vehicle; by leading the cable successively through a set of fair leads, specially designed brakes, and a stern guide plate set at an angle of between 30° and 60° from the horizontal; and by laying the cable on the barge in a figure eight pattern in which each successive coil of the figure eight was to progress by at least one diameter or cable towards the stern of the barge.

In operation, the route of the cable laying barge was charted by means of successive sextant angle shots from the barge to known points ashore. Operations were carried out during calm seas periods and as a consequence navigational problems were minimized. The Sandstone signal and control cable had previously been located and crossing of this cable was avoided in the cable laying operations carried out. The cable laying barge was towed at a constant speed of approximately 4 knots per hour at which speed no difficulties were encountered, even during the passage of the splice cases overboard. Testing of the cable after laying was carried out as a function of the Engineering Division at the Jobsite and is described in Chapter 5.18 of this report. Table 6.6-1 outlines the submarine telephone cable activities carried out for experiment and camp purposes.

It will be seen by reference to the extract from the July 15, 1950, Progress Report presented above as Figure 6.6-1 and by reference to the construction objectives for the first half of 1950 as set out in the Reconnaissance Report that substantially all of the objectives had been met within the planned allocation of time. On the other hand, the changes in the scope of the construction program during this period had the immediate effect of requiring extensive revisions of scheduling. Material reallocations to satisfy the needs of the Construction Battalion and the Military Structures Program on Engebi necessitated reshuffling of forces in accordance with both the availability of materials and the scheduling changes. However, by the end of this period, at the end of June 1950, the rescheduling and redeployment of forces had been accomplished, apparently just in time to face the hurdles interposed by the outbreak of hostilities in Korea.

Each plane arriving at the Atoll brought new drawings for additional stations and facilities. As a consequence, manpower requirements to assure completion by deadline dates were difficult to fix, and weekly upward revisions were the rule at the close of this period and the beginning of the sustained peak effort which followed.

JULY 1950 TO JANUARY 1951

This period in the construction program was highlighted by the completion of all base facilities at the Atoll, the substantial completion of the Military Structures, the construction of more than seven hundred scientific stations, and the receipt of more than three hundred changes in location or reinstatements of structures in the program. A tabulation of these changes is presented as an exhibit at the end of this volume.

Although seriously handicapped by a complete suspension of shipping during July and August, the fact that progress continued is apparent from Figure 6.5-1 above. This fact is further apparent from a detailed comparison of the Progress Reports of July and September 1950, the former of which is extracted above. By September 15, all aluminum buildings on Parry Island were essentially complete as then planned, the extent of completion being given in the September 15 Progress Report as 97 per cent. On Runit, the Aomon Group and Engebi, mess halls and latrines were substantially complete, while service and administration buildings were 75 per cent finished. Sewer systems were complete at all sites. Japtan Island was essentially completed in all respects. Water systems on the experiment islands were between 30 per cent (Runit) and 80 per cent (Engebi) complete. Electrical

TABLE 6.6-1. SUBMARINE TELEPHONE CABLE

Cable No.	Location		TPS Type	No. Pairs and Size	No. Pairs Loaded	Approx. Length In Feet	Remarks
0-101	A	B	16	16/#19	0	23,640	New
0-102	A	B	16	16/#19	12	24,960	New
0-103	A	B	16	16/#19	12	22,980	New
0-104	B	C	16	16/#19	12	58,440	New
0-105	B	C	16	16/#19	12	59,000	New
0-106	C	D	16	16/#19	12	40,140	New
0-107	C	D	16	16/#19	12	42,000	New
0-108	D	P	16	16/#19	12	30,000	New
0-109	D	P	16	16/#19	12	32,000	New
0-108A	P	E	16	16/#19	12	23,000	New
0-109A	P	E	16	16/#19	12	23,000	New
1-112	A	Buoy 93	6	6/#19	0	27,000	*
1-112A	A	Buoy 93	6	6/#19	0	7,500	New
2-113	B	Tele.Buoy	6	6/#19	0	5,000	New
2-114	B	L	6	6/#19	0	13,100	New
2-115	B	L	6	6/#19	0	13,100	New
3-116	C	Tele.Buoy	6	6/#19	0	18,000	*
3-116A	C	Tele.Buoy	6	6/#19	0	6,000	New
3-117	C	M	6	6/#19	0	5,000	New
3-118	C	M	6	6/#19	0	5,000	New
4-119	D	Tele.Buoy	6	6/#19	0	18,000	*
4-119A	D	Tele.Buoy	6	6/#19	0	7,000	New
4-120	D	N	6	6/#19	0	12,500	New
4-121A	D	R	6	6/#19	0	6,500	New
4-121B	R	N	6	6/#19	0	6,000	New
5-124	E	Buoy 767	6	6/#19	0	10,000	New
5-125	E	S	6	6/#19	0	7,000	New
5-126	E	S	6	6/#19	0	7,000	New
5-127	E	Q	6	6/#19	0	22,000	New
5-128	E	Q	6	6/#19	0	22,000	New

* Cable abandoned - Buoy relocated

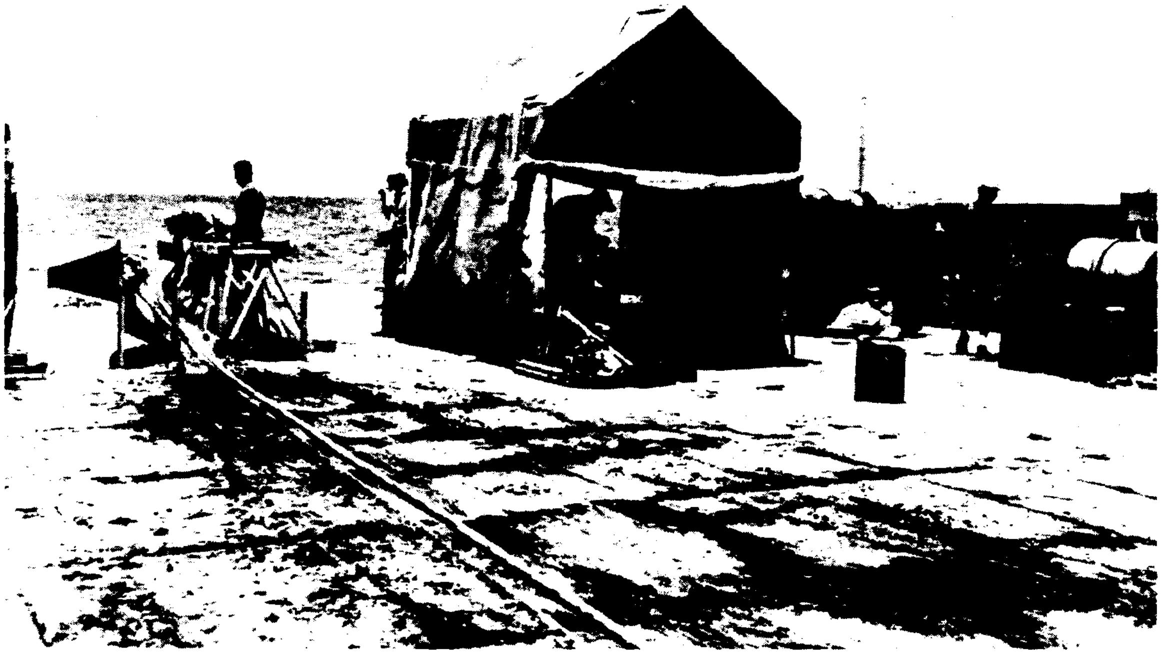
facilities were on the average better than fifty per cent complete at all sites. Piers were all completed as planned. On the Military Structures Program, foundations for seven Navy structures were complete and awaiting the arrival of prefabricated components. One structure, 3.2.7a, was completely finished. The remaining foundations for Navy structures were in various stages of completion. On Army Structure 3.1.1, foundations were complete, 58 per cent of the total required reinforcing steel had been placed, and 64 per cent of the total of mass concrete to be poured had been placed. Air Force structures had proceeded to the point of completion of all excavation and placement of all foundation forms. In addition, on Structure 3.3.5a, fifty per cent of the brickwork had been completed and the rough carpentry had been sixty per cent completed. Five structures, 3.3.8a through e, had been relocated after excavation, and some form work had been completed.

Thus the first major hurdle of the period was passed, but the price paid for progress in terms of effort in rescheduling activities to meet the deficiency in government furnished logistic support cannot be estimated in terms of dollars. The decisions made and the steps taken at the Home Office of Holmes & Narver in relation to the shipping deficiency are discussed in Section 14, Logistics, in Volume 4 of this report and no further evaluation of the impact on the Construction Program will be attempted here. However, a few significant points should be mentioned. The material shortages and resultant reshufflings of manpower and equipment were not alleviated immediately upon the arrival of the USNS Merrill on September 9, 1950, and the USNS Crain on September 20, 1950. Ten thousand tons of cargo were off-loaded from these two ships, overtaxing warehousing facilities, lightering and stevedoring equipment, and crews. Though the need for materials was urgent, checking and sorting of this cargo before distribution was essential in order to guard against any breakdown in material controls. Thus, it was not until almost ten days after cargo discharge was completed that actual utilization could be made of materials received in these shipments.

An additional point of impact of the shipping deficiency was a reflection of the effect on morale of the continual redeployment of forces thus made necessary. During the first week in September more than eighty carpenters demanded pay increases, thus attempting to parallel action by West Coast carpenters during the summer of 1950. The demands were heard and referred to the Home Office of H & N. While the loss of the men involved would have been serious in its effect on construction progress, it was felt that any concessions to such demands would lead only to a complete breakdown in labor relations at the Jobsite. In the face of this attitude the threat disintegrated and was soon forgotten in the rush to make up lost time upon the arrival of the Merrill and the Crain.

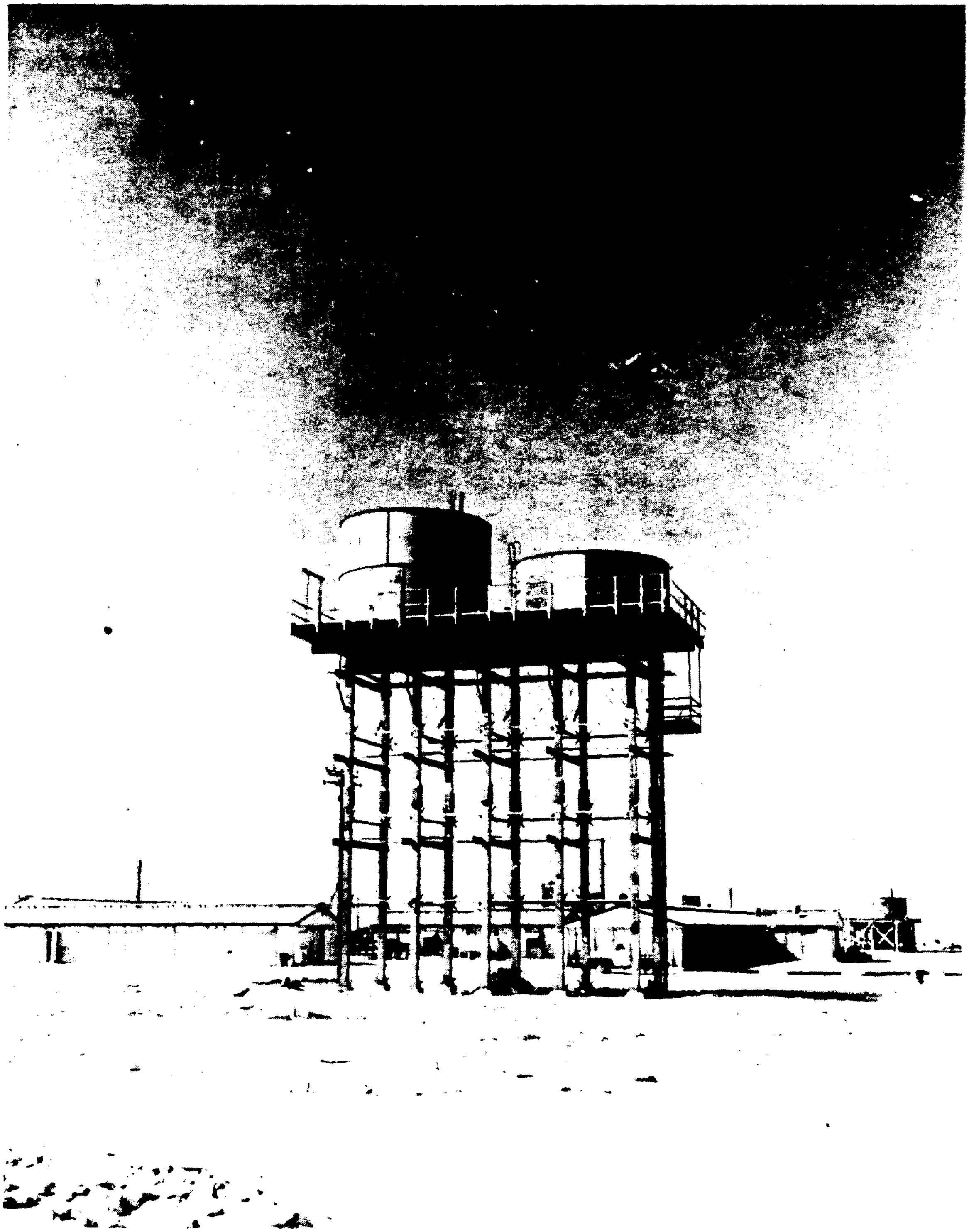
From the beginning of this period, as requirements for scientific stations continued to grow, as did the planned population for Parry Island and the experiment island camps, projections of manpower requirements were a subject of continuous study. Likewise the expansion of facilities to accommodate the new anticipated population peaks was being actively pursued. The manpower question became more pressing in the light of the scheduling losses sustained during the suspension of shipping.

Engineers on Cable Laying Barge Sighting Check Points on Shore.

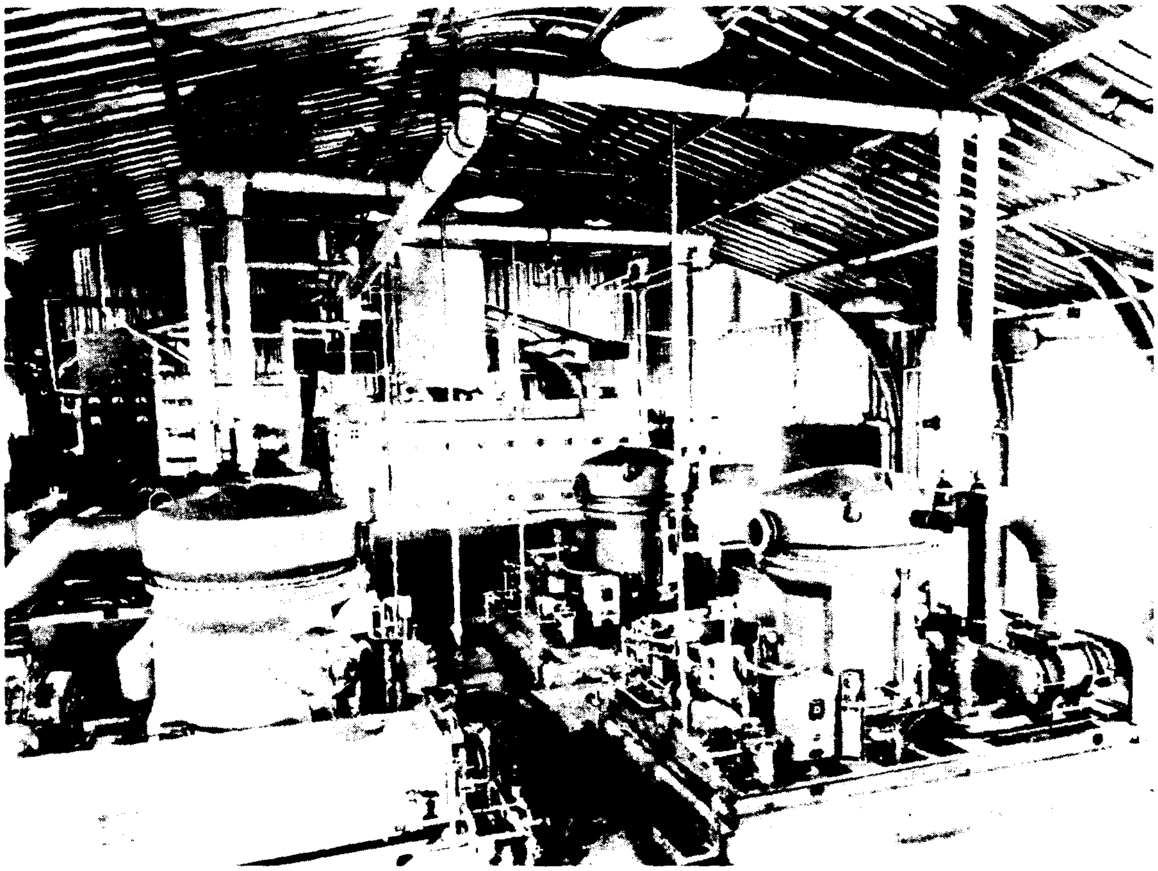


Submarine Cable Laying Barge in Operation, Showing Stern Guide Plate Directing Cable Into Water.

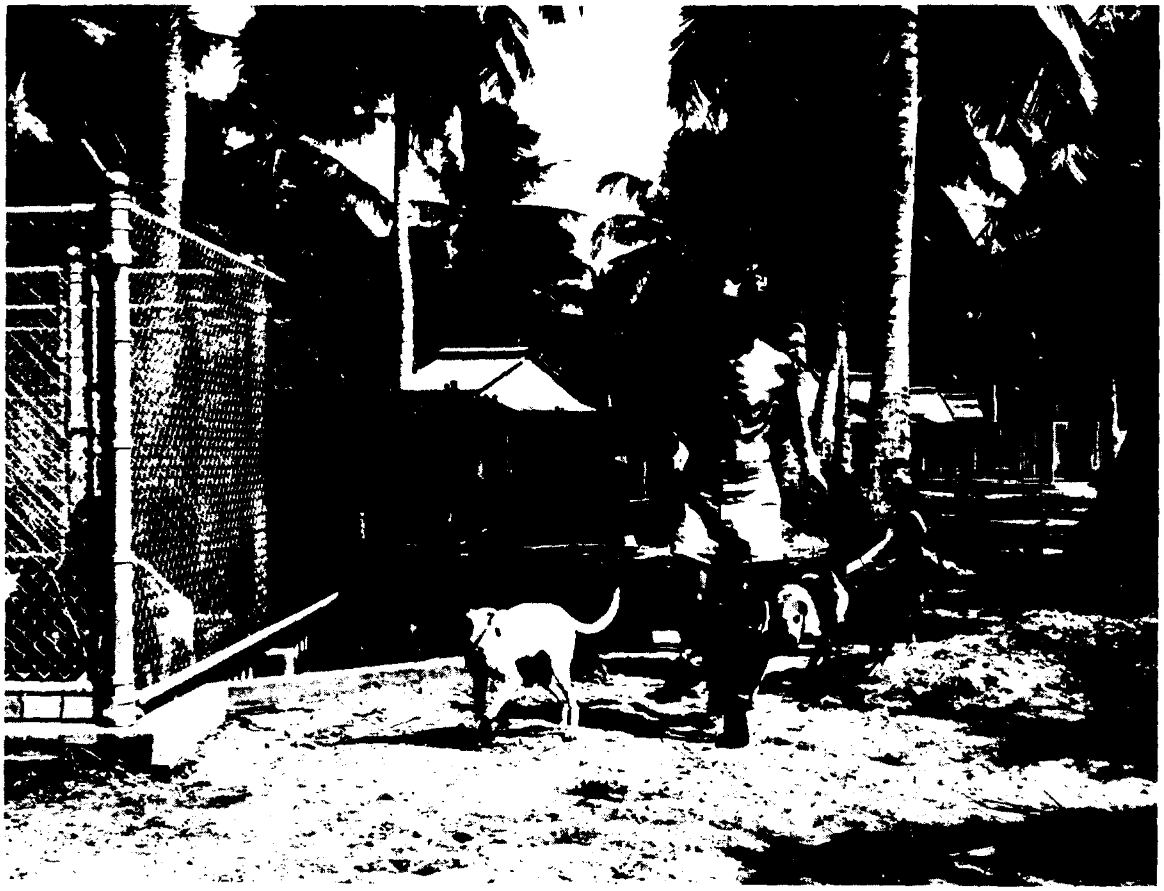
Connecting Transformer Bank for Overhead Power Distribution System, Parry Island.



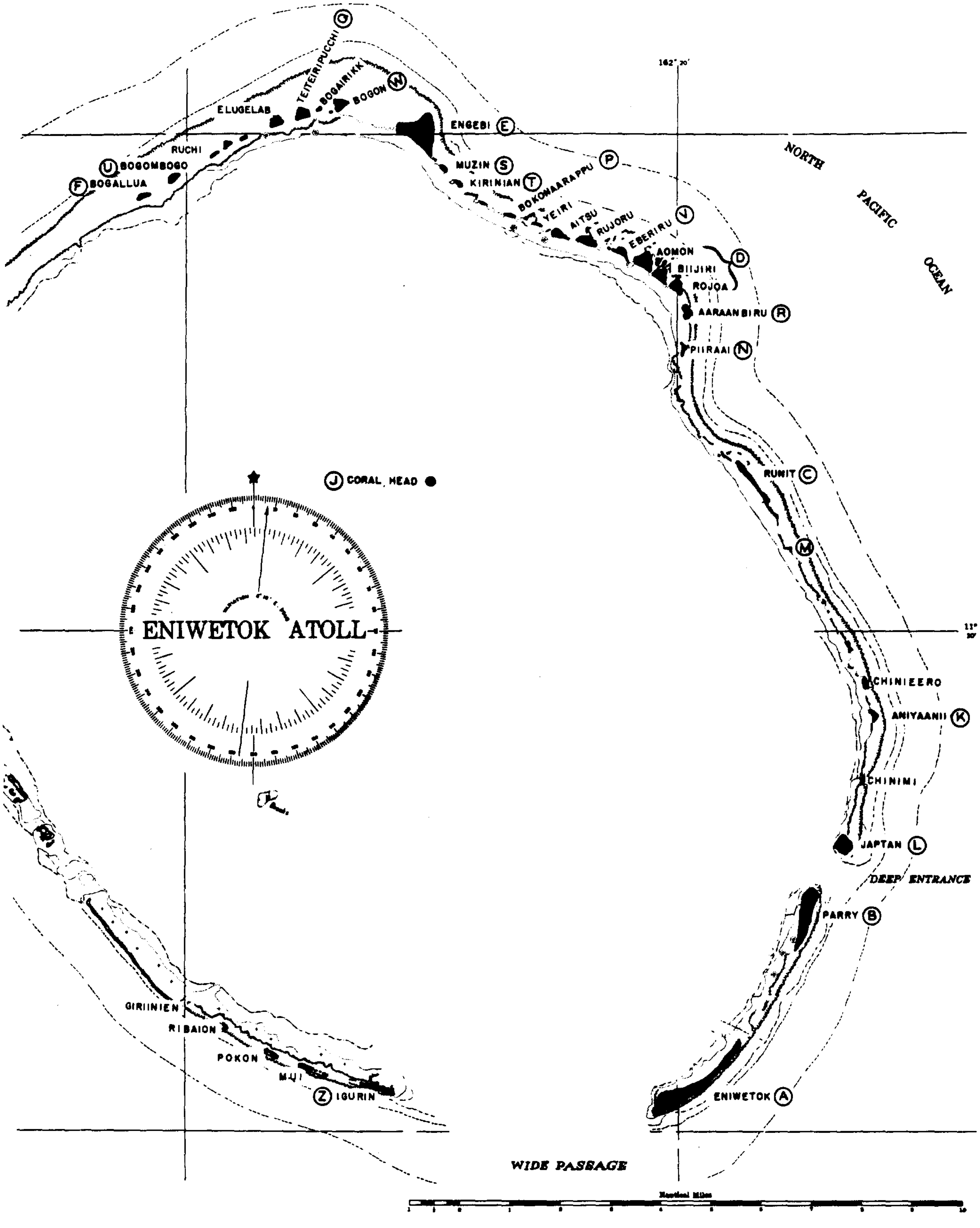
Elevated Salt Water & Fresh Water Tanks for Main Distribution Systems, Parry Island.



Power House on Japtan, Showing Water Distillation Equipment in Foreground and Power Generating Equipment at Rear.



Animal Shelters & Runs, Japtan.


ENIWETOK ATOLL
NORTH PACIFIC OCEAN
162° 20'
11° 30'
Ⓞ TEITEIRIPUCCHI
BOGAIRIKK
BOGON Ⓦ
ELUGELAB
ENGEBI Ⓔ
RUCHI
Ⓤ BOGOMBOGO
Ⓕ BOGALLUA
MUZIN Ⓢ
KIRINIAN Ⓣ
BOKONAARAPPU Ⓟ
YEIRI
AITSU
RUJORU
EBERIRU Ⓥ
AOMON
BIIJIRI
Ⓓ
ROJOA
AARAANBIRU Ⓡ
PIIRAAI Ⓝ
RUNIT Ⓒ
Ⓜ
Ⓙ CORAL HEAD ●
CHINIEERO
ANIYAANII Ⓚ
CHINIMI
JAPTAN Ⓛ
DEEP ENTRANCE
PARRY Ⓑ
ENIWETOK Ⓐ
WIDE PASSAGE
GIRIINIEN
RIBAION
POKON
MUI
Ⓩ IGURIN
Nautical Miles

VOLUME VII - SURVEYS AND LOCATIONS

- Appendix B - Drawing Lists
- Appendix C - Locations of Scientific Stations, Military Structures, and Buildings
- Appendix D - Horizontal Control Survey

VOLUME VIII - FACILITIES AND STATIONS

- Appendix E - Facilities and Stations

VOLUME IX - SPECIFICATIONS (1)

- Appendix F(1) - Specifications

VOLUME X - SPECIFICATIONS (2)

- Appendix F(2) - Specifications

VOLUME XI - OPERATING MANUALS

- Appendix G - Operating Manuals

Earlier, in a Progress Report to the AEC, the Security Division of Holmes & Narver had noted that the deadline date established for "Q" clearances (December 1, 1950) at the Atoll would unquestionably impose a burden on recruiting and shipping of personnel to the Jobsite and would be uneconomical. Still another facet of the same problem resulted from the reflection in decisions of the AEC Resident Engineer of the policy to pursue the construction program and the 1951 operation on an austerity basis. Consideration of these various factors covered all of the third quarter of 1950 and extended into the fourth quarter.

Plans to expand base facilities on Parry were suggested but initially disapproved. Planning of manpower requirements was subjected to sharp scrutiny. Ultimately both of these problems were resolved in a satisfactory manner, largely in accord with the plans submitted.

In the meantime, construction at the various operational sites moved forward. By the beginning of November, the shot island camps were complete and occupied by construction personnel. The three hundred foot tower on Runit was substantially finished as were a number of scientific stations on the same island, including the Stations 33 and 34 series, Stations 26c, 39c, 42, and others. For many of the rest of the planned scientific stations for this site as of this date, forms and reinforcing steel were set.

In the Aomon Group, work on the planned scientific stations had reached approximately the same percentage of completion as at Runit. In view of the greater total number of stations involved at the Aomon site, the total of completed or nearly completed stations was much greater. Significant in the reports of progress of construction is the fact that the Stations 120 and 121 series were awaiting redesign.

On Engebi, by the beginning of November the skyline had definitely taken on an aspect quite foreign to a coral atoll in the mid-Pacific. The structures for the Military Structures Program were nearing closure or were finished, giving unexpected height to the low-lying land mass. Scientific stations appeared everywhere and were substantially ready for the variety of finishing operations. As of November 1, 1950, all or more than 50 per cent of construction had been completed on more than one hundred and thirty scientific stations on Engebi, and completion before deadlines was assured.

Likewise, on the Military Structures on Engebi and Muzin, completion appeared to be assured before the time scheduled for instrument installation. Weighted averages of completion on this portion of the construction effort were given, as of this date, as approximately 65 per cent. This percentage figure reflects the substantial completion of concrete placement in the multistory structure 3.1.1 and 50 per cent completion of structural steel setting and masonry work; completion of steel and concrete placement on structure 3.3.3; completion of Navy Structures 3.2.1a and b, 3.2.2a and b, 3.2.3a and b, 3.2.5, and 3.2.7a and b; about 80 per cent completion of structures 3.2.4a and b and 3.2.6; and about 40 per cent completion of the various Air Force structures.

Preparations for the "E-Plus" Program, the second shot on Engebi Island had begun. The clearing of the extensive Japanese dump at the end of the airstrip was a project of no small proportions. Large quantities of junked equipment, supplies, and materiel had to be removed and the dump area filled and compacted in order to accommodate the stations required for this added program.

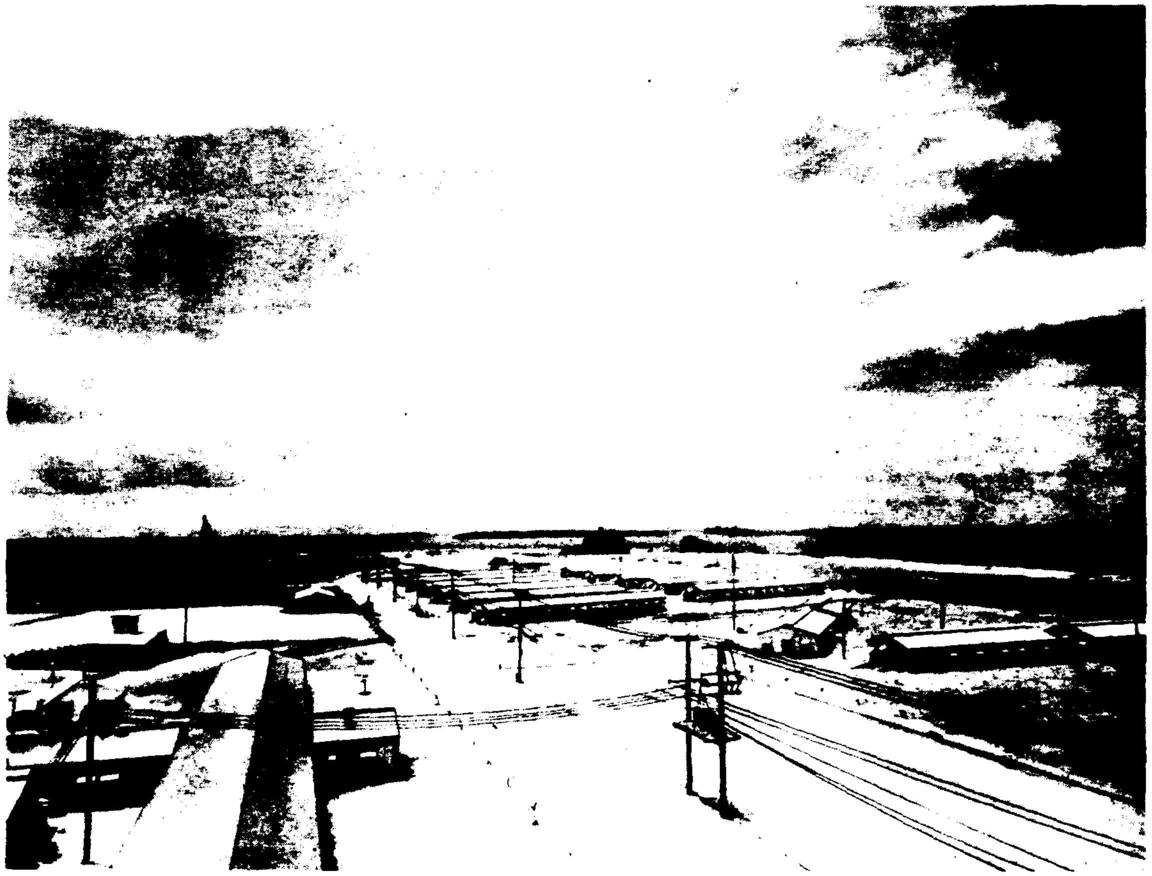
Preliminary work was also under way under the supervision of the Prepakt Concrete Company on the grouting program recommended by consultants to the AEC and the Department of Defense. As the construction forces of Holmes & Narver supplied only the labor for this program, the direction and supervision being the responsibility of the Prepakt Company representatives, details of the results, both hoped for and actual, will not be discussed here. (See Chapter 6.7 of this volume.)

It should be noted, however, that the high priority ultimately given the program by the AEC had the serious effect of diverting construction labor at a time when men could not readily be spared. Recruiting personnel specifically for this program had to be done on a high priority basis, and screening was held to a minimum consistent with security requirements for a "P" approval. A few of the individuals thus obtained proved to be undesirables on the Project and were sore spots until terminated in what otherwise had become a smooth-running construction organization.

Although essentially all of the originally planned construction for Parry Island was complete and a new addition to the tent camp there had been completed, one critical item of construction -- the CMR Building -- was causing anxiety. This structure, comprising a Butler building and a standard aluminum building arranged in spaced relationship with a shed roof covering for the intervening space, had to be ready for the installation of a considerable amount of complex equipment. Some of the construction materials needed were long term procurement items and expediting action had been of little avail. However, the arrival of the required high pressure fittings during January of 1951 permitted completion of this facility and adequate check-out prior to its operational use.

Mention should be made at this point of the many changes in location, deletions, and reinstatements of various scientific stations and military structures which were brought about as a result of many causes ranging from poor foundation conditions to changes in expected overpressures and scientific program. In all, more than three hundred and seventy-five changes were processed involving changes of location, deletion of reinstatement after a previous deletion.

A complete list of location changes is presented as an exhibit at the end of this volume, a summary of design and change order estimates is presented as Table 6.6-2, and a summary of field change orders is presented in Table 6.6-3.



Parry Island, Looking North from Water Tower. Mess Hall in Foreground and Theatre, Day Room, and Barracks in Background.

Parry Island: Warehouse Area & Old Navy Pier in Foreground,
Office & Service Area, Center.

TABLE 6.6-2. SUMMARY OF DESIGN AND CHANGE ORDER ESTIMATES, JUNE 30, 1951

LOCATION AND DESCRIPTION	DATE SUBMITTED	TOTAL NET COST
PARRY ISLAND		
Design Estimates		
Revised final estimate for Modification 7 of Contract, based on known scope of work as of March 24, 1950	4-1-50	5,124,600
Rehabilitate seven quonsets	4-21-50	65,955
Fifty additional tents	10-3-50	99,515
C.M.R. Buildings and facilities	12-1-50	315,130
Underground Shelter Area	12-21-50	26,810
Additional cooling facilities - Photo Lab.	12-21-50	15,120
Connect Buildings 208 and 209	1-12-51	18,470
Additional wing - Mess Hall	1-12-51	22,890
Extension - J.T.F. communications room	1-12-51	2,430
300 additional hot lockers	1-12-51	26,630
Vapor Seal Building 311	1-12-51	1,075
Water Cooler - Building 323	1-16-51	2,134
Inter-com. and radios	1-16-51	39,175
Additional Recreation Building	1-24-51	35,920
Additions, revisions, and water cooler-Building 231	1-24-51	32,210
Additions and revisions - Building 120	1-28-51	22,000
Fence Building 221	2-6-51	3,655
Total Estimated Cost (Net)		5,853,719
Deletion from Original Scope		(84,825)
		5,768,894
Change Order Estimates		
Total Estimated Net Cost of 118 Field Change Orders		485,890
TOTAL ESTIMATED NET COST - PARRY ISLAND		6,254,784
ENIWETOK ISLAND		
Design Estimates		
Revised final estimate for Modification 7	2-10-50	*(3,369,630)
of Contract, based on known scope of	2-11-50	*(3,147,425)
work as of February 7, 1950	5-19-50	3,432,040
Relocate telephone buoys	1-16-51	3,210
Additions to stage - movie	1-24-51	4,050
Additions to Building 90	1-24-51	1,215
Total Estimated Cost (Net)		3,440,515
Deletion from Original Scope		(67,790)
		3,372,725
Change Order Estimates		
Total Estimated Net Cost of 81 Field Change Orders		242,505
TOTAL ESTIMATED NET COST - ENIWETOK ISLAND		3,615,230

SUMMARY OF DESIGN AND CHANGE ORDER ESTIMATES (Continued)

LOCATION AND DESCRIPTION	DATE SUBMITTED	TOTAL NET COST
JAPTAN ISLAND		
Design Estimates		
Revised final estimate for Modification 7 of Contract, based on known scope of work as of February 15, 1950	2-15-50	*(801,240)
	3-28-50	843,605
Additional mouse cages	8-8-50	12,570
Additional mouse house	1-12-51	11,610
Additional facilities (Infirmary)	1-12-51	7,660
Total Estimated Cost (Net)		875,445
Change Order Estimates		
Total Estimated Net Cost of 43 Field Change Orders		75,300
TOTAL ESTIMATED NET COST - JAPTAN ISLAND		950,745
RUNIT ISLAND		
Design Estimates		
Revised final estimate for Modification 7 of Contract, based on known scope of work as of March 24, 1950	5-19-50	1,343,835
Fence Around Zero Area	9-15-50	5,000
Total Estimated Cost (Net)		1,348,835
Deletion from Original Scope		(57,185)
		1,291,650
Change Order Estimates		
Total Estimated Net Cost of 32 Field Change Orders		75,560
TOTAL ESTIMATED NET COST - RUNIT ISLAND		1,367,210
AOMON GROUP		
Design Estimates		
Revised final estimate for Modification 7 of Contract, based on known scope of work as of March 24, 1950	5-19-50	1,637,500
Fence Around Zero Area	9-21-50	5,470
Additional cost - 200' Tower	1-10-51	24,900
Total Estimated Cost (Net)		1,667,870
Deletion from Original Scope		(52,265)
		1,615,605
Change Order Estimates		
Total Estimated Net Cost of 42 Field Change Orders		150,365
TOTAL ESTIMATED NET COST - AOMON GROUP		1,765,970

SUMMARY OF DESIGN AND CHANGE ORDER ESTIMATES (Continued)

LOCATION AND DESCRIPTION	DATE SUBMITTED	TOTAL NET COST
ENGEBI ISLAND		
Design Estimates		
Revised final estimate for Modification 7 of Contract, based on known scope of work as of March 24, 1950	5-19-50	1,405,435
Additional Camp Facilities	5-15-50	60,555
Channel linking "E" to "S"	7-19-50	130,550
Fence Around Zero Area	9-15-50	5,000
Total Estimated Cost (Net)		1,601,540
Deletion from Original Scope		(65,020)
		1,536,520
Change Order Estimates		
Total Estimated Net Cost of 30 Field Change Orders		345,265
TOTAL ESTIMATED NET COST - ENGEBI ISLAND		1,881,785
BOGALLUA ISLAND		
Design Estimates		
Revised final estimate for Modification 7 of Contract, based on known scope of work as of March 24, 1950	5-19-50	804,040
Deletion from Original Scope		(747,340)
Change Order Estimates		
None		
TOTAL ESTIMATED NET COST - BOGALLUA ISLAND		56,700
MISCELLANEOUS ISLANDS, SITES M, N, P, Q, AND J.		
Design Estimates		
Revised final estimate for Modification 7 of Contract, based on known scope of work as of March 24, 1950	5-19-50	694,370
Deletion from Original Scope		(266,135)
		428,235
Change Order Estimates		
Total Estimated Net Cost of 3 Field Change Orders		5,945
TOTAL ESTIMATED NET COST - MISCELLANEOUS ISLANDS		434,180

*Preliminary estimates submitted to AEC prior to receipt of firm scope of work.

TABLE 6.6-3 SUMMARY OF FIELD CHANGE ORDERS

(A complete summary of Engineering Change Orders issued at Jobsite is presented as an exhibit at the end of this volume.)

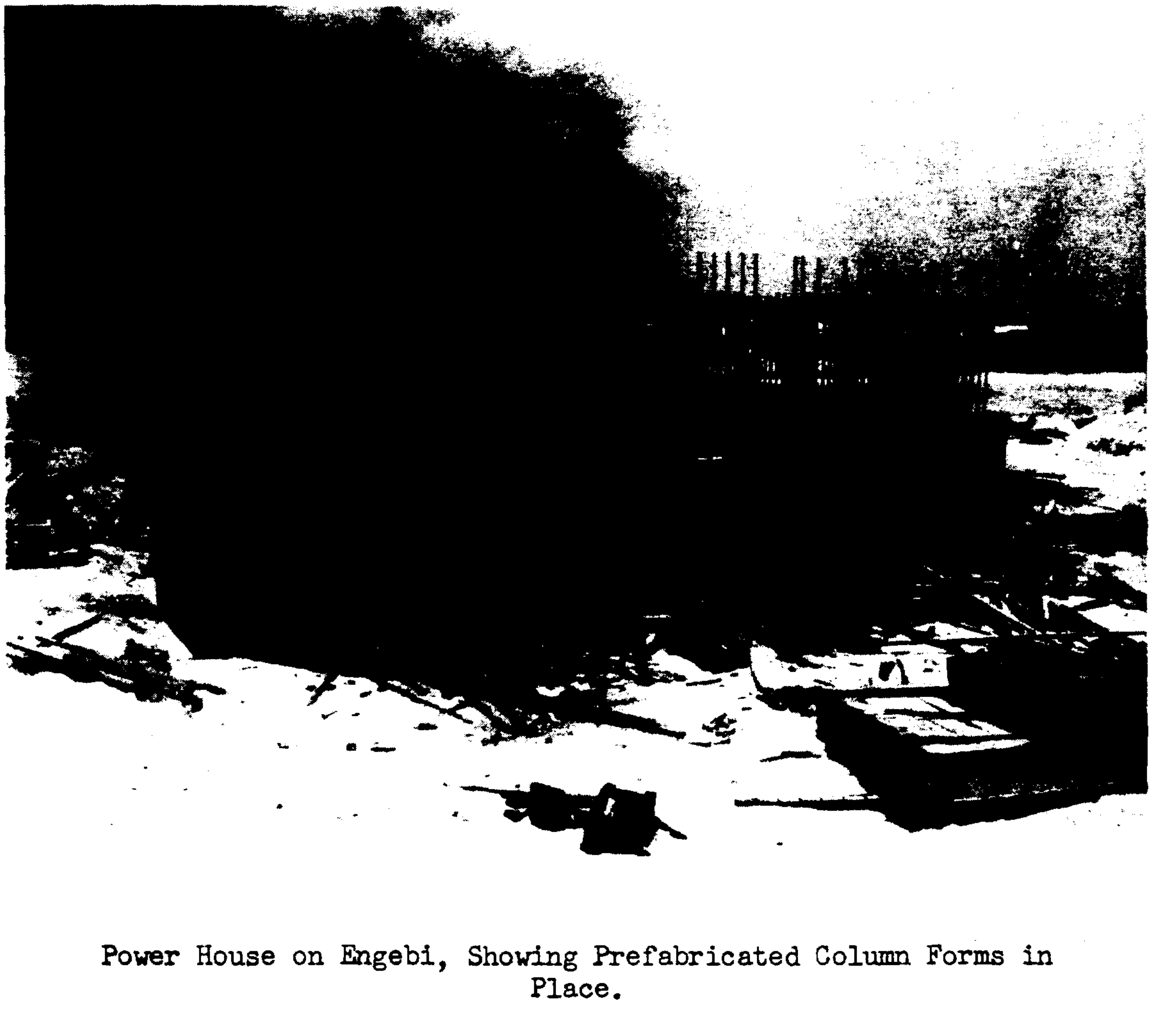
Location	Estimated Net Cost
Parry Island	$ 493,555
Eniwetok Island	242,605
Japtan Island	75,300
Runit Island	90,140
Aomon Island Group	164,940
Engebi Island	364,685
Miscellaneous Islands	9,180
Total	$ 1,440,405

About 25 per cent of these changes involved deletions or reinstatements, thus indicating location changes for more than three hundred stations. It must be noted that most of these location changes did not represent lost construction effort. On the other hand, in a number of cases, changes in location were ordered after varying amounts of construction had been effected. Thus, for example, after excavation for Structures 3.2.1a and b revealed water seepage, the location was changed. On Structures 3.3.3 and 3.3.8 on Muzin, excavation had been completed, reinforcing steel set, and foundation concrete poured for the 308 shelter when the location of the structures was changed by one hundred and fifty feet, forcing abandonment of the 308 site. Much later in the program, entire structures were moved to new locations, such as for example in the case of the Station 625 complex (5 structures) on Kirinian on April 1, 1951.

By the end of 1950, more and more of the items of the Construction Program which were still in progress had reached the "punch-list" or check-out stage. The formal turnover of buildings and stations to the AEC had begun and was well advanced. Fabricated parts for many of the scientific stations which had been long term procurement items had finally arrived at the Jobsite and installation was under way.

On Parry Island, approval had been granted and work had begun on the expansion of certain of the base facilities including the mess hall, post exchange recreation building, AEC office building, power house, water storage facilities, and others. Work was still being done in connection with the installation of equipment in the CMR building. However, by this time a fence had been completed around the building and the area designated as an exclusion area wherein only "Q" cleared personnel were permitted. This requirement necessitated reshuffling of personnel to assure continued progress in accordance with schedules.

Engebi Camp Area, Looking Toward Muzin. Dispensary & Mess Hall in Left Foreground.



Power House on Engebi, Showing Prefabricated Column Forms in Place.

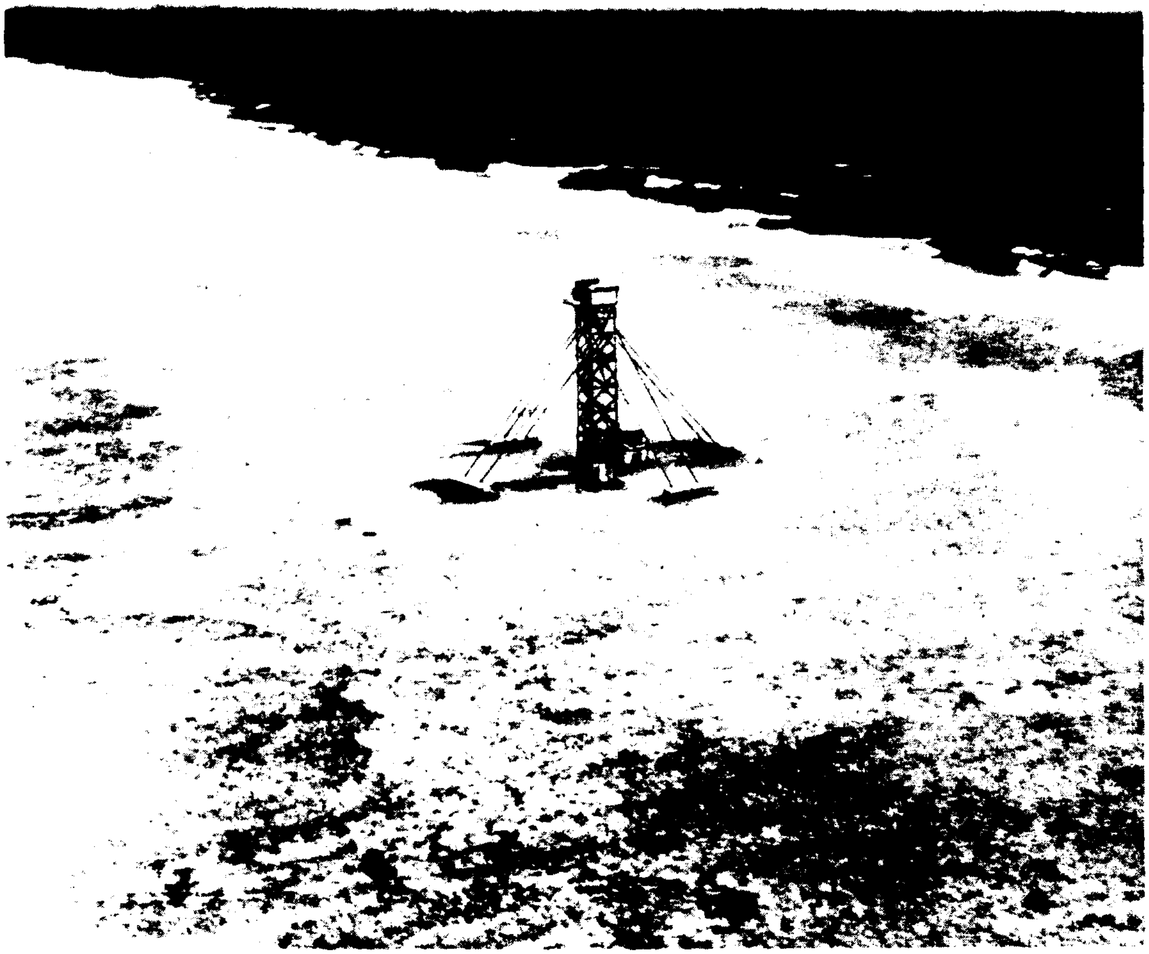


Photo Tower on Reef South of Runit, Showing Completed Structure, with Hoist, Cab, & Guy Cables in Place.

Photo Tower on Reef South of Runit, Showing Cable Anchors at Low Tide.

To close out the year 1950 on the islands to the north of Parry, almost all major pours of concrete had been completed. Difficulties with cement prevented the actual completion of all mass concrete work. One of the brands of cement shipped to the Jobsite was not on a par with other brands. In addition, the various shipments had been held up at Oakland during the suspension of shipping during July and August. Sequential shipments of cement had previously been found desirable in order to avoid protracted storage in the unfavorable Eniwetok climate. However, when shipping space was not available, the pile-up of cement stocks at Oakland became acute. As a result, when shipping schedules returned to normal, all of the backlogged cement was transshipped in one load. The result at Eniwetok was to compel storage of an inordinate amount of cement in the facilities available. Sacks of cement were stacked higher than best practice would dictate. Toward the end of the year, the results of these forced practices became apparent when it was determined that a considerable quantity of the cement on hand had become lumpy and that required concrete strengths could not be obtained if the cement was used in that condition. (Coincidentally, the same brand of cement in which this condition was found to exist had caused difficulties in the precasting of components for the Navy Structures.) (See Chapter 6.7, Military Structures, in this volume.)

Screening through a sixteen mesh screen was found to be necessary in order to salvage this defective cement and through the expenditure of a relatively small amount of labor to accomplish this, the actual loss was made negligible. However, extreme care in concrete production was required, and constant inspection and testing surveillance were carried out to assure compliance with strength and density specifications.

The more difficult stations on the experiment islands, particularly those which involved the accurate alignment of collimators and the placement of limonite-steel aggregate concrete, were well advanced. Techniques had been perfected in the preparation of the limonite concrete, details of which are given as an exhibit at the end of this volume.

In the construction of one of the more complex structures, Station 131, which was reproduced at Engebi and Eberiru, it had been planned, upon the advice of grouting experts, to employ intrusion grouting of a cement limonite mix into steel aggregate contained between the structural forms. The process was tried under the supervision of personnel experienced in intrusion grouting operations but was found to be far less economical than the method devised cooperatively by H & N Construction and Engineering Departments at the Jobsite. A comparison of the concrete placement in the intrusion grouted 131 structure at the Aomon Group and the poured limonite-steel aggregate concrete structure at Engebi showed that the Aomon structure took 20 men 20 hours to pour and resulted in voids requiring patching, whereas the Engebi structure poured by the method devised by H & N took only 12 men 6 1/2 hours to pour and resulted in no voids.

The power houses at Runit, Aomon, and Engebi were substantially complete and the originally specified generators had been set in each.

Increases in power demands had made it desirable to change the installation of additional equipment later planned for each plant from a five cylinder diesel unit to an eight cylinder unit. This change necessitated changing the foundations in each plant to permit the installation of the larger units.

With the substantial completion of the power plants and the installation of switching gear, panel boards and the like, and the imminent arrival of scientific personnel to start instrument installations, the time for power distribution and signal and control cable installation for scientific stations was at hand. Cable trenches for the millions of feet of power, signal, and control cable required spread their network over the islands.

This activity was, at the request of the AEC, scheduled for this late date in order to minimize the effect of moisture in the coral on these very important underground links of the scientific program. Cable laying for power, signal, and communication purposes proceded rapidly by means of the simultaneous unreeling of cable from six reels mounted on a flatbed trailer hauled by a tractor.

The trenching operation for cables was largely routine, but an incident at Parry at this time introduced a note of tension in this normally prosaic activity. In the course of trenching operations for the sewer lines to serve the new tent camp on Parry, an unexploded five hundred pound aerial bomb was unearthed by the ditchdigging machine. Other mines and ammunition had been discovered previously, but none under the circumstances now encountered. (A series of sweeps of the islands by military bomb disposal crews had been carried out in order to alleviate this hazard.) In any event, arrangements were made to evacuate Parry during the removal of the latest discovery and disposal was effected.

At about the same time, excavations near the three hundred foot tower on Engebi uncovered at a depth of more than eight feet, a portion of the Sandstorm tower footings. Radiological safety instruments available at the site indicated, during a survey by the Rad-Safety Officer, a considerable radioactivity hazard, and work on this excavation was halted to permit further investigations. Instruments were flown out from Los Alamos for checks and the supposed hazard was found to be nonexistent.

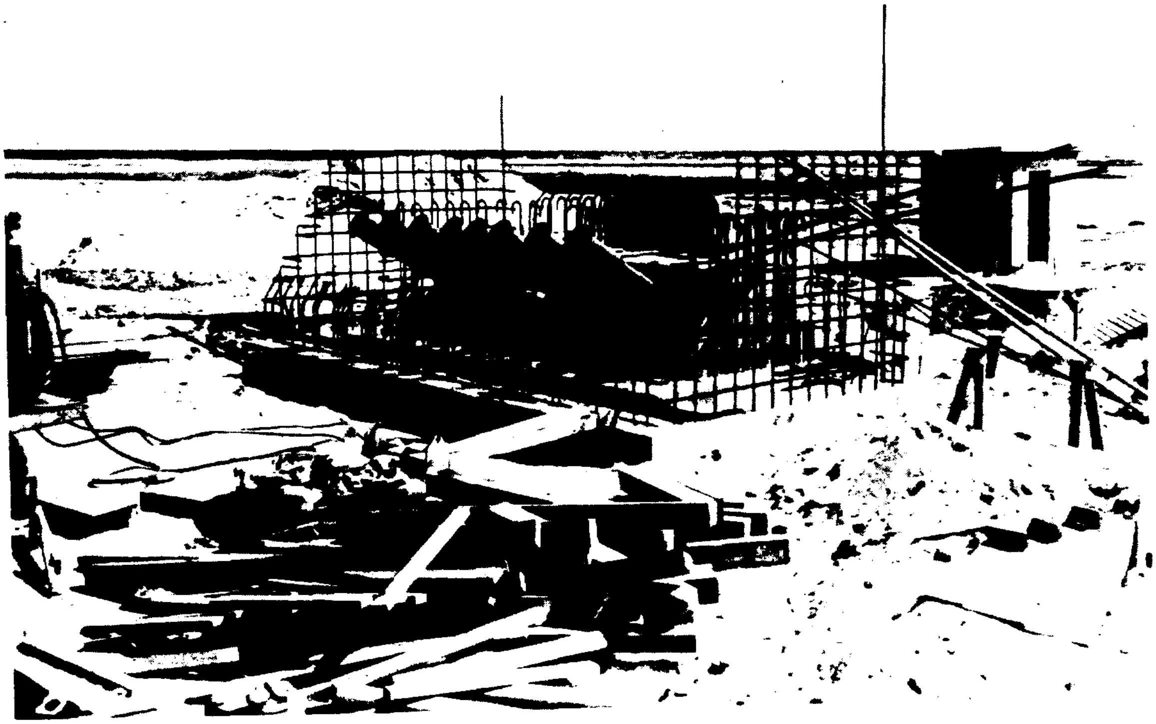
The Military Structures Program was on schedule and the completion of the Holmes & Narver construction responsibility was in sight. The Navy Structures had been completed early in December, 1950. The Air Force Structures had been beset by a series of difficulties arising out of the somewhat unusual designs involved. In the quarter scale model Structure 3.3.8b, rivets three-sixteenths inch in diameter had been specified and the required quantity was on hand. However, when attempts were made to use the rivets, it was found that they could not be upset so as to meet specifications. As a consequence, work had to be suspended until new rivets could be procured and hand carried in a small box to the Jobsite.

Six-Inch Conduit Installation Between Scientific Station 69 & 6b, Biijiri

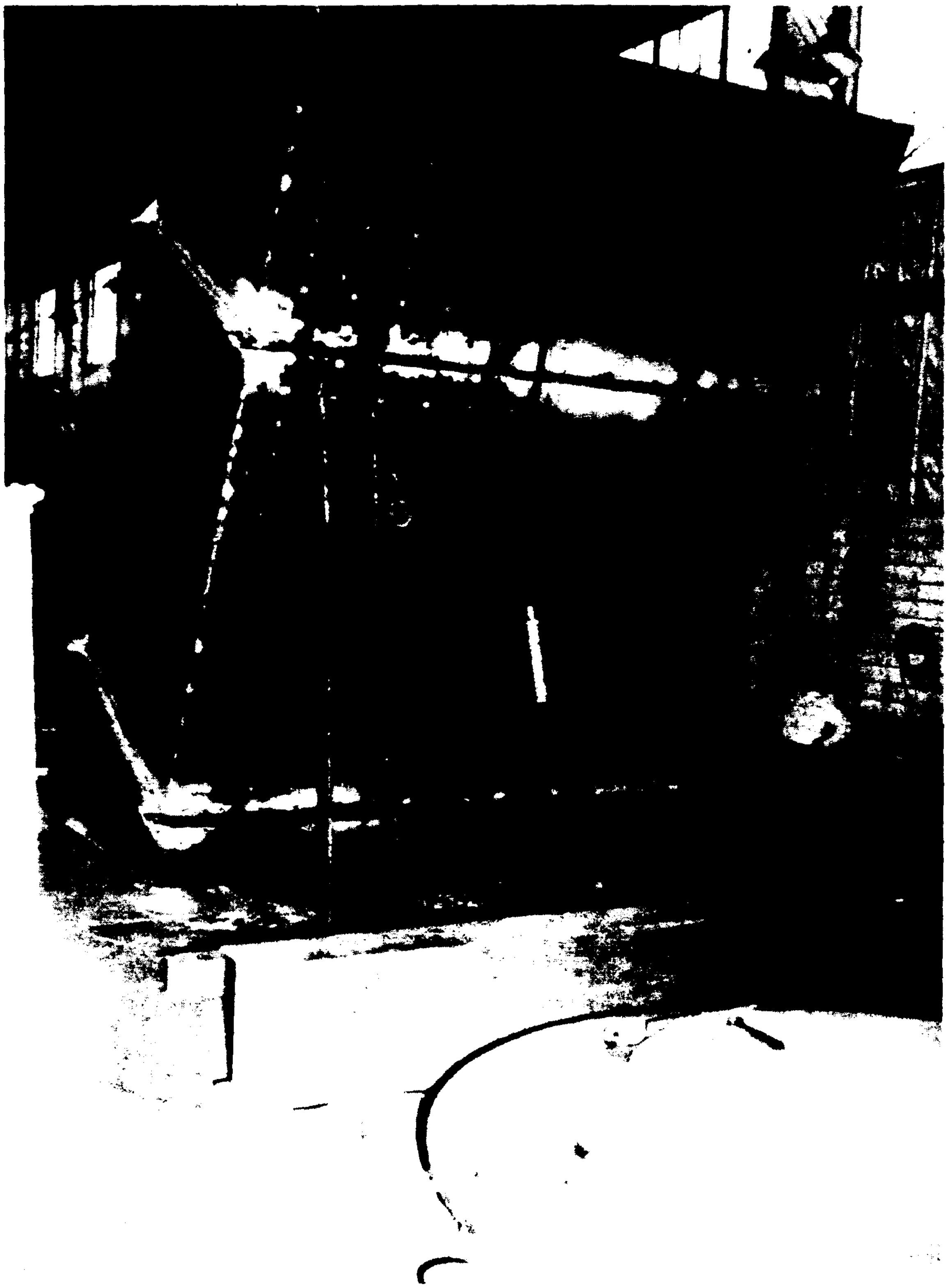
Scientific Station 6a, Biijiri; Dehumidification Units on Left.

Front and Side of Scientific Station 75, Aaraanbiru, after Forms were Removed.

Typical Reinforced Concrete Blast Wall with Instrument Panel Insert in Center, Scientific Station 20.



Reinforcing Steel Partially in Place & Collimator Tubes Set for Station 54, Runit.



Collimator Box & Back End of Collimator Tubes, Scientific Station 52, Being Inspected in Fabricator's Plant.

On the Air Force "idealized" Structures, difficulty in obtaining approval from Jobsite Air Force Inspectors for the erection of structural steel members fabricated for these structures also caused a suspension of work. The members in question had been fabricated in a West Coast plant and had been test-erected in order to check conformance with specifications. Because of the fabrication practice followed, the webs and flanges of the mating members appeared to be distorted when the steel was laid out prior to erection at the Jobsite. Work was stopped pending approval by the design and test groups concerned with these structures. After a considerable lapse of time, approval to proceed with construction was given by the AEC. Upon erection of the steel, the anticipated deviations in matching the members were found to be minimal. However, changes embodying the employment of extra splice plates were specified by design agencies in order to assist in interpretation of test data.

The Army Structures were within schedule and the Prepakt grouting program, although it temporarily reduced the H & N labor potential, appeared to be moving at the necessary rate of progress. Live loading of the upper floors of the multistory building through the placement of sand bags was under way.

The status of the many Scientific Stations may best be seen from the following work status information extracted from the Progress Report of January 15, 1951:

STATUS OF SCIENTIFIC STRUCTURES AND INSTRUMENT STATIONS AS OF 15 JANUARY 1951

SITE C

Station	Status
2	Need finish electrical.
6A, 6B	Laying conduit between 2 sta.
10, 11, 12	Complete
13	Existing
14, 15, 17, 18, 19	Complete
20A, B, C, D, E, F	Panels and forms being set. Pour will be in near future.
23A	Need finish electric.

STATUS OF SCIENTIFIC STRUCTURES AND INSTRUMENT STATIONS AS OF 15 JANUARY 1951 (Continued)

SITE C (Continued)

26C 27A, B, C, D, 28A, B, C, D, E, F, G, H, I, J 30A, B, C	Complete
32A, 32C	No work by H & N
32B	Deleted
33A, B, C, D, E, F, G, H, I 34A, B, C. D	Staked
39C 59A, B, C, D 51A, B. C, D 52, 53	Complete
54	Nearing completion
55	Need vent & finish electr.
57	Nearing pour
69	Comp. except comm. connections
73B, C. D, E. F, G,H 74A, B, C, D, E, F, G, H	Staked
78, 79	Waiting for insulation
591A, B	Need finish electric
773	Complete
4224, 4225, 4226	Complete except for pipe
4242	Complete

SITE D-V

2	Complete
6A, 6B	Complete less electr.
10, 11, 12	Complete less collimator block.

STATUS OF SCIENTIFIC STRUCTURES AND INSTRUMENT STATIONS AS OF 15 JANUARY 1951 (Continued)

<u>SITE D-V</u> (Continued)

14, 15	Complete less collimator block
17, 18	Complete
19	Complete less collimator block
23A	Complete less electr.
28A, B, C, D, E, F, G, H, I, J, K, L, M, N, O, P	Complete
28Q	Deleted
30A, B, C	Complete
32A, B, C, D, E, F, G, H	No work by H & N
36A, B, C, D, E	Forms in place
42	Moved to Site C
50A, B, C, D 51A, B, C, D	Complete
56	Complete less backfill
68	No work
69	Complete less backfill
70A, B, C, D, E, F, G, H, I, J, K, L, M, N, O, P, Q, R, S, T, U, V, W, X, Y, Z 71A, B, C, D, E, F, G	Slab poured, Mouse cyl. legs placed
73A, B, C, D, E, F, G H, 74A, B, C, D, E, F, G, H, 80A, B, C	No work
80D, E	Forms and insert in place
120A, B, C, D, E, 121A, B, C, D, E	No work
123	Complete

STATUS OF SCIENTIFIC STRUCTURES AND INSTRUMENT STATIONS AS OF 15 JANUARY 1951 (Continued)

SITE D-V (Continued)

130	No work
131	Limonite concrete poured
131A, B	No work
132A, B	Floor slab poured, wall forms in place
132C, D	No work
132E	Slab poured, tent frame erected
132F	Complete
132G	No work
133	Complete
134, 140A, B	No work
141A, B, 142A, B	Complete
142C	No work
143	Complete
772	Complete less seismograph
812	No work
4217, 4218, 4219, 4220, 4221, 4221A	Complete

SITE E

2	Complete
6A, 6B	Complete
8, 9	Ready for steel frame
10, 11, 12	Complete
13	Existing Structure
14, 15	Complete
17	Existing slab

STATUS OF SCIENTIFIC STRUCTURES AND INSTRUMENT STATIONS AS OF 15 JANUARY 1951 (Continued)

SITE E (Continued)

18, 20A, B, C, D, E, F, 21A, B, C, 22A, B	Complete
23A	Existing structure
23B	Structure complete
24A, B	Complete
25	Complete except concrete apron
26A, B, 27A, B, C, D, 28A, B, C, D, E, F, G, H, I, J, 29A, B, C, D, E. F, G, H, I, J, K, 30A, B, C, 33C, D, E, F, G, H, I, 34A, B, C, D, 35	Complete
36A, B, C, D	Ready for wood cover
37A. B. C. D, E, F.	Ready for cover plate
39A, B, 40, 50A, B, C. D, 51A, B, C, D, 52, 53	Complete
54	Install tunnel sheathing
55	Complete
57	Structure complete
69, 70A, B, C, D, E. F, G, H, I, J, K, L, M, N, O, P, Q, R, S, T, U, V, W, 71A, B, C, D, 72A, B, C, D, E, F, G, H, 75	Complete
80A	Deleted
80B, C, D, 81, 83A, B, 84A, B, C, D, E, F, 90C, D, F, G, H, J	Complete

STATUS OF SCIENTIFIC STRUCTURES AND INSTRUMENT STATIONS AS OF 15 JANUARY 1951 (Continued)

SITE E (Continued)

120A, B, C, 121A, B	Excavated
132A	Ready for wing walls
132B	Complete
132C	Set footing forms
141A, B	Structure complete
144A	Poured footing
143	Complete
144B	Excavated
301A, B, C, E	Complete
301I, J, D	Install elect. and ventilation
302A, B, C, D	Complete
421, 422, 423, 424, 425, 426, 427, 428, 429	Complete
591A	Slab poured
591B	Structure complete
593C	Complete
771	Complete
145,146	Footing poured

SITE S

41	Ready for lead brick
76	Ready for insulation
80E, 82	
91A, B, C, D, E, F	Staking
101	Ready for hardware
623, 623B, 624B	Concrete poured

STATUS OF SCIENTIFIC STRUCTURES AND INSTRUMENT STATIONS AS OF 15 JANUARY 1951 (Continued)

Site "S" (Continued)

4210	To be relocated
5171	Ditches to Site

SITES N, P, & R

Site	Station	Status
N, P	7	Complete less electrical
N, P	60	Complete less cab doors
N, P	61	Complete less electrical
N	62	Complete less cab doors
N	63	Complete less electrical
N, P	65	Complete
N, P	66	Stabilized and paved
R	75	Complete less insulation
N	76	Complete less insulation
P	79	Complete less insulation
P	92A, B, C, D	No work
P	824, 828	Complete less electrical
P	4214	Complete
R	4222	Complete
N	4223	Complete

SITES F, Q, T & U

Q	60	Ready for side panels
Q	61	Complete
Q	62	Ready for side panels
Q	63, 64, 65	Complete
Q	66	Ready for paving

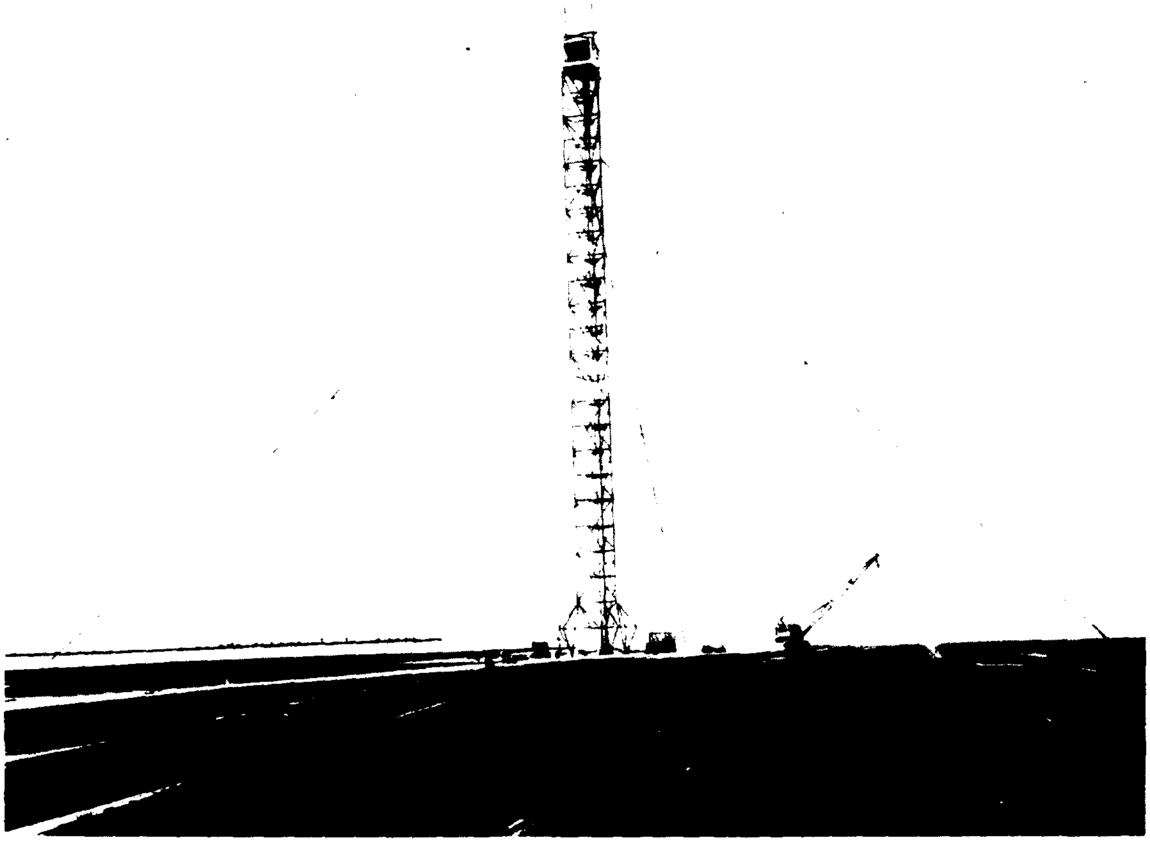
STATUS OF SCIENTIFIC STRUCTURES AND INSTRUMENT STATIONS AS OF 15 JANUARY 1951 (Continued)

		SITES F, Q, T & U (Continued)
T	77, 78	Roof half on. Letter to omit and add two more stations
Q	93A, B, C, D	Complete
U, F	101	Complete
T	101	Ready to paint
T	625	Slab poured
Q	823, 827	Complete
Q	4215, 4216	Complete
		SITE M
M	7	Need electr.
M	60	Ready for concrete pour
M	61	Need electr.

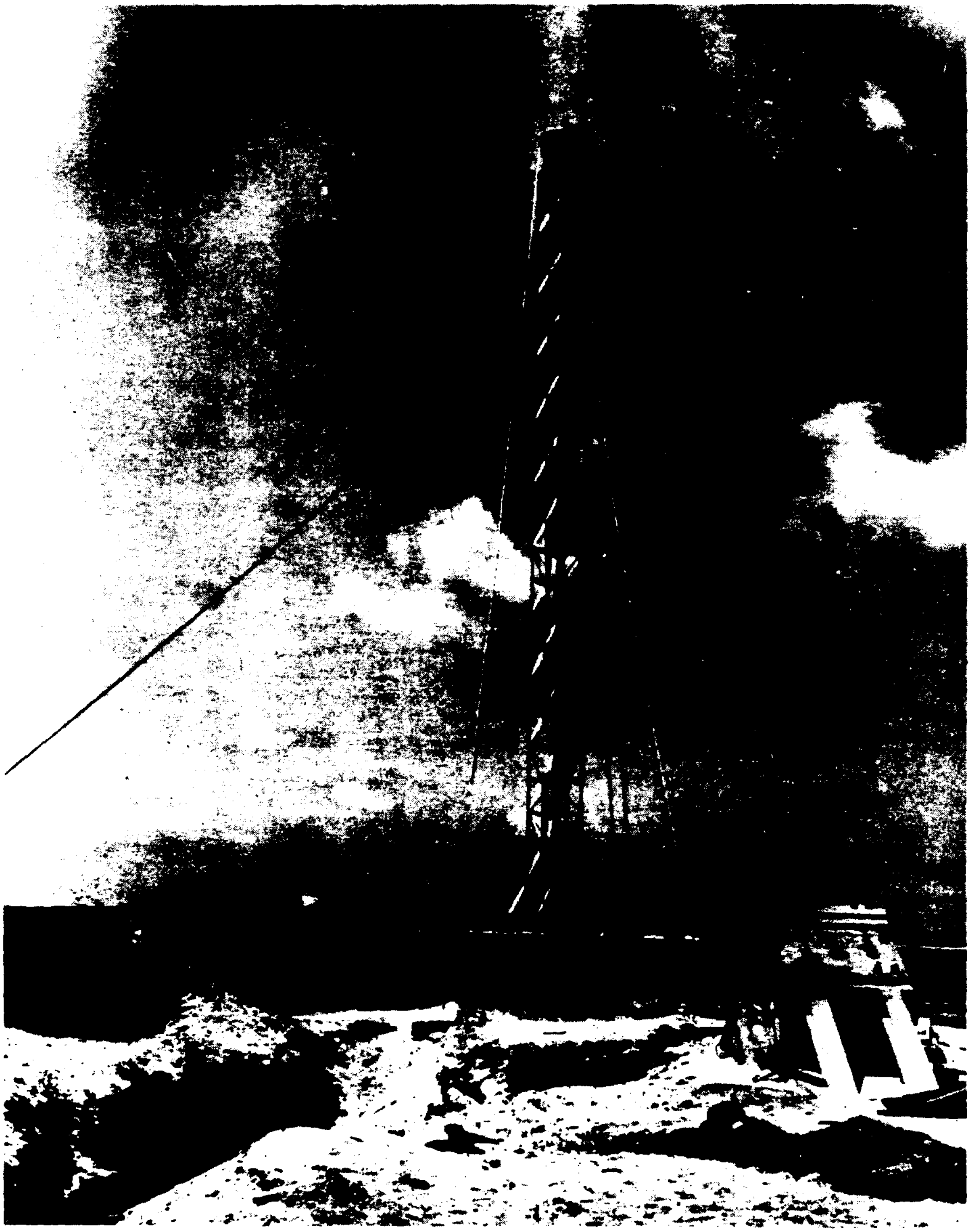
JANUARY 1951 - JULY 1951

At the start of this period, the completion of the construction effort itself, was clearly in sight. The progress curve indicated 95 per cent of completion; the major items remaining included the laying of rigid, semi-rigid, and flexible coaxial cable needed for scientific experiments and supplied by the responsible scientific groups, the completion of the complex tower structure on Ebiriru, extensive earth-moving operations for shielding various structures, and the construction of stations for the "E-Plus" Program on Engebi. Obviously the completion of the last mentioned construction features had to await the detonation of the scheduled first Engebi shot during the latter part of April 1951. The completion of activities related to the laying of coaxial cable was delayed at the request of the AEC until the latest possible time, thus compelling retention of a considerable number of construction personnel at the Jobsite.

In keeping with the completion of more and more of the scientific stations and the arrival at the Jobsite of scientific personnel to start installation of equipment, the efforts of the Construction Department were shifted from Job 3- Construction, to Job 5 - Support of Scientific Groups and Roll-Up. Support activities covered the gamut of equipment requirements and construction skills (requiring at the peak more than 300 men per day) and were embodied in more than a thousand work orders processed through the Holmes & Narver Jobsite



Three-legged 300-ft. Tower on Runit. Note Bitumuls Paving of Entire Zero Area.



Three-legged 300-ft. Tower on Engebi, Showing Two Messenger Cables in Foreground

Reinforcing Steel Prefabricated and Ready to Place in Scientific Station 12, Aomon.

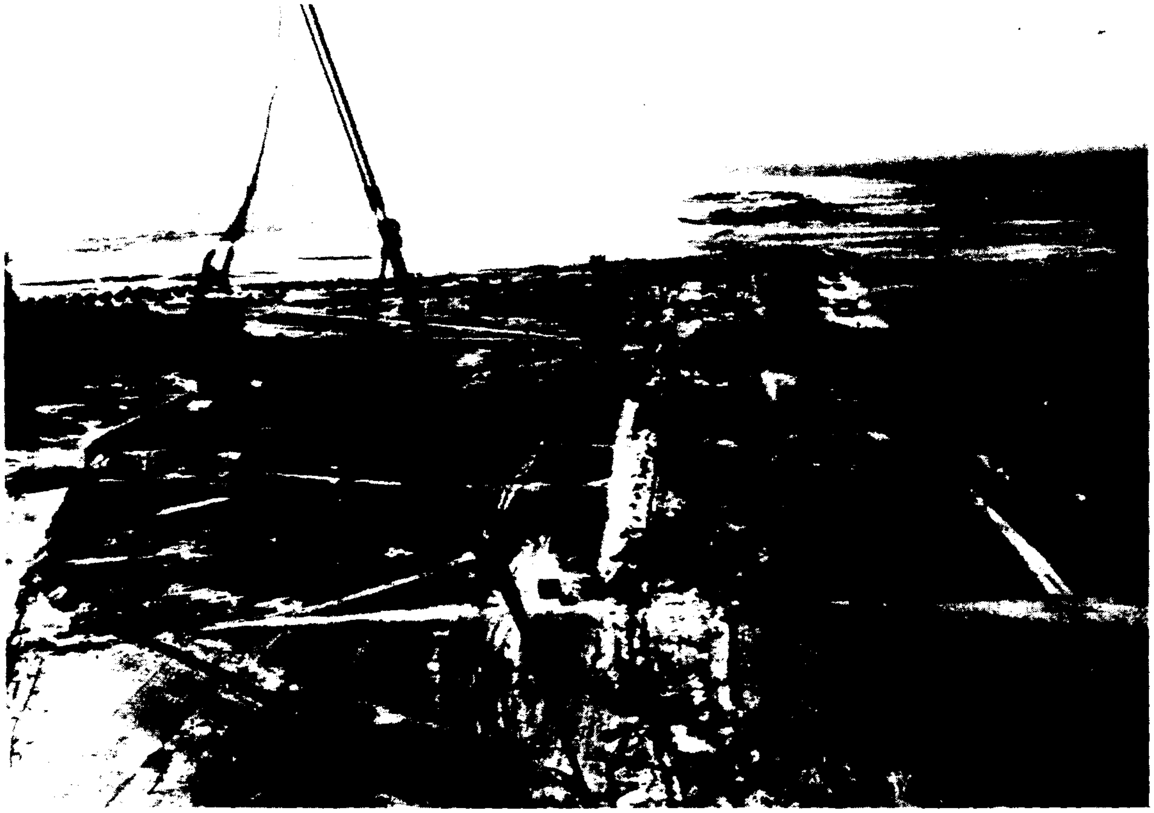
Inspector in Fabricator's Plant Checking Section of 200-ft.
Column Shell to be Installed in Ebiriru Tower.

organization. The details of the nature and scope of this support effort are discussed later in this report. (See Section 17, Support of Scientific Operations and Section 18, Roll-Up, Maintenance, and Salvage, both in Volume 4.) Roll-Up activities, including demolition of structures on the experiment islands, general cleanup, placing the various sites in standby condition, and packing scientific equipment for return to the United States are also discussed hereinafter. Although these activities were performed by H & N construction forces, for the purpose of this chronology it appears to be desirable solely to note here that these requirements also resulted in the retention of construction personnel at the Jobsite through the operational period.

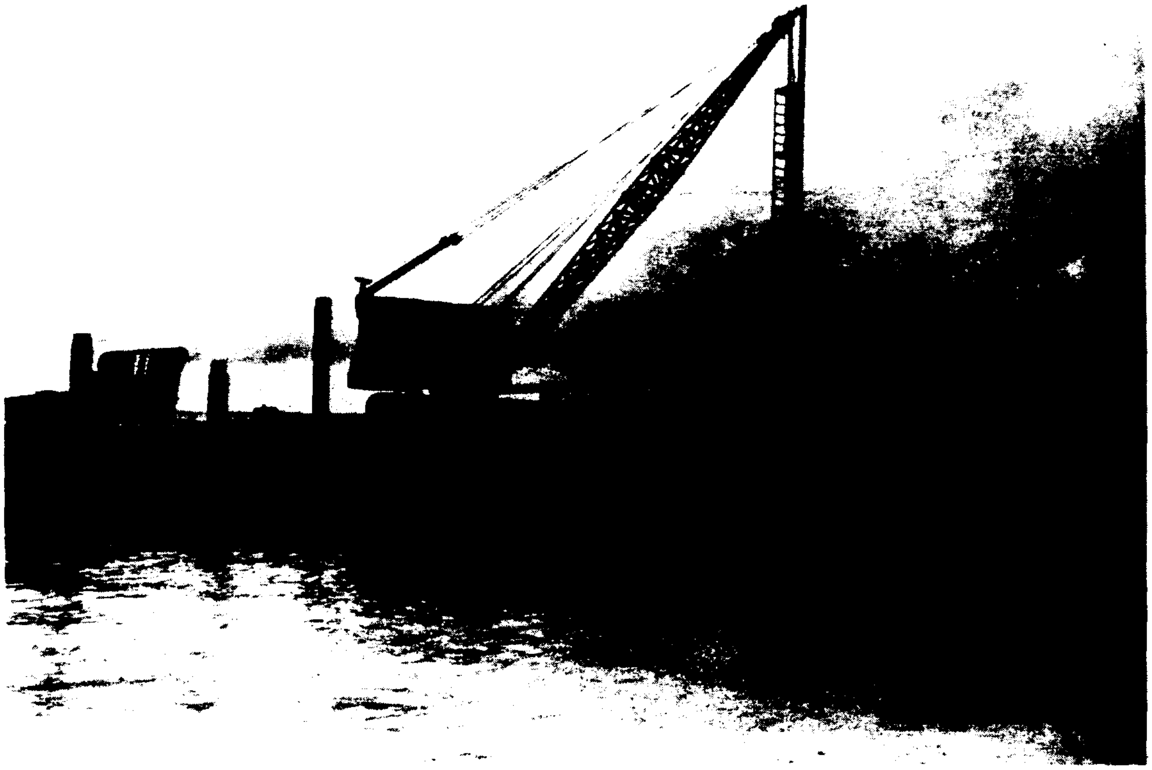
Of the entire construction program, comprising as it did more than a thousand buildings, stations, and installations of varying degrees of complexity, the laying of coaxial cable caused the most concern. The extent of the program was not fully comprehended until rather late in 1950, and even at that time it was hoped that an early start on the laying of the rigid three-inch lines would avoid any difficulty in meeting deadline dates. Installation foremen had been sent to the Naval Research Laboratory, Washington, D. C., for instruction in required welding techniques. The prefabricated sections procured by the responsible scientific group arrived at the Atoll in a series of shipments starting late in December 1950, together with flexible and semi-flexible coaxial cable which was also required in the coax network. Work was started immediately on the flexible lines and no difficulties were encountered. Laying the semi-flexible 1 5/8" cable was also reasonably conventional except that in order to assure proper spacing between the inner and outer conductors it was necessary to unreel the cable into the prearranged trenches and then apply tension to both ends to effect straightening of both conductors. The completion of the three-inch lines, however, required a much larger expenditure of manpower than had been expected.

Welding of successive sections of the rigid line by the prescribed methods was slower and more tedious than anticipated and before long double shifts of welding crews were assigned in order to assure completion on time. The Runit line was completed by the middle of February, but full power checks indicated deficiencies which were not thought to be too serious in view of the projected use of this cable. Installations at the other sites, however, upon being checked were found to be seriously defective.

It was first thought that ineptness on the part of welding crews was the cause, but this was soon disproved when lines welded by expert personnel failed under full power loading. Finally, the defective lines were examined more closely and it was that demonstrated thas various prefabricated sections had been improperly cleaned prior to assembly and in addition that a change in the prescribed welding technique was necessary in order to avoid metal deposition on the insulator spacing rings within the cable. These discoveries lea to a requirement that all installed lines be opened; inner conductors pulled; and all the components thoroughly cleaned, following which



Engebi, Viewed from Tower, Showing Area Adjacent to that on Preceding Page. Open Coaxial Cable Trenches in Foreground, Pier on Right, Muzin Island in Background.



Driving Piles for Rehabilitation of Cargo Pier, Parry Island.

Coral and Sand Fill Causeway Housing Coaxial Cable Trench
Between Ebiriru and **Aomon.**

the Military Structures, the power houses, and many others at the various experiment islands required the moving and placement of more than thirty thousand cubic yards of coral sand. In addition, after the first experiment on Runit, it was decided that sandbagging was required in order to stabilize this type of protective fill on certain of the stations. In fulfillment of this requirement, ten thousand sandbags were procured, filled, and placed.

As construction effort, none of the earthmoving discussed above can be categorized as anything more than routine. On the other hand, it must be realized that at a site at which the preservation of above-water land masses is essential, fill must be almost wholly obtained from underwater sources. This imposes an especially heavy equipment maintenance burden and costs extra manpower to accomplish. Furthermore, personnel force sufficiently in numbers to supply the needed services at the times they are needed must be kept available at the Jobsite.

The availability of competent personnel was particularly apparent in connection with the construction of the tower at Ebiriru. (The complex design of the tower is amply described in Chapter 5-11, Volume 4 of this report.) Because of the loads involved, steel piling had to be driven for foundation support. The actual pouring of the foundations and the erection of the structural steel went forward without incident. The central column erection proved to be more troublesome, however, involving as it did the placement of lead shielding blocks and a steel shell, When this column had been completed to the one hundred and thirty foot level, a small deflection from the vertical was noted and work was stopped for a short time to determine the cause. Various reasons were put forward, none of which indicated defective erection, and it was finally decided to continue this phase of the work. The result was entirely satisfactory, and all members matched properly upon completion.

Shortly before this time, a new requirement had been established for this tower in the form of a series of working platforms at various levels. The steel for these platforms arrived at the Jobsite during March 1951, and structural steel personnel retained at the Jobsite for heavy rigging and the completion of the "E-Plus" tower effected installation.

The last of the major construction features — the work required for the "E-Plus" Program-was completed during the period between April 23 and May 25, 1951. Tower footings and cable installations had been completed earlier, but the erection of the two-hundred foot tower required the completion of all installations; and the placement of necessary fill had to be accomplished. The first seventy-five feet of the tower was preassembled at Parry Island and moved to the test site on Engebi by barge. Work on the tower went forward rapidly after this headstart and the installation was completed before May 20, 1951.

In closing this chronology of the construction effort, note should be made of the fact that in addition to the auxiliary services rendered by the Construction Department under Job 5 of Contract AT-(29-1)-507, the dismanteling of experiment island camps prior to each detonation was effected by construction personnel. Arrangements had been made early in 1951 for the storage of all dismantled buildings, facilities, and equipment at Parry. The removal of tents, mess halls, and other service buildings was effected rapidly, within two days of each experiment; building parts were matchmarked and suitable storage was made, at Parry.

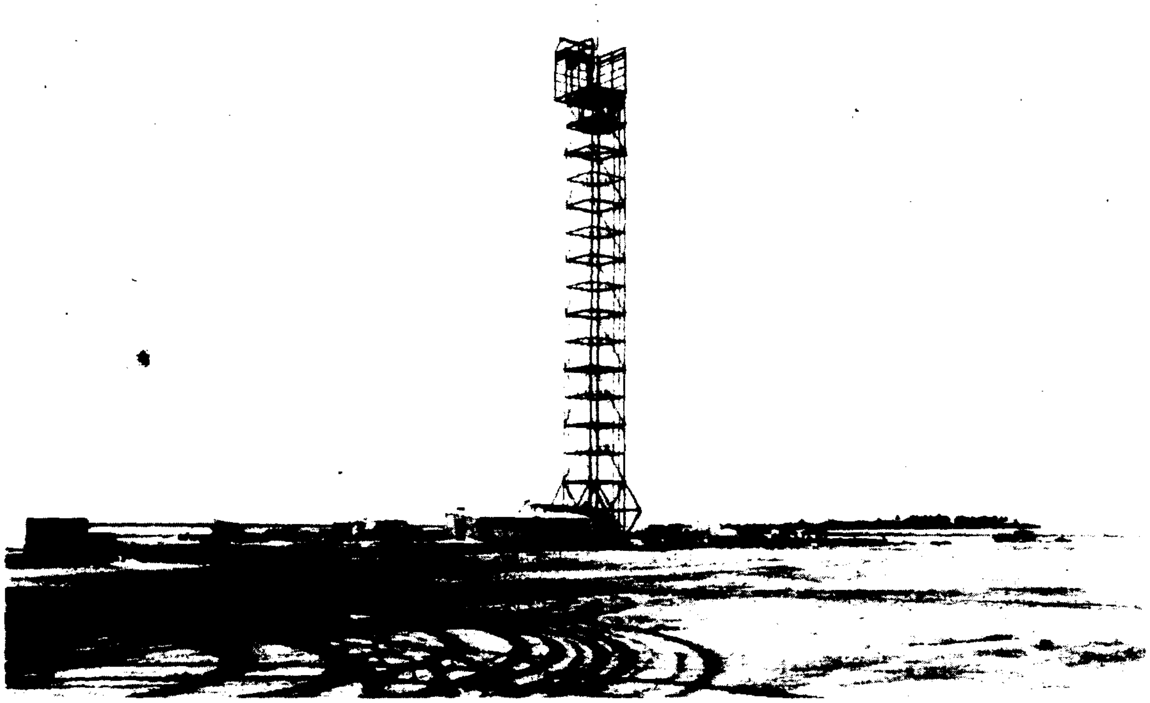
From the re-examination of the Holmes & Narver construction effort at the Proving Ground from July 1949 through June of 1951 which the above chronology affords, certain salient facts are apparent. The attempt has been made to establish these facts in their proper relationship to each other and to the over-all effort. The difficulties inherent in all overseas construction work and those peculiar to work at Eniwetok have been stated and their effect on the construction program in terms of decisions and effort has been noted. Of all the facts, one appears to warrant additional thought. Throughout the course of the work, many radical changes occurred which increased the scope of construction two-fold, and a war intervened with attendant price changes, shortages of materials, lack of shipping, and the like, but the job was done in time for scheduled test operations.

The cost of this construction effort had been estimated to be $26,292,409 exclusive of government-furnished equipment, labor, and transportation. The actual costs incurred, including fees, totaled $24,714,932. A detailed comparison of estimated and actual costs is given in Table 6.6-4; however, it should be noted that the incurred costs listed reflect costs accumulated in accordance with fiscal allocation requirements, which requirements in some respects were not in complete accord with the basis used in the preparation of estimates.

TABLE 6.6-4. COMPARISON OF ESTIMATED COSTS
WITH ACTUAL COSTS AS OF JUNE 30, 1951

			Incurred Cost	
Feature	Estimated Total Cost	Total	Direct	Indirect
PARRY ISLAND - BUILDINGS AND FACILITIES				
Blading & shaping	176,850	252,010.19		
Asphalt surfacing	-	300.17		
Dust palliative	10,870	6,361.73		
	187,720	258,672.09	153,974.07	104,698.02
Aluminum bldgs.	1,999,100	2,309,898.67	1,533,615.73	776,282.94
Frame storage vault	1,715	1,727.88	1,158.78	569.10
Tents and slabs	106,030	94,946.35	55,252.60	39,693.75

H-Beam Piling in Place for 200-ft. Tower on Ebiriru.



General View of Four-Legged 200-ft. Tower on Ebiriru.

Scientific Station No. 121, Large Casting in Place on Foundation.

Ganex Towers, Station Nos. 145 & 146, Erected in Front of Station No. 144a.

	Estimated		Incurred Cost	
Feature	Total Cost	Total	Direct	Indirect
Refrigeration Plant	86,825	127,746.55	112,397.48	15,349.07
Water facilities	652,475	530,438.42	376,236.06	154,202.36
Sewer facilities	130,465	108,434.44	66,511.36	41,923.08
Fuel facilities	434,570	182,121.74	113,941.10	68,180.64
Elec. facilities	359,040	406,779.91	302,931.55	103,848.36
Telephone submarine cable	1,352,305	837,103.41	611,828.05	225,275.36
Telephone facilities	73,975	67,733.59	51,217.36	16,516.23
Control & signal system (included in Bogallua estimate)				
Radio back-up system (Equipment furnished by Military)	11,095	16,689.96	8,505.55	8,184.41
Public Address system	1,885	840.38	840.38	-
Furniture for all buildings	101,275	146,912.74	127,806.80	19,105.94
Equipment for all buildings	76,320	498,154.40	447,834.84	50,319.56
Piers	109,255	154,611.70	88,886.80	65,724.90
Rehabilitation of existing warehouses	106,060	158,366.77	79,080.48	79,286.29
Initial rehabilitation				
C.M.R. Area facilities	335,140	459,765.60	283,508.47	176,257.13
Underground Shelter Area	27,895	29,897.34	16,719.92	13,177.42
Misc. structures & facilities	101,640	58,278.28	27,776.16	30,502.12
Total	6,254,785	6,449,120.22	4,460,023.54	1,989,096.68

Feature	Estimated Total Cost	Total	Incurred Cost Direct	Indirect
ENIWETOK ISLAND - BUILDINGS AND FACILITIES				
Blading & shaping	9,690	3,482.57		
Asphalt surfacing	30,300	63,760.92		
Dust palliative	2,455	2,169.11		
	42,445	69,412.60	61,616.78	7,795.82
Modification of runway	132,440	42,692.44	20,333.62	22,358.82
Plane parking areas	31,765	23,304.35	15,337.74	7,966.61
Air Force Living Camp - aluminum bldgs.	197,175	171,170.48	166,750.33	4,420.15
Tents, including slab	98,140	73,465.75	71,526.33	1,939.42
Army Living Camp - aluminum bldgs.	106,725	93,967.37	90,915.67	3,051.70
Tents, including slab	54,895	40,994.49	39,912.52	1,081.97
Aluminum Bldgs. - Army Service Center	131,240	109,974.48	107,171.63	2,802.85
Aluminum Bldgs. - Common Services	766,365	997,367.85	773,631.42	223,736.43
Tents, including slab	71,860	54,504.63	52,613.11	1,891.52
Aluminum Bldgs. - Air Force Operational	226,455	182,854.09	176,193.09	6,661.00
Aluminum Bldgs. - Transmitter and Receiver bldgs. & Power Houses	80,485	79,811.68	58,990.87	20,820.81

	Estimated		Incurred Cost	
Feature	Total Cost	Total	Direct	Indirect
POL Facilities - On Shore	129,445	95,410.42	92,945.31	2,465.11
POL Submarine lines	36,930	19,778.27	15,256.88	4,521.39
Electrical Generation facilities	313,915	238,915.07	197,472.28	41,442.79
Electrical Distribution facilities	281,880	221,857.50	149,083.95	72,773.55
Telephone facilities	195,600	164,287.41	158,016.55	6,270.86
Sewer Facilities	94,145	57,839.44	56,373.84	1,465.60
Sewer Outfall (only)	32,195	15,478.73	10,199.94	5,278.79
Water Facilities	194,385	87,860.59	71,879.79	15,980.80
Water Distillation Plant (only)	245,440	200,716.66	187,901.00	12,815.66
Cargo Pier	45,740	20,978.38	20,425.01	553.37
Personnel Pier	105,565	45,435.27	27,587.04	17,848.23
Total	3,615,230	3,108,077.95	2,622,134.70	485,943.25
Misc. Services for the Construction Battalion	145,000			
Total	3,760,230			
JAPTAN ISLAND - BUILDINGS AND FACILITIES				
Aluminum Buildings-Quarters	52,450	65,548.59	46,960.72	18,587.87
Aluminum Bldgs. - Mess Hall	36,070	104,865.56	72,729.34	32,136.22
Aluminum Bldgs. - Small Animal Quarters	75,920	98,838.32	79,685.71	19,152.61

Feature	Estimated Total Cost	Incurred Cost		
		Total	Direct	Indirect
Aluminum Bldgs. - Large Animal Quarters	221,470	185,590.18	127,227.32	58,362.86
Aluminum Bldgs. - Animal Food Warehouse	8,795	12,664.03	8,562.20	4,101.83
Aluminum Bldgs. - Laboratory	36,325	81,603.26	48,690.66	32,912.60
Autopsy Building	18,595	16,147.38	9,016.53	7,130.85
X-Ray Building	5,445	7,616.16	3,727.87	3,888.29
Pumphouse	18,605	13,770.20	8,450.14	5,320.06
Greenhouse	750	667.25	370.14	297.11
Roads and Parking Areas	2,840	7,949.54	4,467.99	3,481.55
Telephone Facilities	61,245	27,898.94	16,612.90	11,286.04
Elec. Facilities	158,610	119,594.29	79,758.35	39,835.94
Water Facilities	136,095	159,280.78	111,112.53	48,168.25
Sewer Facilities	58,570	38,583.19	22,239.14	16,344.05
Pier Rehabilitation	4,960	11,407.50	5,315.59	6,091.91
Service Station	3,250	5,105.56	2,491.58	2,613.98
Incinerator	325	266.00	179.04	86.96
Infirmary Bldg. - Wood Frame	7,715	10,057.20	5,385.37	4,671.83
Cargo Pier	39,445	61,631.79	36,429.73	25,202.06
Tents	2,155	645.06	333.47	311.59
Thermal Bldg. and Exposure Units	1,110	955.96	418.86	537.10
Total	950,745	1,030,686.74	690,165.18	340,521.56

Feature	Estimated Total Cost	Incurred Cost		
		Total	Direct	Indirect
RUNIT ISLAND - BUILDINGS AND FACILITIES				
Blading & shaping	38,165	71,464.90		
Asphalt surfacing - Roads	70	18.67		
Asphalt surfacing - Other areas	167,050	118,870.35		
Dust Palliative	11,010	98.90		
Total	216,295	190,452.82	129,011.07	61,441.75
Aluminum Bldgs.	93,555	141,521.40	90,144.07	51,377.33
Concrete Building	181,235	98,271.73	53,291.02	44,980.71
Tents, including slab	56,950	28,997.62	16,016.88	12,980.74
300-foot Tower, complete	197,900	240,083.00	144,761.55	95,321.45
Water Facilities	178,850	178,928.70	128,616.57	50,312.13
Sewer Facilities	72,980	16,140.54	10,067.14	6,073.40
Elec. Facilities	197,685	169,698.32	132,093.05	37,605.27
Telephone Facilities	7,780	10,340.87	8,270.31	2,070.56
Control & Signal Equipment	53,505	38,276.92	21,966.00	16,310.92
Radio Back-up Equipment (Equipment furnished by Military)	10,950	1,661.31	797.38	863.93
Public Address System	1,855	48.89	48.89	-
Equipment (not installed)	5,050	66,767.46	60,758.60	6,008.86
Furniture	4,880	4,725.72	2,300.72	2,425.00

Feature	Estimated Total Cost	Incurred Cost		
		Total	Direct	Indirect
Cargo Pier	87,740	133,845.01	78,848.44	54,996.57
Initial rehabilitation				
Total	1,367,210	1,319,760.31	876,991.69	442,768.62
AOMON GROUP - BUILDINGS AND FACILITIES				
Blading & shaping	57,530	85,359.30		
Asphalt Paving, Roads	26,070	2,082.64		
Asphalt Paving, Other Areas	306,115	190,921.72		
Dust Palliative	8,305	752.47		
	398,020	279,116.13	174,081.84	105,034.29
Aluminum Bldgs.	84,850	110,382.86	69,357.66	41,025.20
Concrete Building	179,670	109,105.64	57,393.21	51,712.43
Tents, including slab	66,725	48,671.30	25,484.10	23,187.20
200-foot Tower, complete	224,305	449,358.54	248,800.01	200,558.53
Water Facilities	176,020	203,274.47	141,755.96	61,518.51
Sewer Facilities	72,560	14,615.76	10,152.02	4,463.74
Elec. Facilities	194,290	187,694.84	146,628.56	41,066.28
Telephone Facilities	7,720	10,307.75	8,285.39	2,022.36
Control & Signal System	52,215	22,150.43	13,723.13	8,427.30
Radio Back-up System (Equipment furnished by Military)	10,875	817.45	427.12	390.33

	Estimated		Incurred Cost	
Feature	Total Cost	Total	Direct	Indirect
Public Address System	1,775	48.60	48.60	-
Furniture	4,875	6,310.29	5,408.33	901.96
Equipment (not installed)	5,105	60,265.39	51,461.93	8,803.46
Causeway & Pier	286,965	351,181.10	213,595.33	137,585.77
Initial rehabilitation				
Total	1,765,970	1,853,300.55	1,166,603.19	686,697.36
ENGEBI ISLAND - BUILDINGS AND FACILITIES				
Blading & shaping	21,405	80,069.37		
Asphalt Paving, Roads	19,410	11,378.67		
Asphalt Paving, Other Areas	243,600	120,606.54		
Dust Palliative	6,465	4,543.18		
	290,880	216,597.76	140,713.25	75,884.51
Aluminum Bldgs.	292,230	226,273.23	132,651.06	93,622.17
Concrete Building	178,050	134,828.77	73,306.99	61,521.78
Tents, including slab	190,065	80,579.74	43,595.81	36,983.93
300-foot Tower, complete	93,650	278,761.97	173,797.97	104,964.00
Water Facilities	194,370	194,304.62	139,878.21	54,426.41
Sewer Facilities	73,790	25,830.55	16,257.86	9,572.69
Elec. Facilities	207,770	275,004.66	199,443.03	75,561.63
Telephone Facilities	7,720	18,451.09	13,630.41	4,820.68

Feature	Estimated Total Cost	Total	Incurred Cost Direct	Indirect
Control & Signal System	49,790	59,748.51	46,321.60	13,426.91
Radio Back-up System (Equipment furnished by Military)	10,860	1,437.60	699.04	738.56
Public Address System	1,855	48.72	48.72	-
Furniture	12,215	7,680.48	6,398.28	1,282.20
Equipment (not installed)	9,170	136,850.70	120,776.10	16,074.60
Pier & Channel	269,370	345,222.35	194,017.96	151,204.39
Initial rehabilitation				
Total	1,881,785	2,001,620.75	1,301,536.29	700,084.46
<u>BOGALLUA ISLAND - BUILDINGS AND FACILITIES</u>				
Blading & shaping	20,850	20,111.37	14,873.39	5,237.98
200-foot Tower, complete	-	20.54	20.54	-
Service Buildings	-	985.27	985.27	-
Tents, including slab				
Concrete Power Plant Bldg.				
Concrete Timing Station				
Water Facilities	-	651.56	651.56	-
Elec. Facilities	-	1,190.63	1,190.63	-
Communications System, including submarine cable	26,400	25,113.17	19,149.53	5,963.64

Feature	Estimated Total Cost	Incurred Cost Total	Incurred Cost Direct	Incurred Cost Indirect
Control & Signal System, including submarine cable	5,420	5,888.12	4,769.69	1,118.43
Pier & Channel	4,030	3,737.38	1,979.94	1,757.44
Furniture				
Equipment (not installed)				
Total	56,700	57,698.04	43,620.55	14,077.49
MISCELLANEOUS ITEMS AND SITES M, N, P & Q AND FACILITIES				
Blading & shaping	18,045	20,114.29	14,457.13	5,657.16
Asphalt Handling Facilities	95,010	83,820.80	50,778.42	33,042.38
Dust Palliative	-	545.76	440.50	105.26
Tents, including slab				
75-foot Towers	213,215	209,280.08	135,427.78	73,852.30
Elec. Facilities	99,515	72,299.64	59,260.73	13,038.91
Radio Facilities	2,380	-	-	-
Control & Signal System	6,015	-	-	-
Water Facilities	-	1,732.36	1,732.36	-
Latrines				
Piers	-	226.25	226.25	
Furniture				
Total	434,180	388,019.18	262,323.17	125,696.01

Feature	Estimated Total Cost	Total	Incurred Cost Direct	Indirect
MILITARY STRUCTURES, PROGRAM 3, INCLUDING INSTRUMENTATION				
Structure 3.1.1	1,356,545	1,221,981.82	674,326.73	547,655.09
Structure 3.1.3	86,400	72,558.21	42,759.26	29,798.95
Structure 3.2.1a	58,560	49,618.17	29,740.12	19,878.05
Structure 3.2.1b	74,140	71,106.91	45,375.09	25,731.82
Structure 3.2.2a	48,770	35,543.34	22,794.22	12,749.12
Structure 3.2.2b	66,080	42,295.84	27,507.50	14,788.34
Structure 3.2.3a & b	155,165	117,621.14	86,382.53	31,238.61
Structure 3.2.4a	59,765	39,974.04	25,606.05	14,367.99
Structure 3.2.4b	78,750	43,377.49	28,372.05	15,005.44
Structure 3.2.5	78,940	46,140.62	30,065.96	16,074.66
Structure 3.2.6	42,175	34,296.77	21,376.43	12,920.34
Structure 3.2.7a	38,690	31,000.44	18,330.70	12,669.74
Structure 3.2.7b	37,695	42,187.63	25,540.17	16,647.46
Prefab Spare Parts	30,000	-	-	-
Structure 3.3.3	536,420	460,242.17	267,363.99	192,878.18
Structure 3.3.4	192,815	170,737.11	93,803.16	76,933.95
Structure 3.3.5a & b	248,480	233,293.49	121,325.32	111,968.17
Structure 3.3.8a thru h	571,285	390,561.51	239,513.18	151,048.33
Total Program Three	3,760,675	3,102,536.70	1,800,182.46	1,302,354.24
MILITARY STRUCTURES, PROGRAM 8.2 - TOTAL	165,140	141,800.84	82,671.46	59,129.38

Feature	Estimated Total Cost	Incurred Cost		
		Total	Direct	Indirect
MILITARY STRUCTURES, LORAN STATION - TOTAL	100,270	56,080.94	40,637.83	15,443.11
TOWERS				
Two 300' Towers & one 200' Tower (stored at Jobsite)	319,100	213,905.72	195,447.43	18,458.29
Mock-up Section of 200' Tower (delivered to Los Alamos)	18,000	18,221.13	17,768.91	452.22
Total	337,100	232,126.85	213,216.34	18,910.51
TOTAL - ITEMS 1 - 12	20,834,790	19,740,829.07	13,560,106.40	6,180,722.67
SCIENTIFIC STRUCTURES				
N.O.B.L. Program	246,715	260,339.13	167,621.13	92,718.00
J-7 Program	7,150	10,456.97	5,305.65	5,151.32
N.B.S. Program	1,238,980	818,198.85	596,564.19	221,634.66
E.G.G. Program	444,865	354,744.24	206,163.02	148,581.22
N.R.L. Program	219,715	297,748.20	189,369.05	108,379.15
J-3 Program	320,405	229,043.40	145,279.99	83,763.41
LD-50 Program	131,520	131,230.57	69,433.15	61,797.42
T-B Program	70,600	98,649.55	55,003.27	43,646.28
M-D Program	19,685	20,239.26	11,069.74	9,169.52
A.M.C. Program	14,305	7,555.33	3,381.38	4,173.95
All Users				
U.C.R.L. & N.R.L.K Program	878,295	659,843.83	440,832.76	219,011.07
O.C.S.O. Program	8,400	8,087.35	4,419.40	3,667.95

	Estimated		Incurred Cost	
Feature	Total Cost	Total	Direct	Indirect
Meteor Program	17,200	19,551.37	9,288.80	10,262.57
Rad-Chem Program	514,250	415,479.95	280,183.24	135,296.71
N.R.D.L. Program	31,025	41,107.42	20,504.83	20,602.59
AFOAT Program	30,835	26,040.84	14,633.40	11,407.44
A.C.C. Program	1,035	1,675.86	790.98	884.88
BRL-APG Program	1,085	11.67	11.67	-
A.E.C. Program	7,700	10,189.29	6,757.92	3,431.37
Total	4,203,765	3,410,193.08	2,226,613.57	1,183,579.51
GROUTING PROGRAM				
Military Program	530,375	648,801.20	314,263.92	334,537.28
Scientific Program	-	23,847.00	10,448.74	13,398.26
Total	530,375	672,648.20	324,712.66	347,935.54
DRILLING PROGRAM				
Military Program	53,390	65,473.24	37,240.82	28,232.42
Scientific Program	65,470	74,055.83	39,343.81	34,712.02
Total	118,860	139,529.07	76,584.63	62,944.44
E-PLUS PROGRAM - TOTAL	749,620	783,457.96	482,341.20	301,116.76
TOTAL CONSTRUCTION COSTS DISTRIBUTED TO PROJECTS IN PROGRESS	26,437,410	24,746,657.38	16,670,358.46	8,076,298.92
Less: Radio Back-up System Costs	-	(31,724.62)		
TOTAL	26,437,410	24,714,932.76		

Feature	Estimated Total Cost	Total	Incurred Cost Direct	Indirect
JOB 4: CAMP OPERATION, MAINTENANCE AND MANAGEMENT	6,894,685	5,844,512.10	-	-
JOB 5: SUPPORT AND ROLL-UP	-	2,382,847.58		
Plus: Radio Back-up System		31,724.62		
Total Job 5	3,172,900	2,414,572.20		

Table 6.6-5 shows relevant unit costs of construction developed from the costs given above.

TABLE 6.6-5 UNIT COSTS OF CONSTRUCTION

Blade and Shape - Site Preparation	$ .35 per sq. yd.
Blade, Shape, and Stabilize Roads and Airstrips	.63 per sq. yd.
Asphalt Surfacing	1.28 per sq. yd.
Tents (slab, frame, and canvas)	2.56 per sq. yd.
Tents (slab and frame - Eniwetok Island)	1.40 per sq. yd.
Sewers (complete systems, including pumps lines, manholes, and outfalls)	10.63 per lin. ft.
Water facilities (complete systems, including stills, tanks, pumps, and lines)	33.77 per lin. ft.
Electrical facilities (complete system, including generators, switchgear, and all distribution)	512.50 per kw
Telephone Facilities (lines on existing poles, switchboards, and instruments)	
Aluminum Buildings (average of base facilities structures)	See analysis on pages 6-94 and 6-95.

INCURRED UNIT COSTS FOR ALUMINUM BUILDINGS, AS OF MAY 30, 1951

Item	Square Feet Completed	Direct Material	Direct Labor	Indirect	Total Unit Cost *
PARRY					
POL Facilities	852	24.11	13.16	18.06	55.33
S.W. Pump House	852	4.95	1.87	2.28	9.10
Power House	5,628	3.80	3.91	4.99	12.70
Telephone Building	446	.69	6.72	8.63	16.04
Telemeter Building	651	5.62	10.88	14.39	30.89
Recreation Building	15,453	2.69	2.41	2.93	8.03
Admin. Building	27,287	4.08	3.10	3.90	11.08
Barracks	67,378	4.30	2.34	2.89	9.53
Infirmary	3,518	5.20	4.23	5.45	14.88
Commissary	1,760	3.14	1.36	1.54	6.04
Mess Hall	14,144	3.65	3.65	4.63	11.93
Fire Station & Security	1,387	4.01	2.76	3.44	10.21
Reefer & Storage	5,524	3.46	3.95	5.03	12.44
P. X.	3,295	4.49	6.02	7.83	18.34
Warehouse	10,424	3.11	1.21	1.34	5.66
Laundry	3,940	3.92	4.84	6.25	15.01
Bakery	1,255	3.90	2.53	3.12	9.55
Repair & Service Shop	10,697	4.77	2.29	2.84	9.90
Latrines & Showers	5,506	5.99	5.70	7.44	19.13
Material Test Laboratory	651	3.84	3.41	4.30	11.55
Boiler House	1,302	16.19	6.07	8.30	30.56
Laboratory Buildings	9,295	5.93	6.22	8.15	20.30
TOTAL BUILDINGS SITE "B"	191,245				
AVERAGE UNIT COST SITE "B"		4.33	3.14	3.97	11.44
JAPTAN					
Quarters	6,788	4.42	2.19	3.03	9.64
Mess Hall	3,109	11.53	7.99	11.30	30.82
Small Animal Quarters	4,258	11.64	3.59	4.87	20.10
Large Animal Quarters	31,200	2.48	1.63	2.08	6.19
Animal Food Warehouse	1,557	3.12	2.19	2.93	8.24
Laboratory	4,135	5.64	6.22	8.21	20.07
Autopsy Building	1,200	2.66	4.61	6.22	13.49
X-Ray Building	325	1.91	9.49	13.24	24.64
Pump House	450	8.30	9.54	13.11	30.95
Infirmary	507	3.09	7.56	10.22	20.87
TOTAL BUILDINGS SITE "L"	53,529				
AVERAGE UNIT COST SITE "L"		4.30	2.83	3.79	10.92

INCURRED UNIT COSTS FOR ALUMINUM BUILDINGS, AS OF MAY 30,1951 (Cont'd.)

Item	Square Feet Completed	Direct Material	Direct Labor	Indirect	Total Unit Cost*
RUNIT					
Recreation Building	1,292	.27	1.87	2.28	4.42
Admin. Building	1,155	3.69	2.25	2.92	8.86
Fire House & First Aid	551	3.98	2.71	3.55	10.24
Mess Hall	2,628	5.57	5.56	7.42	18.55
Reefer & Storage	1,120	.92	1.90	2.37	5.19
Repair & Service Shop	3,360	1.28	1.25	1.49	4.02
Latrines & Showers	2,862	6.10	4.10	5.48	15.68
Boiler House	120	.62	2.44	3.07	6.13
TOTAL BUILDINGS SITE "C"	13,088				
AVERAGE UNIT COST SITE "C"		3.63	3.18	4.17	10.98
AOMON					
Recreation Building	1,434	.04	2.42	3.03	5.49
Admin. Building	1,155	3.24	1.93	2.49	7.66
Mess Hall	3,520	3.96	3.39	4.47	11.82
Fire Station & First Aid	551	4.18	3.94	5.20	13.32
Service Shops	2,400	1.79	1.35	1.67	4.81
Latrines & Showers	1,906	5.43	3.92	5.22	14.57
Boiler House	143	-0-	4.29	5.53	9.82
TOTAL BUILDINGS SITE "D"	11,109				
AVERAGE UNIT COST SITE "D"		2.87	2.74	3.56	9.17
ENGEBI					
Infirmary	1,782	1.13	2.54	3.20	6.87
Mess Hall	8,766	2.46	3.21	4.16	9.83
Fire Station	660	.40	1.50	1.82	3.72
Reefer & Storage	204	2.08	2.37	3.02	7.47
P.X.,Commissary and Recreation Building	2,813	.84	1.53	1.84	4.21
Latrines & Showers	4,796	4.82	4.67	6.18	15.67
Material Testing Laboratory	800	1.78	2.38	3.03	7.19
Boiler House	143	7.29	16.77	22.47	46.53
TOTAL BUILDINGS SITE "E"	19,964				
AVERAGE UNIT COST SITE "E"		2.62	3.26	4.23	10.11

* The Unit costs shown above are for the building completely erected on concrete slab and include all permanently installed equipment.

SUMMARY

In order to summarize the construction effort associated with Base Facilities and Scientific Stations at the Proving Ground, statistics have been tabulated relevant to each of the sites involved. These tables are discussed in the following pages. Descriptions of each of the items constructed, together with references to pertinent as-built drawings and costs incurred, are given in Appendix E, Facilities and Stations, Vol. 8 of this report.

Parry Island. Parry Island was the headquarters island for construction activities from the first part of 1950. The main warehouses and shops were located there, and as a consequence construction at this site, after early 1950, was not beset by the difficulties of intra-atoll transportation of men, materials, and equipment. Likewise, after the construction of aluminum barracks and other base facilities into which H & N forces moved from the interim camp on Eniwetok Island, more normal living conditions aided in maintaining the morale of personnel on Parry at a high level. However, this location felt the impact of program and population changes to a greater extent than other locations and, as a result, construction activities were still going on during the first quarter of 1951. The additional facilities required to accommodate increased numbers of personnel included tents and latrines, additions to the powerhouse and water distillation facilities, mess hall, recreation building, theatre, and post exchange. A concrete reservoir was required to meet increased demands for fresh water for the photographic laboratory and the CMR building.

Aside from the CMR building none of the construction was of an extraordinary nature requiring highly specialized skills, close tolerances, or unusual construction materials. The CMR building was complicated by virtue of the time scale allowed for procurement and construction, expecially with respect to the rather complex high pressure and normal pressure piping systems required.

Table 6.6-6 is a summary of significant quantities related to construction on Parry.

TABLE 6.6-6. CONSTRUCTION SUMMARY, PARRY ISLAND

Feature	Unit	Description
CAMP FACILITIES		
Blade & Shape, Roads	61,200 sq yds	
Blade & Shape, Site	372,100 sq yds	
Blade & Shape, Airstrip	26,600 sq yds	
Aluminum Buildings	191,128 sq ft	105 Buildings
Frame Storage Vault	252 cu ft	
Tents	36,065 sq ft	101 Tents
Refrigeration Plant	37,610 cu ft	

TABLE 6.6-6. CONSTRUCTION SUMMARY, PARRY ISLAND (cont'd)

Feature	Unit	Description
CAMP FACILITIES		
Water Facilities, Salt Water System	10,328 lin ft	Includes well 24'-6" deep and 42,000 gallon elevated storage tank
Water Facilities, Fresh Water System	9,110 lin ft	Includes concrete reservoir with 13,500 cu ft capacity,21,000 gallon elevated storage tank, and two 21,000 gallon storage tanks
Sewer Facilities	10,950 lin ft	
Fuel Facilities	1 lot	1 42,000 gal gas storage tank 2 42,000 gal diesel oil tanks 5 10,000 gal diesel oil tanks 6 42,000 gal additional tanks 1 gasoline service station 1 5,000 gal diesel oil tank for boat fueling facilities
Electrical Facilities	852 kw	167 poles, 33,050 feet of primary, 48,650 feet of secondary, 4,639 feet of street lighting, and 6,050 feet of buried cable
Telephone Submarine Cable	598,500 lin ft	Cable to All Sites
Telephone Facilities	17,750 lin ft	300 Phones
Theatre	658 seat	
Piers	1 lot	1 Freight Pier, 40' x 180' 1 Marine Ramp, 50' x 85' 1 Marine Ramp, 50' x 170' 1 Navy Pontoon Pier, 40' x 125' 1 Personnel Pier & Float, 30' x 200'

TABLE 6.6-6. CONSTRUCTION SUMMARY, PARRY ISLAND (cont.)

Feature	Unit	Description
CAMP FACILITIES		
Rehabilitation of Existing Warehouses	67,200 sq ft	27 Buildings
CMR Area Facilities	6,364 sq ft	3 Aluminum Buildings and 1 Underground Shelter
Underground Shelter Area	172 sq ft	1 Underground Shelter and 2 Guard Posts
LORAN STATION	288 sq ft	2 Buildings, 1 Foundation, and 1 - 75' Antenna
SCIENTIFIC STATIONS	1 each	1 Calibration Station, 101 sq ft

Eniwetok Island. The araangements for the performance of construction services on Eniwetok Island by the 79th Engineer Battalion are discussed above in this section. The features of the Eniwetok Island Base Facilities and stations constructed by H & N forces are indicated by an asterisk in Table 6.6-7 below. However, it should be noted, that in addition to these items of construction Holmes & Narver provided a construction superintendent and craft foremen to assist the Battalion and also provided skilled personnel, when required, to actually perform certain construction operations, such as, for example, in the construction of the Air Force briefing room.

Table 6.6-7 gives significant quantities associated with construction on Eniwetok Island.

TABLE 6.6-7. CONSTRUCTION SUMMARY, ENIWETOK ISLAND

Feature	Unit	Description
CAMP FACILITIES		
Blade & Shape, Roads	40,000 sq yds	
Blade & Shape, Site Preparation	46,000 sq yds	
Asphalt Paving, Roads	24,000 sq yds	
Asphalt Paving, Airstrip	64,173 sq yds	
Air Force Living Camp, Alum. Bldgs.	33,661 sq ft	19 Buildings
Air Force Living Camp, Tents	52,610 sq ft	104 Tents
Army Living Camp, Aluminum Bldgs.	29,055 sq ft	17 Buildings
Army Living Camp, Tents	29,460 sq ft	58 Tents
Army Service Center, Alum. Bldgs.	8,955 sq ft	3 Buildings

TABLE 6.6-7. CONSTRUCTION SUMMARY, ENIWETOK ISLAND (cont.)

Feature	Unit	Description
CAMP FACILITIES		
Common Services, Aluminum Bldgs.	72,051 sq ft	22 Buildings
Common Services, Tents	38,390 sq ft	76 Tents
Alum. Bldgs., Air Force Operational	15,580 sq ft	11 Buildings
*Aluminum Buildings, Transmitter and Receiver Bldgs. & Power House	352 sq ft	1 Building
P.O.L. Facilities, On Shore	1 lot	4 42,000 gal 100 Octane Aviation gas tank 1 42,000 gal Mogas tank 4 10,000 gal 91 Octane Avgas tanks 1 42,000 gal diesel oil tanks 4 10,000 gal diesel oil tanks 1 42,000 gal JP-1 fuel tank
*P.O.L. Submarine Lines	2,490 lin ft	
*Electrical Generation Facilities	852 kw	
*Electrical Distribution Facilities	1 lot	31,842 feet of primary, 103,243 feet of secondary, 21,954 feet of buried cable, 137 poles
Telephone Facilities	41,500 lin ft	300 Phones
Sewer Facilities	12,276 lin ft	
*Sewer Facilities, Outfall	2,440 lin ft	
Water Facilities, Salt Water	22,900 lin ft	1 42,000 gal storage tank
Water Facilities, Fresh Water	22,565 lin ft	1 21,000 gal storage tank
*Water Distillation Plant	7,310 sq ft	
Cargo Pier	4,481 sq ft	
*Personnel Pier	640 sq ft	
*SCIENTIFIC STATIONS	4 each	2 Photo Huts, 1 Seismograph, and 1 Steam Cleaning Plant
LORAN STATION	2,418 sq ft	1 Aluminum Building, and 2 75' Antennas

*Constructed by H & N

Japtan Island. At this site one of the prime requirements imposed was that trees should be left standing in order to afford maximum shade for the animal facilities. As a consequence, normal construction procedures were impossible in some cases. Furthermore, no gross site grading could be done, which resulted in a more than normal amount of hand work in trenching for water and sewer lines and the like. In addition, great care was required in laying pipe lines to assure gradient and flow.

Significant quantities associated with construction at Japtan are given in Table 6.6-8.

TABLE 6.6-8. CONSTRUCTION SUMMARY, JAPTAN ISLAND

Feature	Unit	Description
CAMP FACILITIES		
Aluminum Buildings	30,306 sq ft	54 Buildings
Greenhouse	220 sq ft	
Roads & Parking Areas	12,000 sq yd	
Telephone Facilities	3,775 lin ft	8 Phones
Electrical Facilities	193 kw	4,700 feet of primary 15,750 feet of secondary 27 Poles
Water Facilities, Salt Water	3,700 lin ft	1 42,000 gallon elevated tank 2 1,300 gallon storage tanks
Water Facilities, Fresh Water	3,415 lin ft	1 42,000 gallon elevated tank 1 4,200 gallon storage tank 1 1,300 gallon storage tank
Sewer Facilities	3,450 lin ft	
Service Station	89 sq ft	Grease Rack only
Incinerator	1 each	2 bbl. size
Cargo Pier	2,660 sq ft	
Tents	2,432 sq ft	6 Tents
Thermal Building	50 sq ft	
SCIENTIFIC STATIONS	2 each	2 Tents

Engebi-Muzin. Construction on Engebi, in view of the time scale involved in the Military Structures Program, the E-Plus Program, and late changes in the Scientific Stations, presented the most complicated scheduling problems. In addition, the nature of the construction performed at this site, requiring as it did, practically every craft employed in the construction industry (and even some not normally found) enhanced the difficulties involved. Yet, by maximizing coordination of the various Jobsite departments and providing warehousing and shop facilities at the site, the orderly progress of construction was never impaired. True, there were times when construction stopped on some of the buildings for lack of specialized materials on which procurement had taken more time than anticipated or because approval to proceed depended on communication with Users in the United States. But these occasions were not so numerous as to create a dangerous situation in which completion on schedule was deemed to be impossible. The delays in making locations firm or in finalizing designs and requirements were of much more concern to the H & N organization, and in particular, to the personnel responsible for construction on Engebi and Muzin.

The base facilities for this experiment site were similar to those at the other experiment sites although on a larger scale to accommodate the greater population in residence. In view of the greater number of scientific data channels planned for this site as compared to the others, power requirements were not only greater, but distribution systems were much more extensive. Camp facilities were taxed to the limit and additions were required. Telephone service far beyond original plans required the expenditure of effort in this regard during a much later period than originally anticipated and scheduled. Thus, while the same conditions of continual increase in requirements and commensurate increase in facilities existed at all of the major locations at the Proving Ground, it was at Engebi that the impact of the condition was most evident.

Although the details of the Military Structures Program are given in the following chapter of this volume, it might be noted here that the program was in the discussion stage for more than six months before any reference to drawings was had by H & N representatives. By November 1949, after a wait from July when preliminary timetables were submitted by H & N, the dangers of greatly increased cost and postponement of test operations inherent in further delay in initiating procurement were brought to the attention of all concerned. Yet is was not until January 1950, that H & N was authorized to proceed with limited procurement and construction and not until March 1950 that formal authorization to proceed was forthcoming. The impact of such a schedule on construction at the Jobsite was, in itself, serious as may be seen from Figures 6.6-2, 6.6-3, and 6.6-4. When one considers in addition the shipping hiatus during the critical months of July and August, 1950, the reflection of continuous progress in the periodic reports on Engebi construction is significant.

The imposition of new User requirements and the resulting expansion of power generation and distribution facilities during the course of construction at Engebi is mentioned briefly above. It might be noted that this extension involved the preparation of a new foundation in Station 100 (power house) to accommodate a larger diesel generator unit than originally planned; a delay in installation of primary and secondary distribution systems for Scientific Stations until new, greater capacity wire could be obtained; and the necessity for providing temporary power systems.

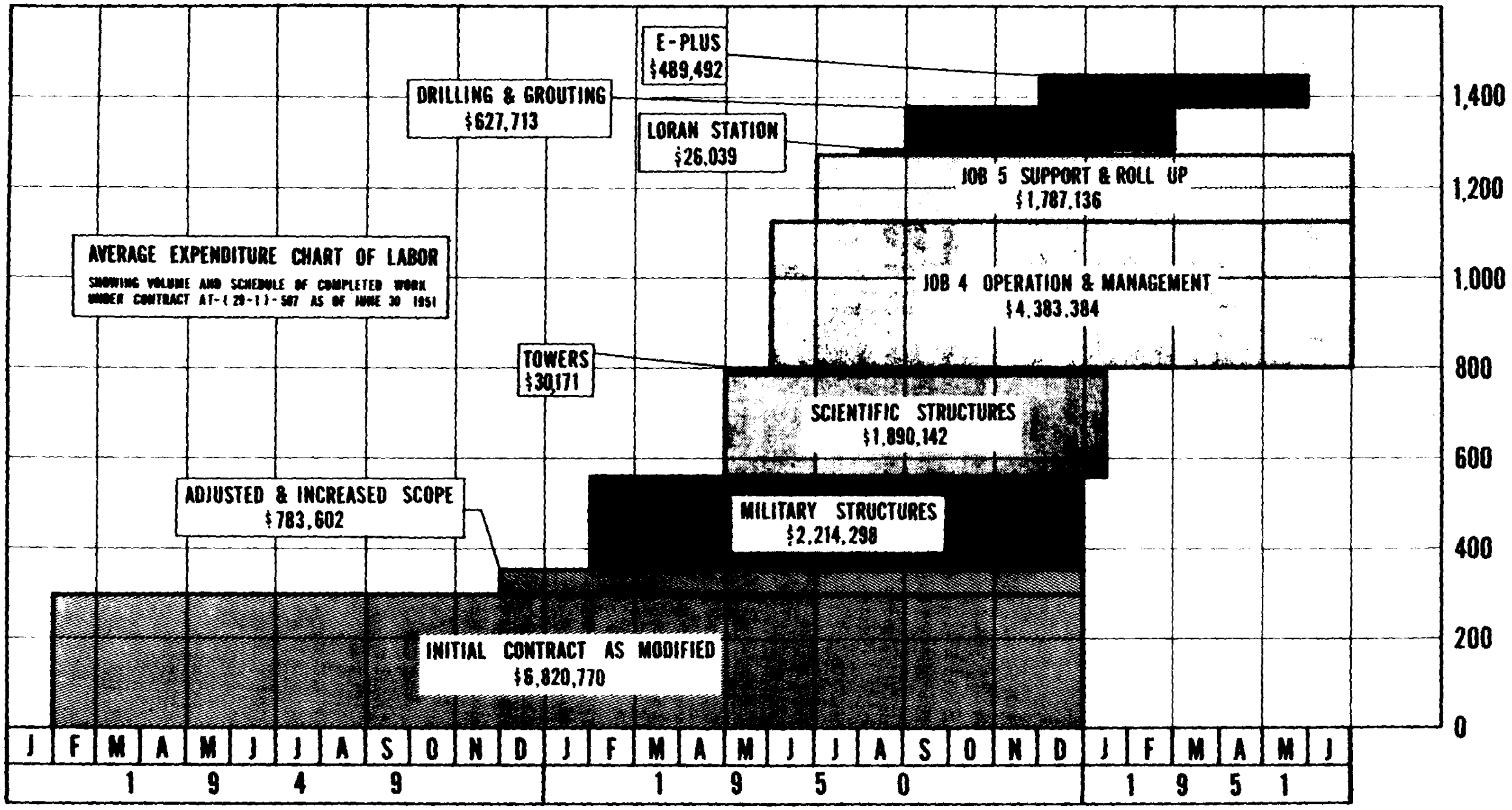


Figure 6.6-2 Chart Showing Impact of Increased Scope of Work on Expenditures for Labor

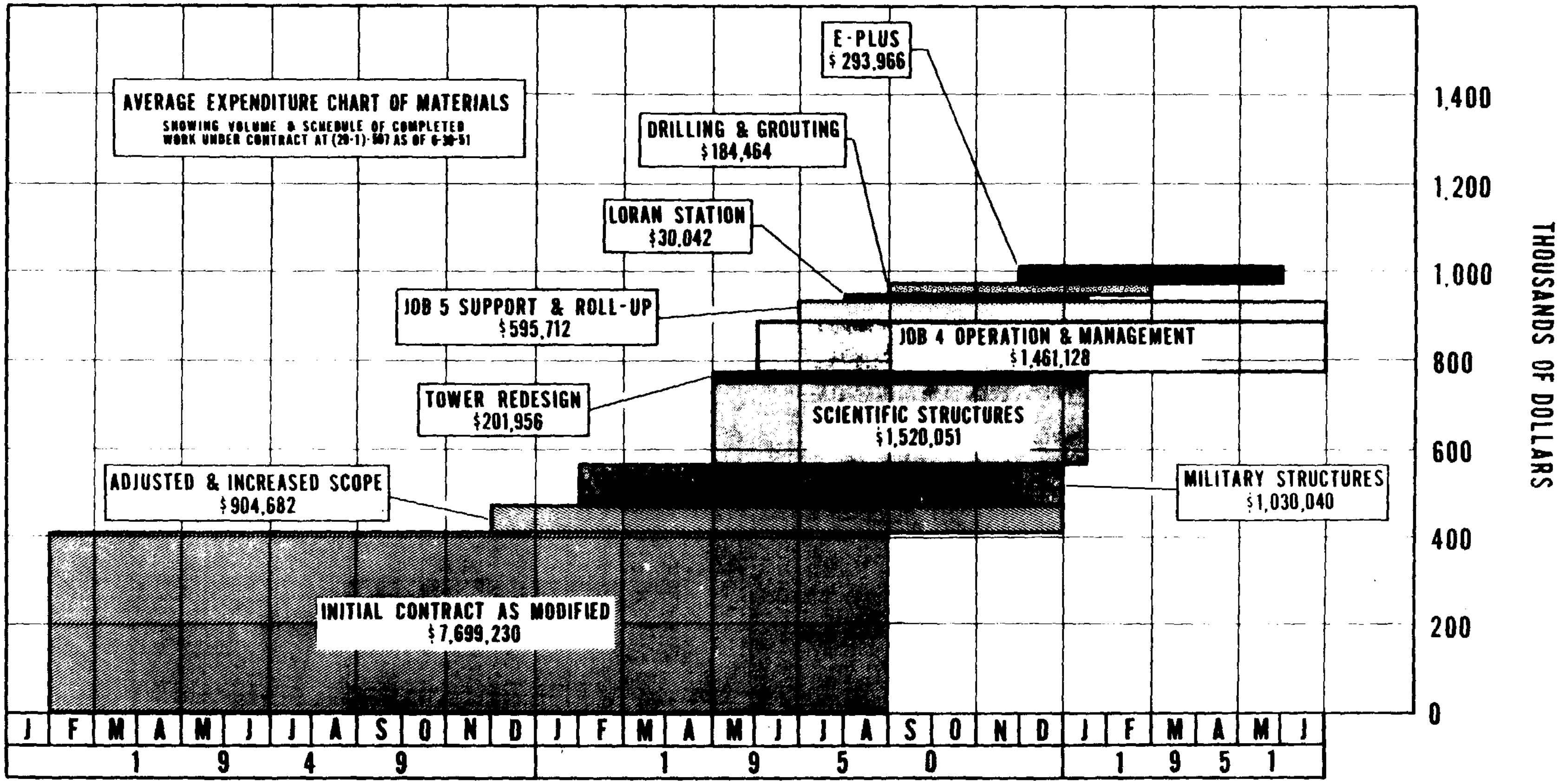


Figure 6.6-3 Chart Showing Impact of Increased Scope of Work on Expenditures for Materials

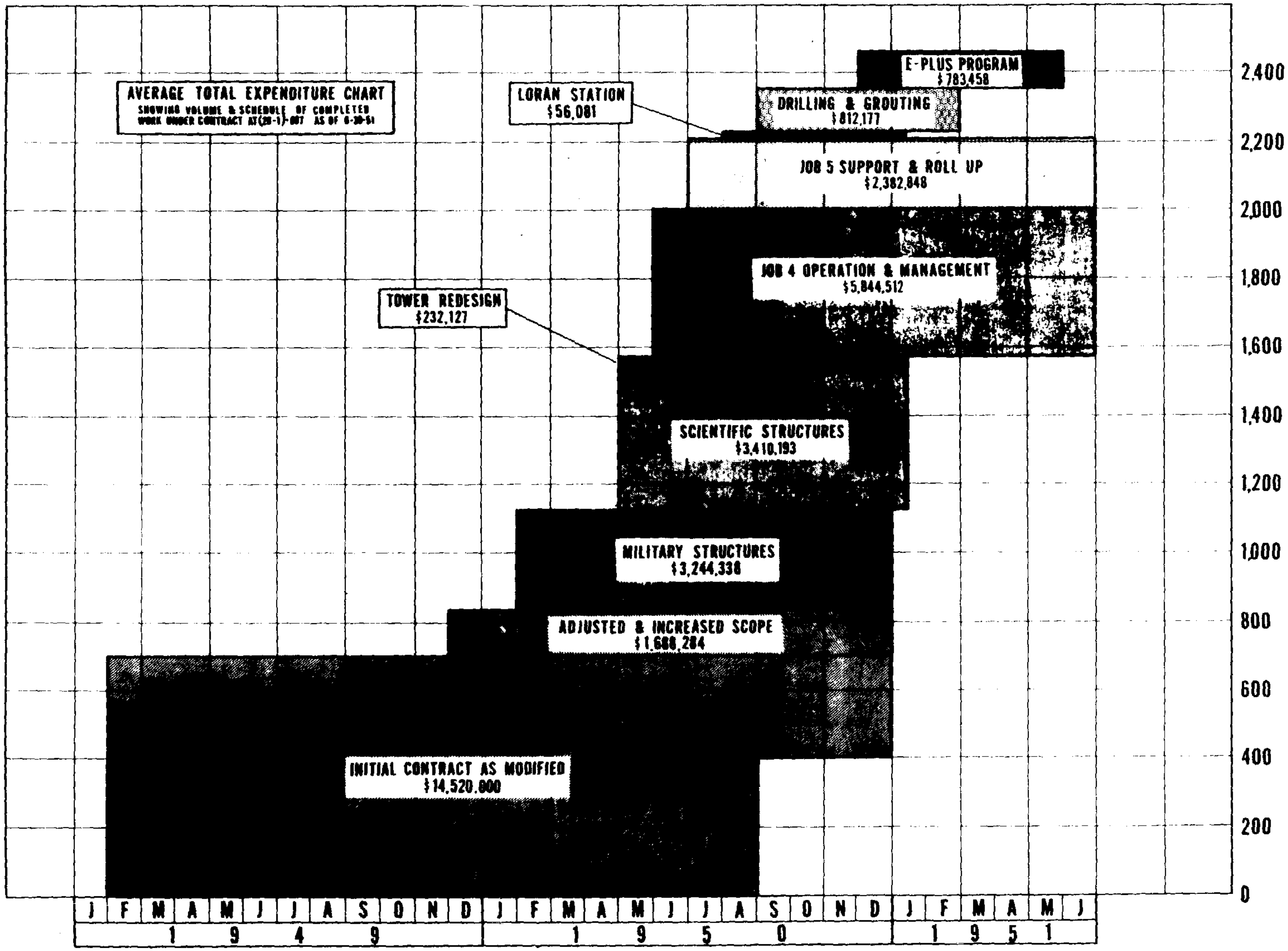


Figure 6.6-4 Chart Showing Impact of Increased Scope of Work on Total Expenditures

The precise and unusual nature of construction in experimental structures was most evident at Engebi and Muzin, as was the fact that a substantial portion of H & N's construction activity on the experiment islands was on a "handmade" or "jobbing shop" basis. For example, tolerances on some structures were as small as plus or minus a sixteenth of an inch. Thus, concrete pouring, instead of being more or less routine in spite of unusual amounts of reinforcing steel or the peculiarities of limonite-steel aggregate concrete, became an operation requiring extreme care to avoid the slightest movement of inserts, survey points, or forms. Likewise, the many collimator assemblies required extreme care in setting and hand grouting to assure the desired accuracy in the ultimate arrangement. The necessity for following such practices is persuasive evidence that construction of many of the Scientific Stations was in effect an integral part of the construction of the scientific instruments themselves.

One last point should be considered in connection with Engebi-Muzin construction (which is applicable to all construction at the Atoll). Of the 383 Scientific Stations on this experiment island group, it is noted that many were simple slabs or pipes embedded in concrete foundations. However, the fact remains that to perform even such services required many manhours of work. Locations had to be fixed, holes had to be dug, forms set, concrete poured, and backfilling accomplished. Thus, although constructing a single concrete base 10 feet by 13 feet by one foot thick is a simple construction job, constructing 72 such bases, as on Engebi, is a construction chore calling for the direct effort of a considerable number of laborers, carpenters, steel workers, and concrete workers to excavate, form, pour, and incorporate angularly disposed supports; and 72 such bases call for considerable equipment, including earthmovers, cranes, transit-mix trucks, a batch plant, aggregate plant, mechanical shovels, and other equipment. The significance of the effort is enhanced when it is remembered that the materials used must be warehoused at the site and distributed, that equipment must be repaired and maintained under difficult climatic conditions, and that these and all the many other activities in support of construction must be carried out at a subsidiary site in a Proving Ground five thousand miles from the West Coast source of supply.

Table 6.6-9 gives the significant quantities associated with construction at Engebi and Muzin.

TABLE 6.6-9. CONSTRUCTION SUMMARY, ENGEBI-MUZIN ISLANDS

Feature	Unit	Description
CAMP FACILITIES		
Blade & Shape, Site Preparation	185,365 sq yds	
Blade & Shape, Roads	26,700 sq yds	
Blade & Shape, Airstrip	6,780 sq yds	
Asphalt Paving, Roads	6,000 sq yds	

TABLE 6.6-9. CONSTRUCTION SUMMARY, ENGEBI-MUZIN ISLANDS (cont.)

Feature	Unit	Description
CAMP FACILITIES		
Aluminum Buildings	32,818 sq ft	31 Buildings
Tents	32,448 sq ft	156 Tents
Water Facilities, Salt Water	1,610 lin ft	1 4,200 gal elevated tank 1 1,300 gal elevated tank
Water Facilities, Fresh Water	1,890 lin ft	1 4,200 gal elevated tank 1 1,300 gal elevated tank
Sewer Facilities	3,100 lin ft	
Electrical Facilities	431 kw	2,800 feet of primary, 3,900 feet of secondary 49 Poles, and 28,800 feet of buried cable
Telephone Facilities	3,900 lin ft	
Control & Signal System	684,100 lin ft	
Jetty	1,500 sq yds	350 feet long
Channel	2,000 lin ft	
Theatre	403 seat cap	
MILITARY STRUCTURES		
Army Structures	11,443 sq ft	1 Multistory Concrete Bldg 1 Underground Test Shelter
Navy Structures	10,656 sq ft	12 Concrete Buildings
Air Force Structures	42,222 sq ft	13 Concrete, Brick, & Steel Buildings
SCIENTIFIC STATIONS	343 each	195 stations require 3,488 cu yds of concrete, 11 stations are tents, 97 miscellaneous stations
E-PLUS SCIENTIFIC STATIONS	42 each	
TOWERS		
300 Foot Tower	1 each	

TABLE 6.6-9. CONSTRUCTION SUMMARY, ENGEBI-MUZIN ISLANDS (cont.)

Feature	Unit	Description
E-PLUS TOWER		
200 Foot Tower	1 each	

Runit Island. Of the experiment islands, Runit presented the least complexity in construction. The number of structures involved was relatively small; no radical changes in program or features were required (other than the designation of this site for the first detonation). However, as an example of the type of work which had to be done which never appears in a tabulation of relevant construction quantities, the fact should be noted that a considerable effort was required to remove more than 60 abandoned M-boat hulls which littered the proposed campsite area.

This island was in essence an elongated sand spit, which resulted in difficulty in certain construction operations. Thus, for example, sloughing of trenches was a continual annoyance. In one case, in trenching near Station 51, this condition became so bad that a considerable amount of shoring around the station was required to prevent loss of foundation. Also, because of the conditions at this site, the ocean side of the island was rip-rapped for more than five hundred feet to provide protection for fill required to cover underground cables.

Table 6.6-10 shows significant quantities associated with construction at Runit.

TABLE 6.6-10. CONSTRUCTION SUMMARY, RUNIT ISLAND

Feature	Unit	Description
CAMP FACILITIES		
Blade & Shape, Roads	20,000 sq yd	
Blade & Shape, Site Prep.	119,708 sq yd	
Airstrip Paving	7,323 sq yd	
Aluminum Buildings	12,643 sq ft	15 Buildings
Tents	12,272 sq ft	59 Tents
Water Facilities, Salt Water	1,353 lin ft	1 4,200 gallon elevated tank
Water Facilities, Fresh Water	1,353 lin ft	1 7,500 gallon storage tank 1 4,200 gallon elevated tank
Sewer Facilities	1,182 lin ft	Plus 500 feet of outfall lines

TABLF 6.6-10. CONSTRUCTION SUMMARY, RUNIT ISLAND (cont.)

Feature	Unit	Description
CAMP FACILITIES		
Electrical Facilities	354 kw	750 feet of primary 3,560 feet of secondary 17 Poles 16,775 feet of buried cable
Telephone Facilities	4,650 lin ft	
Control & Signal	230,000 lin ft	
Cargo Pier	3,267 sq ft	
Theatre	202 capacity	
SCIENTIFIC STATIONS	141 each	75 stations required 1,930 cu yds of concrete 8 stations are tents 58 miscellaneous stations
TOWERS		
300 foot tower	1 each	

The Aomon Group. The facilities, stations, and structures constructed on the Aomon Group and Engebi are significant in their complexity, variety, and number. The wide variety of crafts required, coupled with the many changes which occurred, introduced more than normal scheduling difficulties. The first step in construction following decontamination and cleanup was the trestle causeway between Biijiri and Rojoa. Work on this feature was accomplished by crews living on a modified LCT in order to minimize the time lost in shuttling to and from the base camp, at that time on Parry. The construction of base facilities followed in due course, and progress is discussed above.

The Eberiru-Aomon causeway, an expedient for providing shielding for coaxial cable, and secondarily, an access road between these two islands, was constructed late in 1950 and involved moving a considerable amount of fill material.

The most complex construction work at this site was that connected with the erection of the zero tower. This structure, 200 feet high was designed for a 200-ton load in the cab and a total load on the foundations of 2100 tons. Sixty foot steel H-beams were driven to assure sufficient bearing, and foundations were then poured. Erection of the tower itself was not unusual in the light of the erection of the 300 foot towers on Runit and Engebi. On the other hand, the assembly of the lead shielding column associated with the tower was more than a construction chore. During this phase of the work a deflection of the column was noted when work was approximately fifty per cent complete and further activities were halted until the cause of the deflection could be investigated and a check be made with the H & N Engineering Division. It appeared after investigation that the deflection was not significant and was probably due to unequal expansion resulting from heating by the sun's rays.

One of the changes introduced during construction was a requirement for fourteen working platforms at various levels on the tower. Later, certain cab members which interfered with planned observations had to be removed, the latest such change coming during the operational period.

The Aomon Group was the site at which attempts were made to use intrusion grouting methods for limonite-steel aggregate structures. As noted above in this section, this work was done under the supervision of grouting experts brought to Jobsite in connection with the grouting program for Structure 3.1.1 on Engebi, but did not prove economical in the single scientific station in which the method was tried. The several remaining stations of this type of material were poured in accordance with the methods described above devised by cooperative effort of H & N engineering and construction forces in the field and proved much more satisfactory and economical.

Considerable complexity was introduced at this experiment site by the multiplicity of changes in location and requirements and the late dates at which these were received. However, though scheduling was difficult at times. the flexibility provided in the construction organization made possible the accomplishment of the assigned tasks within the period before tests began. Changes of the type noted involved such construction efforts as the placement of large berms over coaxial cables, sandbagging coral fill covered stations to stabilize the fill, the placement of lead brick shield at the back of Stations 132a and b, and the provision of an auxiliary 75kw generator at the last named station to alleviate the overload condition introduced just before test operations be increased User requirements. Cable trenches were held open at this site as at the others until the latest possible moment before the experiment performed thereon. In fact, in order to permit still further change at the last moment, at Station 69, the signal, control and communications station, extra communication cable pairs were drawn through and left protruding from the earth fill blast protection provided for the station.

Still another late requirement at this location involved the construction of a pile pier on Rojoa and clearing the associated channel to permit re-entry to this group of islands under conditions of extreme contamination. Studies to determine the best location for the pier and channel were carried out in December 1950, shortly after the requirement for the pier was received. The pier and channels were completed on April 3, 1951.

Table 6.6-10 shows significant quantities associated with construction at the group of islands comprising Aomon, Biijiri, Rojoa, and Eberiru, which formed an experiment and living complex.

TABLE 6.6-10. CONSTRUCTION SUMMARY, THE AOMON GROUP

Feature	Unit	Description
CAMP FACILITIES		
Blade & Shape, Roads	18,000 sq yds	
Blade & Shape, Site Preparation	119,700 sq yds	
Blade & Shape, Airstrip	7,300 sq yds	
Paving, Roads	1,445 sq yds	
Road Grading & Stabilizing	7,700 sq yds	
Paving & Airstrip	7,130 sq yds	
Aluminum Buildings	9,938 sq ft	12 Buildings
Tents	16,432 sq ft	79 Tents
Water Facilities, Salt Water	1,017 lin ft	1 4,200 gal elevated tank
Water Facilities, Fresh Water	935 lin ft	1 4,200 gal elevated tank
Sewer Facilities	1,200 lin ft	
Electrical Facilities	431 kw	2,325 feet of primary 1,550 feet of street lighting, 7,650 feet of secondary, 28,405 feet of underground cable, and 21 poles
Telephone Facilities	2,500 lin ft	
Control & Signal System	450,000 lin ft	
Causeway	490 lin ft	20 feet wide
Personnel Pier	120 sq ft	
Cargo Pier	2,220 sq ft	
Theatre	160 seats	
SCIENTIFIC STATIONS	181 each	76 stations required 2,133 cu yds of concrete, 5 stations are tents, 100 miscellaneous stations
TOWERS		
200 Ft. Tower	1 each	

Miscellaneous Sites. The construction at the various miscellaneous sites is noteworthy in the fact that provision had to be made to transport all materials, equipment, and personnel to these sites daily or, as in the case of Bogallua, to provide personnel support facilities in the form of a modified LCT. At Site M, a tower location on the reef, work had to be scheduled in accordance with tides and weather. At all of the miscellaneous island sites, a limited amount of channel clearance and beach preparation was necessary to permit access on schedules which would minimize the amount of time lost in transportation.

Table 6.6-11 shows the significant quantities associated with construction on Bogallua, Piiraai, Bokonaarappu, Teiteiripucchi, and Site M (Photo tower located on the reef south of Runit).

TABLE 6.6-11

MISCELLANEOUS SITES

Feature	Unit	Description
CAMP FACILITIES		
Blade & Shape, Sites	65,744 sq yd	
Blade & Shape, Airstrips	6,957 sq yd	
Control & Signal Cable	78,750 lin ft	
Asphalt Handling Facilities	1 lot	
Electrical Facilities	4,000 lin ft	Buried Cable
Pier	20 lin ft	
Breakwater	1,300 lin ft	
TOWERS		
75' Photo Tower - M	1 each	Plus generator & battery shack
75' Photo Tower - Piiraai	2 each	Plus generator & 2 battery shacks
75' Photo Tower - Bokonaarappu	1 each	Plus generator & battery shack
75' Photo Tower - Teiteiripucchi	2 each	Plus generator & 2 battery shacks
SCIENTIFIC STATIONS	55 each	30 stations required 1,191 sq yds of concrete, 25 miscellaneous stations

CHAPTER 6.7

MILITARY STRUCTURES PROGRAM

CHRONOLOGY

July		1949	At request of AEC, Holmes & Narver submitted proposed timetable for Military Structures Program.
November		1949	Meeting of representatives of all groups concerned with Structures Program to check on status.
December		1949	Holmes & Narver representatives visit design groups to check status of Military Structures drawings.
January		1950	Deadline for completion of design drawings on all structures.
January		1950	Cost estimate submitted to BuDocks in Washington, D.C., for the Navy Special Military Structures Program.
January	18	1950	Teletype received by Holmes & Narver from AEC authorizing procurement of material not to exceed $200,000.00.
January	30	1950	Holmes & Narver received approved design drawings and specifications for the Army Special Military Structures.
February	13	1950	Holmes & Narver submitted a cost estimate on the entire Military Structures Program to AEC in accordance with request of February 7, 1950.
February	14	1950	Preliminary design drawings for Air Force Structures received by Holmes & Narver.
February	27	1950	Approved design drawings for Navy Structures received by Holmes & Narver.
February	28	1950	Approved design drawings for Air Force Special Military Structures Program received by Holmes & Narver.
March	1	1950	Specifications for the Air Force Special Military Structures Program received by Holmes & Narver.
March	6	1950	Revised detailed cost estimate for Special Military Structures Program submitted to AEC by Holmes & Narver.

March 9 1950	Specifications for Navy Special Military Structures received from BuDocks.
March 9 1950	Teletype received from AEC by Holmes & Narver authorizing full procurement and construction of the Special Military Structures.
March 14 1950	Work authorization 50-507-9 for procurement, construction and instrumentation received from AEC by Holmes & Narver.
March 20 1950	Received design drawings adding Structure 3.2.7b to Navy Structures.
March 20 1950	Revised foundations of Buildings No. 1, 2, 6, & 7 of Army Structure 3.1.1.
March 20 1950	Purchase Order issued for structural steel for Army Structures 3.1.1 and 3.1.3.
March 20 1950	Purchase order issued for reinforcing steel for Army Structures 3.1.1 and 3.1.3.
March 23 1950	Purchase order issued to American Pipe & Construction Company for pre-cast pipe and bulk heads for Army Structure 3.1.3.
March 28 1950	Letter from Holmes & Narver to AEC submitting cost estimates for Air Force Structures 3.3.4 and 3.3.8a, b, c, d, e, f, and g.
March 28 1950	Purchase Order for trusses for Navy Structure 3.2.1b issued.
March 30 1950	Received first shop drawing for trusses for Navy Structure 3.2.1b from Nigg Engineering Company.
March 30 1950	Received first shop drawing for structural steel for Army Structure 3.1.1.
March 30 1950	Received first shop drawing for reinforcing steel for Army Structures 3.1.1 and 3.1.3.
March 31 1950	Received last shop drawing for trusses for Navy Structure 3.2.1b.
April 7 1950	Final approval of shop drawings for trusses for Navy Structure 3.2.1b granted by BuDocks.
April 11 1950	Partial shipment of structural steel for Army Structures.
April 11 1950	Purchase order issued for structural steel for Air Force Structures 3.3.3 and 3.3.4.

April	12 1950	Air Force Structures 3.3.8a, b, c, d, e, f, and g revised.
April	12 1950	Addendum to Air Force Structures Specifications.
April	13 1950	Purchase order issued for structural steel for Air Force Structures 3.3.8a, b, c, d,, e, f, and g.
April	13 1950	Subcontractor notified of award of contract for fabrications of precast components for Navy Structures and authorized to proceed.
April	14 1950	Purchase order issued for structural steel for Air Force Structure 3.3.8h.
April	14 1950	Received first shop drawings for structural steel for Air Force Structures 3.3.3 and 3.3.4.
April	17 1950	Received first shop drawing for reinforcing steel for precast members for Navy Structures.
April	17 1950	Purchase order issued for V-beam siding for Army Structure 3.1.1.
April	18 1950	Received design drawings from BuDocks adding Structure 3.2.3b.
April	20 1950	Received first shop drawing for structural steel for Air Force Structure 3.3.8h.
April	20 1950	Received first shop drawing for structural steel for Air Force Structures 3.3.8a, b, c, d, e, f, and g.
April	26 1950	Received last shop drawing for reinforcing steel for precast members for the Navy Structures.
April	1950	Started excavation for Army Structure 3.1.1 at Jobsite.
May	8 1950	Received first shop drawings for crating and miscellaneous iron and steel for the Navy Structures.
May	9 1950	Received first shop drawing for structural steel for Army Structure 3.1.3.
May	11 1950	Received last shop drawing for structural steel for Army Structure 3.1.3.
May	12 1950	Received design drawings extensively revising Air Force Structures 3.3.8a, b, c, d, e, f, and g.
May	12 1950	Purchase order issued for steel sash for Air Force Structures 3.3.3 and 3.3.4.

May	16 1950	Received shop drawings for trusses for Navy Structures 3.2.3a and b.
May	19 1950	Received shop drawings for steel sash for Air Force Structures 3.3.3 and 3.3.4.
May	24 1950	Purchase order issued for trusses for Navy Structure 3.2.1a.
May	26 1950	Purchase order issued for corrugated asbestos siding for Army Structure 3.1.1.
May	26 1950	Started shipments of reinforcing steel for Army Structures.
May	29 1950	Received last shop drawing for structural steel for Army Structure 3.1.1.
May	1950	Started excavation and construction of Army Structure 3.1.3, Navy Structures 3.2.1a and b and 3.2.2b, and Air Force Structures 3.3.5a and b.
June	6 1950	Received shop drawing for trusses for Navy Structure 3.2.1a.
June	6 1950	Received last shop drawing for structural steel for Air Force Structure 3.3.8h.
June	7 1950	Final approval received from Air Force representatives on shop drawings submitted for structural steel for Air Force Structure 3.3.8h.
June	12 1950	Revised cost estimates for the Military Structures Program submitted to AEC.
June	15 1950	Final approval received from BuDocks on shop drawings submitted for trusses for Navy Structure 3.2.1a.
June	28 1950	Final approval received from OCE representatives on shop drawings submitted for structural steel for the Army Structures.
June	29 1950	Final approval received from Air Force representatives on shop drawings submitted for structural steel for Air Force Structures 3.3.3 and 3.3.4.
June	1950	Started construction of Navy Structures 3.2.2a, 3.2.4a and b, 3.2.5, 3.2.6, and 3.2.7a and b, and Air Force Structures 3.3.3, 3.3.4, 3.3.8g, and 3.3.8h.
July	11 1950	Received final approval from BuDocks on shop drawings submitted for trusses for Navy Structures 3.2.3a and b.

July	13	1950	Received last shop drawing for crating of precast members for the Navy Structures.
July	14	1950	Specifications addendum received on Army Structures.
July	17	1950	Design drawings revising footings and floors of Navy Structures received from BuDocks.
July	17	1950	Received last shop drawing for miscellaneous iron and steel for Navy Structures.
July	18	1950	Received final approval for shop drawings submitted for precast members of the Navy Structures.
July	18	1950	Received shop drawings for V-beam siding for Army Structure 3.1.1.
July	21	1950	Received last shop drawing for reinforcing steel for Army Structure 3.1.1.
July	24	1950	Received last shop drawing for reinforcing steel for Army Structure 3.1.3.
July	30	1950	Final revision of design drawings for Army Structures received.
July		1950	Started construction of Navy Structures 3.2.3a and b, and again started construction of Navy Structures 3.2.1a and 3.2.7b, due to relocation of structures. Again started construction of Air Force Structures 3.3.3, 3.3.4, and 3.3.8g, due to relocation of structures.
August	3	1950	Final approval of shop drawings received from BuDocks for reinforcing steel for precast members for Navy Structures.
August	18	1950	Final approval of shop drawings received from OCE representatives for reinforcing steel for Army Structure 3.1.3.
August	29	1950	First shop drawing for corrugated asbestos siding for Army Structure 3.1.1 received.
August	31	1950	Last shop drawing for corrugated asbestos siding for Army Structure 3.1.1 received.
August		1950	Started construction of Air Force Structures 3.3.8a, b, c, and d at Jobsite. Finished construction of Navy Structure 3.2.7a at Jobsite.
September	11	1950	Reinforcing steel design drawings for Air Force Structures 3.3.8a, b, c, d, e, f, and g received.

September 14 1950	Shipment of reinforcing steel completed for the Army Structures.
September 14 1950	Precast pipe and bulkheads for Army Structure 3.1.3 shipped complete.
September 19 1950	Final approval of shop drawings for steel sash for Air Force Structures 3.3.3 and 3.3.4 received from Air Force representatives.
September 21 1950	Received last shop drawing for structural steel for Air Force Structures 3.3.8a, b, c, d, e, f, and g.
September 25 1950	Final approval of shop drawings for V-beam siding for Army Structure 3.1.1 received from OCE representatives.
September 27 1950	Final approval of shop drawings for reinforcing steel for Army Structure 3.1.1, received from OCE representatives.
September 1950	Started construction of Air Force Structures 3.3.8e and f at Jobsite.
October 1 1950	Structural steel for Air Force Structures 3.3.3 and 3.3.4 shipped complete.
October 10 1950	Received final approval from Air Force representatives of shop drawings for structural steel for Air Force Structures 3.3.8a, b, c, d, e, f, and g.
October 12 1950	Air Force Structures design drawings for reinforcing steel for Structures 3.3.8a, b, c, d, e, f, and g revised.
October 14 1950	Completed shipment of structural steel for the Army Structures.
October 14 1950	First shipment of structural steel for Air Force Structures 3.3.8a, b, c, d, e, f, and g.
October 18 1950	New purchase order issued as replacement for purchase order previously issued to another supplier of structural steel for Air Force Structure 3.3.8h.
October 23 1950	Final approval of shop drawings for miscellaneous iron and steel for the Navy Structures received from BuDocks.
November 2 1950	Final approval of shop drawings for V-beam siding for Army Structure 3.1.1 received from OCE representatives.

November	22 1950	V-beam siding for Army Structure 3.1.1, shipped complete.
November	22 1950	Structural steel for Air Force Structure 3.3.8h shipped complete.
November	26 1950	Final shipment of structural steel Air Force Structures 3.3.8a, b, c, d, e, f, and g.
November	26 1950	Corrugated asbestos for Army Structure 3.1.1 shipped complete.
November	1950	Completed construction of Navy Structures 3.2.1a and b, 3.2.5, 3.2.6, and 3.2.7b at Jobsite.
January	1951	Completed construction of Navy Structures 3.2.2a and b, 3.2.3a and b, 3.2.4a and b, and Air Force Structures 3.3.5a and b at Jobsite.
February	1951	Completed construction of Army Structures 3.1.1 and 3.1.3 and Air Force Structures 3.3.3, 3.3.4, and 3.3.8a, b, c, d, e, f, g, and h at Jobsite.

GENERAL

During the summer of 1949, Holmes & Narver was informed that consideration was being given to the addition of a program involving construction at Eniwetok Atoll in connection with experiments sponsored by the Department of Defense. In order to aid in the determination as to whether such a construction program was feasible, Holmes & Narver was requested to analyze the problem in the absence of even preliminary sketches of what would be required, but using as a working basis the assumption that the proposed program would require 2,000 man months of work.

On the premise stated, a very tentative schedule was submitted by Holmes & Narver to the AEC[1] at the end of July 1949 which stated in part:

> "If it is decided that Holmes & Narver undertake the proposed program, the following recommendations are made:
>
> August 1949
>
> Decision that Holmes & Narver will undertake the job.

---

[1] See HN-1032.

September 1949

Services to propose tentative scope of design and construction.

Authority for Holmes & Narver to proceed with preliminary requirements.

Holmes & Narver to issue logistic forecasts and preliminary cost estimates.

October 1949

Services to make available to AEC funds for approved program.

November 1, 1949

AEC to negotiate supplemental contract with Holmes & Narver.

November-December 1949

Engineering design and procurement schedules.

January 1, 1950

Initiate procurement and shipping.

January-March 1950

Mobilize to 700 men, increase base camp to capacity; activate subcamps in work areas.

April 1, 1950

Start construction, services requirements.

January 31, 1951

Substantial completion of services construction."

By November 1949, it was apparent that the tentative schedule was not being met. More had been learned by Holmes & Narver representatives of the general types of the structures now under design by other groups, but no information was available upon which forecasts of materials, equipment, or manpower could be based, nor had authorization to proceed been received from the AEC. Concern over this state of affairs was expressed by Holmes & Narver representatives to all concerned at a meeting in Washington on November 28, 1949. It was there stated that if drawings were not made available to Holmes & Narver by January 1950, in order to permit initiation of procurement and shipping, it was clear that personnel requirements would increase in order to get the job done on time and there would be attendant increases in cost.

In order to help expedite the program, arrangements were made at this meeting for Holmes & Narver personnel to visit the architect-engineer groups engaged in the design of the special structures in order to ascertain the type and magnitude of construction work involved, the magnitude of the procurement program and the like, so that organizational arrangements could be made. Such a review was accomplished during December from which it was clear: (1) that the 1 January 1950 deadline could not be met; (2) that Holmes & Narver could expedite procurement by doing all material take-off from the drawings rather than waiting for the preparation of bills of materials; and (3) that substantially more than 2,000 man months of work were involved in the program.

Between January 30, 1950 and March 14, 1950, drawings on substantially all of the structures ultimately included in the program were received by Holmes & Narver[1]. Many were only preliminary but did make possible the formulation of estimates of basic construction materials and manpower. In the meantime, discussions were being held on the subject of enlisting Holmes & Narver assistance in manning the Sandia-directed instrumentation program for the military structures. Tentative informal agreements had been reached which placed Holmes & Narver in the position of supplying a "force account" technicians' pool for the Sandia Corporation as well as rendering some engineering design services on instrumentation shelters.

In view of the delays encountered in receiving drawings, the AEC, during January 1950, authorized limited ($200,000) procurement of special materials needed early in the program, including structural steel, reinforcing steel, cement, brick, lumber, and miscellaneous hardware and metal for two Army Structures, two Navy Structures, and three Air Force Structures.

On March 9, 1950, full authorization to proceed was given to Holmes & Narver by the AEC in the form of a teletype which was confirmed on March 14, 1950, by Work Authorization No. 50-507-9. Because this authorization defines the responsibility of Holmes & Narver in regard to the Military Structures Program it is set forth at length below.

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[1] A record of all drawings on the Military Structures is presented as an exhibit at the end of this section.

HNC 1349
Auth. No. 51-507-14
Date: October 9, 1950

U. S. ATOMIC ENERGY COMMISSION
SANTA FE OPERATIONS OFFICE
LOS ALAMOS, NEW MEXICO

E-5

Holmes & Narver
824 South Figueroa St
Los Angeles 14, Calif.

Subject: WORK AUTHORIZATION, CONTRACT NO. AT-(29-1)-507, FOR:

A. CHANNEL FACILITIES BETWEEN SITES E and S
B. ADDITIONAL COST OF INSTRUMENT SHELTERS FOR INSTRUMENTATION OF MILITARY STRUCTURES SITES E AND S
C. ADDITIONAL TENT CAMP ON SITE B
D. CONNECTING BUILDING BETWEEN AEC ADMINISTRATION BUILDING AND HOLMES & NARVER ADMINISTRATION BUILDING, SITE B
E. ADDITIONAL WING TO EXISTING MESS HALL, SITE B
F. EXTENSION TO COMMUNICATION ROOM IN JTF BUILDING SITE B
G. ADDITIONAL MOUSE CAGE RACKS SITE L
H. ADDITIONAL FACILITIES ON SITE L
I. PROTECTIVE FENCING & LIGHTING AROUND TOWERS, SITES C, V, E
J. GROUTING FOR MILITARY STRUCTURES, SITE E
K. STEAM CLEANING SHELTER FOR PROGRAM 6.7 SITE A
L. ADDITIONAL HOT LOCKERS
M. FOUNDATION INVESTIGATION

Gentlemen:

A. Channel Facilities between Sites E and S:

1. Reference is made to your letter CHN-786, dated 19 July 1950, requesting formal authorization for this work. You are hereby authorized to proceed with this work and to furnish all plans, specifications, materials procurement, labor, transportation, and equipment necessary for construction;

2. The cost is estimated to be as follows:

a.	Material		$ 4,430
b.	Labor		98,700
c.	Equipment		27,095
d.	Transportation		325
		TOTAL	$ 130,550

B. Additional Cost of Instrument Shelters for Instrumentation of Military Structures, Sites E and S:

1. Reference is made to your letter CHN-647, dated June 14, 1950, submitting detailed cost estimates for these shelters. You are hereby authorized to proceed with construction of these shelters furnishing all plans, equipment, labor, material, etc., necessary to accomplish this work.

2. The estimated additional cost is $208,250

C. Additional Tent Camp on Site B:

1. Reference is made to your letter CHN 971, dated October 3 1950, wherein you submitted cost estimate for additional tent camp on site B. You are hereby authorized to furnish all material, labor, equipment, transportation, procurement, plans, etc., necessary to accomplish this work.

2. The cost is estimated to be as follows:

a.	Material	$ 44,325
b.	Labor	42,200
c.	Equipment	5,185
d.	Transportation	7,805
	TOTAL	$ 99,515

D. Connecting Building between AEC Administration Building and Holmes & Narver Administration Building, Site B:

1. You are hereby authorized to proceed with plans, specifications, material, labor, transportation, equipment, etc., necessary to accomplish this work.

2. The estimated cost of this work is $ 16,800

E. Additional Wing to Existing Mess Hall, Site B:

1. You are hereby authorized to proceed with plans, specifications, material, labor and transportation, equipment, procurement, etc., necessary to accomplish this work.

2. The estimated cost of this work is $ 24,000

F. Extension to Communications Room in JTF Building, Site B:

1. You are hereby authorized to proceed with plans, specifications, material, labor, transportation, equipment, etc., necessary to construct this extension.

2. The estimated cost of this work is $ 3,000

G. Additional Mouse Cage Racks, Site L:

1. Reference is made to your letter CHN 829 dated August 8, 1950, wherein you submitted an estimate of cost for these additional cage racks. You are hereby authorized to proceed with procurement, installation, etc., of these racks.

2. The estimated cost of this work is $ 12,570

H. Additional Facilities on Site L:

1. Reference is made to our letter SD 5951, dated August 15, 1950, authorizing this work. You are hereby formally authorized to proceed with plans, specifications, material, labor, transportation, equipment, procurement, etc., necessary to accomplish this work.

2. The estimated cost of this work is $ 6,000

I. Protective Fencing and Lighting Around Towers, Sites C, V, E:

1. Reference is made to your letter CHN 933, dated September 21, 1950, submitting an estimate of cost for this work. You are now formally authorized to proceed with plans, specifications, material, labor, transportation, equipment, procurement, etc., necessary to accomplish this work.

2. The estimated cost of work is as follows:

a. Site C, material, labor, transportation and equipment	$ 3,970
b. Site E, material, labor, transportation and equipment	5,730
c. Site V, material, labor, transportation and equipment	5,770
TOTAL	$ 15,470

J. Grouting for Military Structures, Site E:

1. You are hereby authorized to proceed with the furnishing of all specifications, material, labor, equipment, transportation, procurement, etc., necessary for the performance of this work in accordance with instructions from Dr. Raymond E. Davis, AEC Consultant, and Mr. John Rantilla, AEC, Materials Engineer:

2. The estimated cost of this work is pending your formal contract with the Intrusion Prepakt Company.

K. Steam Cleaning Shelter for Program 6.7 Site A:

1. Reference is made to your letter CHN 957, dated September 28, 1950, submitting an estimate of cost for this work. You are hereby authorized to proceed with plans, specifications, materials, labor, transportation, equipment, procurement, etc., necessary for the performance of this work.

2. The estimated cost of this work is $ 3,850

L. Additional Hot Lockers:

1. You are hereby authorized to proceed with procurement, labor, transportation, equipment, etc., necessary for the performance of this work.

2. The estimate of cost of this work is $ 16,600

M. Foundation Investigation:

1. You are hereby authorized to proceed with procurement, labor, materials, transportation, equipment, necessary for the performance of drilling operations, coring, etc., pertinent to this investigation.

2. The estimated cost of this work is not available at the present time.

The total cost, exclusive of your fees, and Items J and M, included in this authorization, is as follows:

A.	Channel Facilities Between Sites E and S	$ 130,550
B.	Additional cost of Instrument Shelters for Instrumentation of Military Structures, Sites E and S	208.250
C.	Additional Test Camp on Site B	99,515
D.	Connecting Building Between AEC Administration Building and Holmes & Narver Administration Building, Site B	16.800
E.	Additional Wing to Existing Mess Hall Site B	24,000
F.	Extension to Communication Room in JTF Building, Site B	3,000
G.	Additional Mouse Cage Racks, Site L	12,570
H.	Additional Facilities on Site L	6,000
I.	Protective Fencing and Lighting Around Towers, Sites, C, V, E	15,470
J.	Grouting for Military Structures Site E	- - -
K.	Steam Cleaning Shelter for Program 6.7 Site A	3,850
L.	Additional Hot Lockers	16,600
M.	Foundation Investigation	- - -
	TOTAL	$ 536,605

Fees for your services for the above portion of work which constitutes a change in scope (including Titles I, II and III) and construction services will be negotiated with you after receipt of all of your estimates for the work covered by the authorization. Costs of the work specified herein are chargeable to Budget Project No. 3-311-9030.

Authorized by:

/s/ C. L. TYLER, MANAGER

DISTRIBUTION:
Holmes & Narver (Orig & 6)
AEC Resident Engineer (1)
Gen. McCormack, AEC, Washington
J-Division, LASL (2)
P. W. Spain (1)
Commander, JTF-3 (2)
Stanley Burris, J-10, LASL (1)
J-6 (1)

It is thus seen that the Holmes & Narver obligations were:

1. To render construction services and inspection services (as defined) on the Military Structures designated.

2. To render design engineering, inspection, and construction services with respect to instrumentation for the structures, as well as to provide a group of technicians in the field to render services as directed by Sandia Corporation representatives.

Thus, with respect to the Military Structures Program, Holmes & Narver was in a radically different position from that established for the balance of the work under Contract AT(29-1)-507. In view of the fact that Holmes & Narver had not participated in design of the structures for Program 3, and further that the design criteria were unknown to Holmes & Narver personnel, new liaison arrangements were necessary to assure proper interpretation of plans and specifications. Furthermore, even though Holmes & Narver's Inspection and Test Section at the Jobsite carried a direct responsibility for inspection, it was in the somewhat anomolous position of not being able to rule on matters requiring interpretation.

While direct liaison between Holmes & Narver and Department of Defense representatives was authorized to alleviate some of the difficulties inherent in the position of Holmes & Narver in this arrangement, adherence to the formal requirements of the contractual relationship existing between the AEC and Holmes & Narver was necessary. This latter requirement led to the somewhat circuitous arrangement defined in paragraph 5 of Work Authorization No. 50-507-9.

In anticipation of the different responsibility which Holmes & Narver would have in the Structures Program, (i.e., no design engineering and related responsibility), changes in the delegations of responsibilities relating to Contract No. AT-(29-1)-507 within the Holmes & Narver organization were accomplished. These changes were designed primarily to expedite, as far as possible, the detailed work involved in procurement checking shop drawings, expediting and inspecting fabrication of materials. As a secondary.result the changes reflected the necessary removal of responsibility from the Holmes & Narver Engineering Division except to the extend specifically authorized. In short, on the Military Structures Program, Holmes & Narver was merely a construction contractor; the rendering of inspection services, in the absence of authority or basis for interpretation of plans, was an adjunct to the construction contract.

That the relationship existing between the AEC, the interested service agencies, and Holmes & Narver on this program was unusual and called for clear statements of responsibility was recognized by all concerned. Thus, on April 26, 1950, the AEC advised[1]:

> "As you know it is considered essential that construction of Military Structures under the subject contract be inspected by qualified service personnel.
>
> In order to arrange for this inspection it is requested that a construction schedule for these structures be furnished this office as soon as possible......"

Later, on May 25, 1950, when it was apparent that the need for Service Inspectors at the Jobsite was urgent in connection with interpretation of requirements for foundations, Holmes & Narver was advised by the AEC Office of Engineering and Construction, Los Alamos[2]:

> "This will serve to confirm my telephone conversation with Mr. Sherwood B. Smith and Lt. Cmdr. Rowen on May 23, with respect to certain features of the Military Structures Program.
>
> I pointed out to Mr. Smith that it was necessary that Services Inspectors be sent to the Jobsite as quickly as possible, in view of the fact that a requirement had been established for approval of foundation borings before the start of construction. Mr. Smith stated that a representative of the Office, Chief of Engineers, Captain Beck, would depart for the Jobsite on June 6, and that he would also attempt to send at the same time, Major Pettit representing the Air Material Command. I requested that Mr. Smith attempt to have Captain Beck armed with authority to approve borings for all structures as an interim emergency measure until the remaining inspectors arrive at the Jobsite."

---

[1] Reference E-1, SD5541

[2] Letter dated May 23, 1950

At a series of meetings of representatives of the Services, LASL, AEC, and Holmes & Narver held at Los Alamos on June 28 and 29, to discuss the Structures Program, it was noted that a gap existed in regard to the engineering services required by the Program and that the Program Director would attempt to obtain resolution of the difficulty[1]. As a result of these comments, Holmes & Narver, on July 11, 1950, wrote the following letter to the Manager, AEC, Los Alamos, on the subject of Military Structures Program Work Authorization No. 9, Contract No. AT-(29-1)-507:

> "Dear Sir:
>
> At conferences held in Los Alamos, June 28 and 29, attended by our Mr. Schoolmaster and East, there was some difference of opinion expressed as to the responsibility of Holmes & Narver in the matter of design of foundation or supporting elements for various structures under subject program. This letter is to set forth our understanding of our responsibilities in this matter.
>
> By Work Authorization No. 9 and subsequently by Modification 7 to subject contract, Holmes & Narver were instructed to proceed with the construction of the Military Structures, including those for the Army, Navy, and Air Force, and were also charged with the responsibility for complete Title III (Inspection) work. The designing engineers for these Military Structures, however, were other than Holmes & Narver.
>
> It is part of the designing engineers' responsibility in designing a structure to take into consideration the characteristics of the foundation material upon which the footings rest (foundation material being the natural earth, rock, or other material on which the structure rests). In order to successfully determine whether the foundation material for a given structure is suitable or whether it must be artifically strengthened, it is necessary to know the requirements of the structure, the use of the structure, its allowable settlement, differential deflections, etc.,—such knowledge forming the criteria upon which the engineer bases the design. During construction, it is not uncommon to develop unexpected foundation conditions which require the designing engineer to review his work and make changes, adjustments or reinforcements. Such changes in design must be based not only on the requirements of the new foundation conditions, but must necessarily take into consideration the criteria mentioned above, and must be founded on the full knowledge of the original conditions which the designing engineer possesses......"

---

[1] See Minutes of the Meetings of June 28 and 29, 1950, presented as an exhibit at end of this section.

In the light of the above-mentioned considerations and on the basis of Authorization -9, full-scale procurement was initiated and manpower mobilization was begun. In view of the experimental nature of the structures, complete materials testing programs were established. Physical tests of all concrete placed at the Jobsite were accomplished by the Inspection-Test Section of the Jobsite Engineering Department. On reinforced concrete components, prefabricated in the United States, arrangements were made for physical tests of reinforcing steel and concrete. Certified mill reports were required for all reinforcing and structural steel used in construction of all structures and when necessary, these were supplemented by independent investigation. A summary of all test reports on materials used in each structure is presented as an exhibit at the end of this section.

Construction schedules called for foundation work to begin in April. However, it must be remembered that concurrently with the increase in interest in the Military Structures Program at the end of 1949, arrangements were being made for an Engineer Brigade to move to Eniwetok Atoll to undertake construction of base facilities on Eniwetok Island and to be responsible for stevedoring and other support activities. The amount of construction now contemplated for Eniwetok Island was greater than originally planned and this construction was being initiated at a much earlier date than scheduled by Holmes & Narver. Thus, even basis construction materials on hand at the Atoll could not be made available for the Military Structures Program in more than small quantities.

Nevertheless, upon arrival of authorized representatives of the Services at the Jobsite to resolve problems connected with foundations, work got under way. The foundation questions, as noted above, could only be answered by those who knew the purpose and use of the structures, i.e., the basic design criteria. Thus, the final decision on whether to proceed with construction at the specified locations or to move the structure to a new, specified location, could only be made by the agencies and groups responsitle for basic criteria and design. As will be seen later in the discussion of the details of the Army, Navy, and Air Force structures, these decisions were ultimately made by the Services Agencies and Holmes & Narver was authorized to proceed in accordance therewith. In some cases reinforcement of foundation materials (i.e., natural earth, rock, etc.), was directed by the use of lean mix concrete under the footings; in another case, intrusion grouting was prescribed; in still other cases changes in location were specified. The first construction objectives on the Structures Program were thus attained and, in the Progress Report as of 15 September 1950, it was noted for the first time that all structures were under active construction.

From this time until essential completion of all Army and Navy structures on December 15, 1950, and the Air Force Structures by January 15, 1951, the construction problems encountered in connection with the Military Structures were for the most part the same as those noted previously in connection with Base Facilities and Scientific

Structures. Difficulties in procurement and shipping affected this program in approximately the same way as they affected other work; however, it should be noted that a greater variety of unusual materials were required for the Military Structures, for example, as in the case of the Air Force model Structure 3.3.8h. The fact that the tolerances specified were unusual has been noted, and the education of construction personnel to bring about appreciation of these requirements was a necessary chore. Likewise, the establishment of construction procedures was required to meet the specified tolerances and to permit efficient accomplishment of concrete placement in the presence of unusual amounts of reinforcing steel and accurately placed gauge and survey point inserts. These factors were, after the initial impact, accepted as part of the construction effort.

ARMY STRUCTURES

The Army Structures in the Military Structures Program were designed as Structures 3.1.1 and 3.1.3.

Structure 3.1.1 - Multi-Story Building. Structure 3.1.1 comprised seven independent three-story buildings of distinct design; the total dimensions of the composite were 195 feet, 10 inches in length, 52 feet in width, and 36 feet in height above grade. A total of approximately 3000 cubic yards of concrete and 300 tons of reinforcing steel were required. The amount of reinforcing steel employed was unusually large. For example, in building number four the ratio of cubic yards of concrete to tons of reinforcing steel was approximately 1.63, nearly twice as great as the ratio of these materials in typical commercial reinforced concrete buildings of comparable dimensions.

Another feature of design of this structure involved the utilization of various types of materials in the walls, including reinforced concrete, common bond brick, asbestos sheathing, protected metal sheathing, structural steel, and reinforced concrete sheathing and reinforced brick. In addition, various sizes of openings were provided in some of the walls and specifications for certain of the buildings called for the placement of live-loads on the upper floors.

The most significant problem which arose in connection with this structure was related to basic criteria and design, which, as noted above, were the responsibility of agencies and groups other than Holmes & Narver.

During October, 1949, at the request of the AEC, tests were conducted on Engebi Island to obtain information as to the existence of a suspected subsurface lens or cavern. These limited tests failed to reveal any evidence of a lens down to a depth of nine feet at one point and a depth of five feet at a second. At both points coral rock was encountered at the depths mentioned.

In the course of the same tests samples of coral aggregate and sand were obtained from Engebi and shipped to the AEC. Earlier, loose samples had been obtained by the Reconnaissance Party in October 1948, and these formed the basis for design of the structures and facilities for which Holmes & Narver was responsible. (For further details of soil investigations carried out in connection with Holmes & Narver design engineering activities, see Chapter 5.9, Vol. II, of this report.)

Thereafter, when plans and specifications were received on January 30, 1950, on structure 3.1.1, it was noted that the specifications included the following provision:

> 1-03 EXCAVATION
>
> a. General: The area indicated on the drawings shall be cleared of all natural obstructions and other items which will interfere with the construction operations. The excavation shall conform to the dimensions and elevations indicated on the drawings for the buildings, except as specified below, and all work incidental thereto.
>
> As soon as the site has been established borings and probings shall be made so as to determine the characteristics of the soil, to locate any large voids or water pockets, and to establish the depth of the bed rock. The foundation bearing shall be as indicated on drawing No. 1, i.e., 10 tons p.s.f. under the rear portion of the building and 5 tons p.s.f. under the front portion of the building. Four load tests shall be made along the line of the rear footings, one at each of buildings 1 and 7 plus two intermediate load tests between buildings 1 and 7. A stress strain load curve shall be drawn for each load test point increasing the load in two ton increments from zero to either 12 tons p.s.f. or the yield point of the soil, whichever is less. For each increment the load shall remain in place until there is no settlement in a two-hour period. The yield point is defined as the load under which the strain continues to increase under the applied load. If the load tests indicate that the yield point of the soil under the rear wall footings is less than 10 tons per square foot the foundations materials shall either be removed and replaced by a lean (1:8) mix concrete, or consolidated by injection of a neat cement grout. If suitable bearings are encountered at different elevations from those indicated on the drawings the footing depth may be increased up to 12 inches. In no case, however, shall the top of the footing be changed or the depth of the footing be decreased from that shown on the drawings.
>
> All pockets beneath the footing areas shall be filled with grout of the above mix.

Engebi: Military Structures Program, Station 3.1.1 (Army), Rear View on September 30, 1950.

Engebi: Military Structures Program, Station 3.1.1 (Army),
Front View of Completed Building.

These provisions were complied with and by June 15, 1950, about 350 yards of lean mix fill had been poured as authorized. However, it was understood that final approval of whether soil conditions found would be suitable was to rest with the Military Services as confirmed in the AEC letter to H&N on May 23, 1950, in which it was stated, among other things, that "it was necessary that Services Inspectors be sent to the Jobsite as quickly as possible, particularly in view of the fact that a requirement had been established for approval of foundation borings before the start of construction".

The findings under date of June 16, 1950, of the representative of OCE sent to the Jobsite in June 1950, in accordance with the plan outlined in the above letter, are given as an exhibit at the end of this section. Briefly stated, it was reported that subsoil conditions were unsatisfactory and that, while tests performed in accordance with specifications indicated that no settling occurred under specified loads, these data were considered misleading. Pressure grouting at the back of Structure 3.1.1 was recommended to correct the conditions which were deemed to be undesirable.

As a result of this report, meetings were held at Los Alamos on June 28 and 29, 1950, attended by representatives of the agencies interested in Program 3, Military Structures, by representatives of the AEC Office of Engineering and Construction, Los Alamos, and by H&N representatives. Based upon these discussions the decision was reached that the AEC and the three services would retain an expert consultant on soil mechanics, and a meeting with this consultant was arranged for July 6, 1950. H&N was requested to have a representative at the meeting because it was anticipated that a program for field investigation would be established.

At the meeting on July 6, 1950, it was decided that grouting experiments should be carried out under the direction of the AEC consultant, using high pressure instrusion grouting methods and a patented grouting mix. In the meantime an AEC representative and a soil mechanics expert retained by H&N in connection with exploration and tests required for the design of the foundation for the 200-foot heavy tower, would conduct further investigations in connection with Structure 3.1.1.

The investigations at the Jobsite were carried out as were the grouting experiments. As a result, the decision[1] was made, in accordance with the recommendation of the AEC consultant, to proceed with the grouting program. Holmes & Narver was formally directed to proceed by Work Authorization No. 51-507-14, dated October 9, 1950, which stated:

> "You are hereby authorized to proceed with the furnishing of all specifications, material, labor, equipment, transportation, procurement, etc. necessary for the performance of this work in accordance with instructions from Dr. Raymond E. Davis, AEC Consultant, and Mr. John Rantilla, AEC, Materials Engineer".

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[1] See Minutes of Meeting of August 2, 1950, presented as an exhibit at the end of this section.

It might be noted at this point that prior to the issuance of this directive a program of exploration involving a considerable amount of drilling and coring at various locations in the Atoll was recommended by soils experts. This program was also authorized by Work Authorization 14 and the scope of the work was indicated in a letter dated October 13, 1950 to H&N from the AEC[2] in which it was noted that, "Dr. Davis and Mr. Rantilla will direct this program at the Jobsite".

The data collected in the course of this program are presented as an exhibit at the end of this section.

Upon the recommendation of the AEC consultant and pursuant to the directive contained in the Minutes of the Meeting of August 2, 1950, H&N entered into a subcontract with the owners of the patented grouting process and materials to be used in the grouting program. The subcontract covered the services of expert personnel to supervise work at the Jobsite, and the sale of special materials used in the patented process.

Thus, through the Labor pool supplied by H&N, the expert supervision supplied by the designated subcontractor, and pursuant to the technical direction and specifications of the AEC consultant and Jobsite representatives, the work was ultimately performed. Details of the procedures are given as an exhibit at the end of this volume. Details of the results of the grouting program are given in the report of the AEC consultant which is included in the same exhibit in order to provide complete documentation of this work.

Structure 3.1.3 - Underground Test Shelter. This structure was cross-shaped and after completion was covered with coral fill. One section of the structure was unusual in that plans called for fabrication of reinforced concrete pipe sections by centrifugal casting methods. A subcontract was entered into with a West Coast fabricator of cast concrete conduit for the fabrication of the necessary components for this section. No difficulties were experienced in fabrication or installation at the Jobsite.

NAVY STRUCTURES

The construction performed by H&N on the Navy portion of Program 3 involved work on twelve structures, nine of which utilized precast components assembled on foundations poured at the specified locations.

The Navy Special Military Structure Program consisted of twelve separate Structures: 3.2.1a, 3.2.1b, 3.2.2a, 3.2.2b, 3.2.3a, 3.2.3b, 3.2.4a, 3.2.4b, 3.2.5, 3.2.6, 3.2.7a and 3.2.7b.

Structure 3.2.1a was constructed of concrete heavily reinforced with steel trusses inbedded throughout. This Structure was 28-feet square with an overall height of 11-feet which was composed of a 5-foot thick roof, a 3-foot open center portion with 3-foot thick walls and a

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[2] This letter is presented as an exhibit at the end of this section.

3-foot foundation slab. A change in foundation and location was required because of poor soil conditions at the original location.

Structure 3.2.1b was constructed of concrete heavily reinforced with steel trusses imbedded throughout the foundation, precast concrete cells forming the main structure and a reinforced concrete roof slab. This structure was 28-feet square, with an over-all height of 10-1/2 feet above the grade line. The footings extended 6-feet below the grade line. The upper half of the foundation was open with 3-foot walls. The structure proper was composed of three layers of precast concrete cells which were 2-foot 9-inch cubes. The first layer immediately above the foundation walls and the third layer immediately under the roof slab were composed entirely of cells. The second or middle layer was composed of alternately laid cells, the voids and the insides of the cells being completely filled with concrete. The outward facing cells were covered with a concrete outside wall provided with openings corresponding to the cell openings of the upper layer of cells.

Structure 3.2.2a was constructed of precast reinforced concrete walls, panels, columns and beams. This structure had 2-feet by 5-feet concrete pads under each corner and in the middle of each side. The dimensions of this structure were: length 41-feet; width 21-feet 2-inches; and height 11-feet 6-inches. All precast members were ribbed and were either bolted or welded together by means of plates set in the precast members.

Structure 3.2.2b was constructed of precast reinforced concrete wall and roof panels assembled on poured in place foundations. An inside wall of 12-inch brick was constructed immediately inside the precast concrete panel walls and was connected to the outside wall by means of bolts. The inside brick wall was provided with 3 x 12 inch wood roof joists with 1-inch sheathing immediately under the precast concrete roof panels and was connected to the outside roof by means of bolts. All precast concrete panels were connected by means of bolts through the ribs or by welding steel plates imbedded in the castings. This structure was 43-foot 6-inches long, 21-feet 6-inches wide, and 11-feet above the grade line.

Structures 3.2.3a & b were identical except for instrumentation. They were constructed of precast wall and roof panels which were formed from 16-inch square by 8-inch high cells with 5/8-inch thick walls. After assembly the cells were covered with an 1-3/8 inch reinforced concrete facing. A total of 135 trusses were imbedded in each structure in the various precast panels. The various members were welded, grouted and anchored to a 3-foot deep by 2-foot 8-inch wide continuous foundation set on a 6-inch reinforced concrete slab. The structure was 41-feet 7-3/8 inches long, 21-feet 7-5/8 inches wide and 10-feet 9-1/4 inches above grade.

Structure 3.2.4a was constructed of precast wall, roof, and floor panels. One 12-inch square concrete strut was used to connect the two longitudinal side walls and took the place of one floor panel. This structure had an arch type roof and wing walls along the front face. The entire structure was covered with an earth fill up to the wing walls. The dimensions of this structure exclusive of the wing walls were: length, 44-feet 1-inch; width, 22-feet 10-inches; and height, 13-feet.

Structure 3.2.4b was constructed of precast reinforced concrete wall, roof and floor panels. Two 12-inch square concrete struts were used to connect the two longitudinal walls and took the place of two floor panels. This structure had an arch type roof with various roof panels inverted. This structure was similar to Structure 3.2.4a and was 22-feet 10-inches wide, 45-feet long, and 13-feet high. The structure was set on 2-foot thick footings.

Structure 3.2.5 was constructed of precast reinforced concrete floor and roof panels and was in the general form of a quonset hut. This structure was anchored to 2-foot thick footings. This structure was 41-feet long and 23-feet 6-inches wide with a 10-foot 6-inch radius of arch.

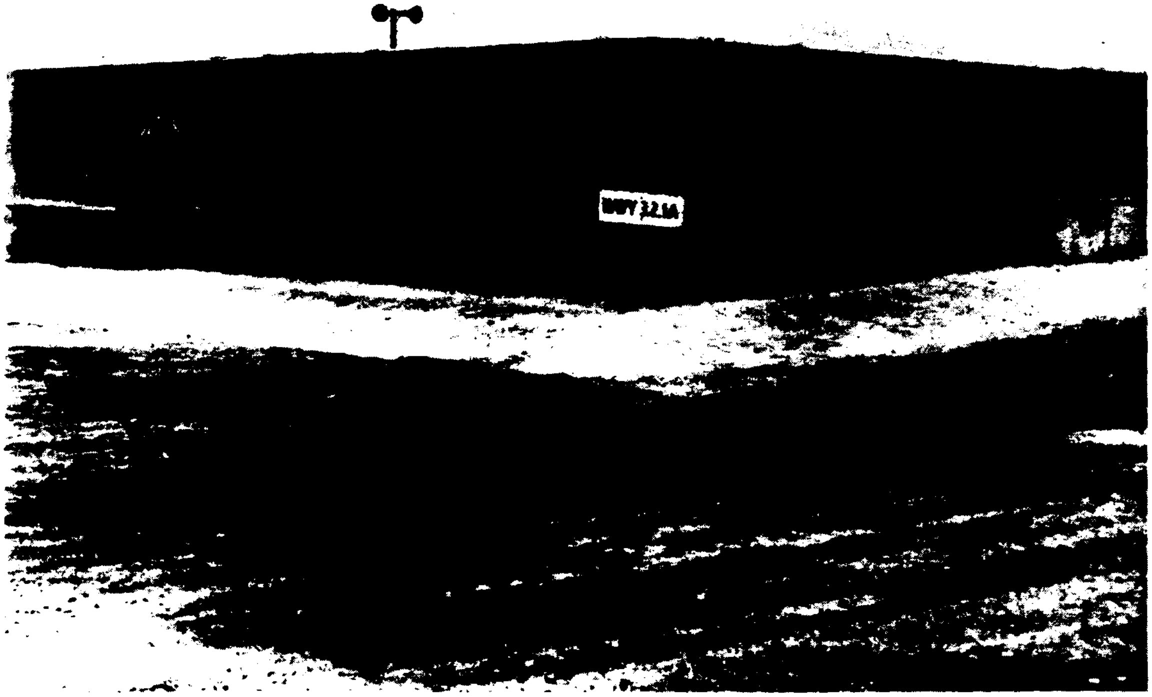
Structure 3.2.6 was dome shaped, constructed of precast reinforced concrete components. The entire structure was covered with a 2-foot fill. The 6-inch thick reinforced concrete floor slab was placed over 2-foot 3-inch footings.

Structures 3.2.7a and b were similar in dimension and appearance; the chief point of difference being in the reinforcing steel. Both structures were poured in place, the outside dimensions being 21-feet in width, 41-feet in length, and an 11-feet 6-inches in height. The floor slabs were 12-inches thick and foundation footings extended 3-feet below grade. Each structure had one end opening fitted with a metal door.

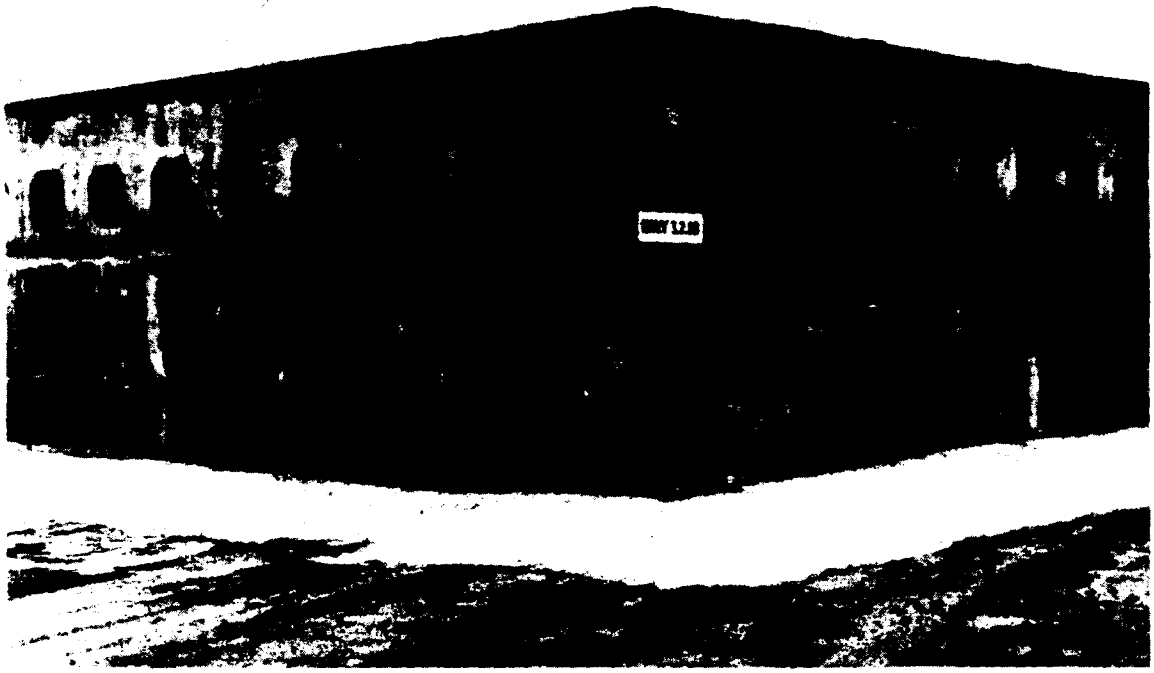
In order to avoid overloading the construction forces at Eniwetok Atoll and in view of the construction deadline, it was decided to prefabricate the steel-reinforced concrete components required for the Navy Structures in the United States and thereafter to ship the components to Eniwetok for assembly on foundations there provided.

As a consequence, shortly after receipt of the plans (on February 27, 1950) which had been prepared by the Bureau of Yards and Docks, inquiry was initiated by Holmes & Narver to determine the qualifications of a number of firms to perform the prefabrication operations. Thereafter, on March 29, 1950, invitations to bid were sent to approximately a dozen prospective bidders and replies received from nine. At the bid opening on April 10, 1950, a contracting firm of San Francisco, California, was apparent low bidder with a bid of $61,569.00. After analysis of the bids and examination of the qualifications of each of the bidders, the acceptance of the low bid was authorized by the AEC on April 14, 1950.

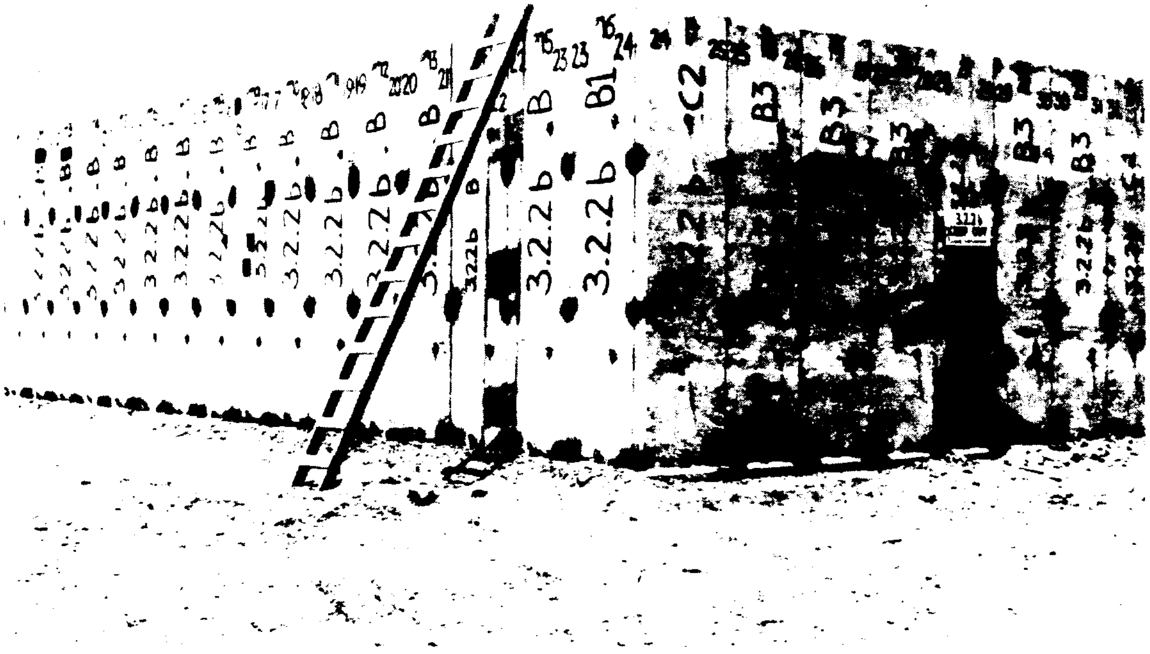
The successful bidder was immediately notified to initiate procurement and planning of the work, and a purchase order to cover the



Military Structures Program, Station 3.2.1a (Navy). Reinforced Concrete.

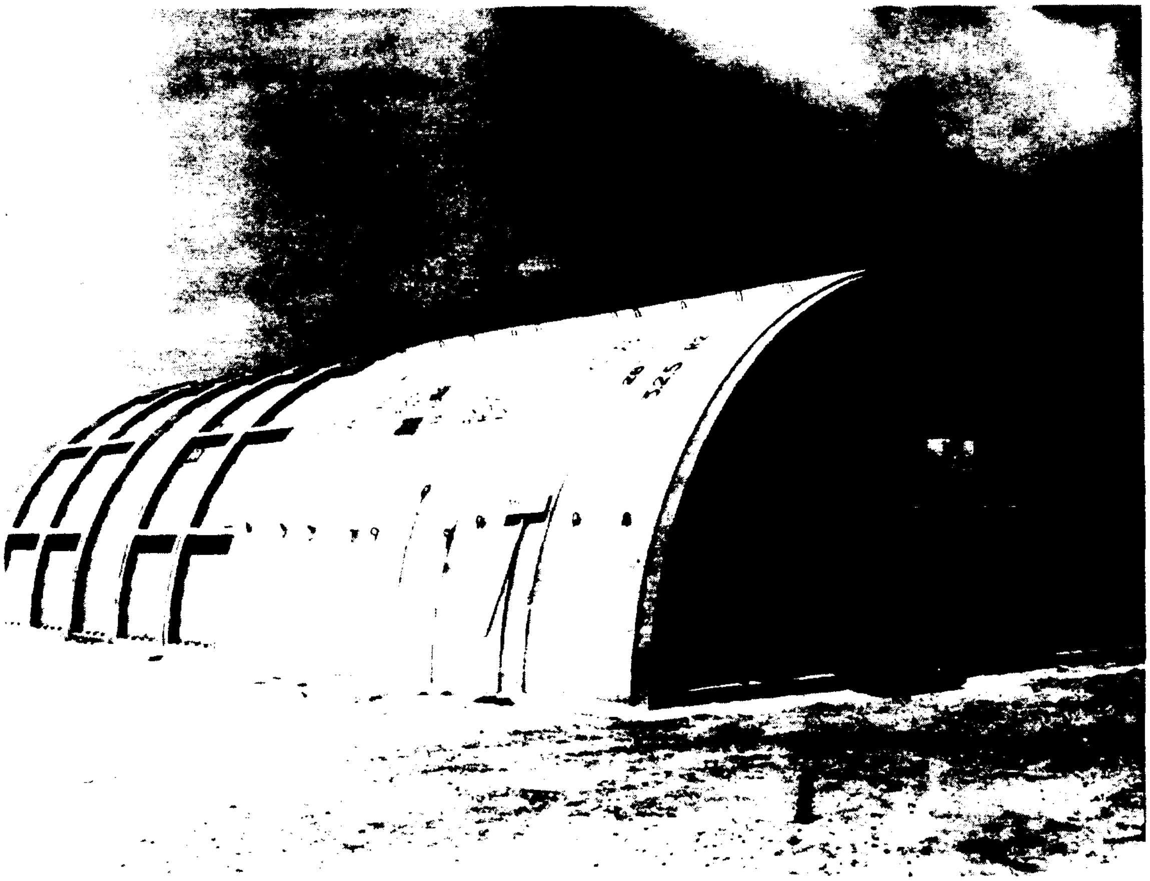


Military Structures Program, Station 3.2.1b (Navy). Reinforced Concrete.



Military Structures Program, Station 3.2.2b (Navy). Precast Concrete Sections.

Military Structures Program, Station 3.2.3a (Navy). Precast Concrete Sections.



Military Structures Program, Station 3.2.5 (Navy). Precast Concrete Sections.

Military Structures Program, Station 3.2.4a (Navy). Precast Concrete Sections.

work was issued in due course. Various revisions of this purchase order were issued during the course of the work to cover (1) the fabrication of spare components; (2) changes in design; and (3) the furnishing and installation of inserts for instrument mounts. A second purchase order was issued to cover crating of the prefabricated components for export shipment.

Changes in the plans and specifications were directed from time to time. The most important of these were (1) the changes specified in Revision No. 3 to the original purchase order; (2) the relaxation of the specification on concrete compression strength; and (3) the approval of the use of "gunite" procedures on certain panels which were otherwise not acceptable.

The performance of the work by the subcontractor was interferred with at one time or another by a few unfortunate events. The supplier of the required iron and steel work was unable to supply all of the material needed and, initially, did not assign sufficiently expert personnel to the job. The advent of the Korean situation created additional procurement problems. The concrete subcontractor changed cement during the course of the work, resulting in casting difficulties and an ultimate (28-day) strength below original specifications but conforming to the amended specifications. Approval of drawings submitted on various details was delayed by the requirement that such matters must be transmitted through H&N to BuDocks and returned through the same channels. One example of such difficulties is found in the delay in approval for a variety of reasons of a drawing covering miscellaneous bolts and nuts for connecting the panels. Almost five months was consumed in the approval process, sixty days of which can be ascribed to "mailing time".

Norwithstanding these events, all of the originally ordered prefabricated components were shipped by the beginning of September 1950 (approximately a month late), and the shipment of spares was accomplished by mid-October. Placement and assembly was accomplished at the Proving Ground by the middle of January 1951. In all, 2414 components, including cells and panels and spares of each, were produced and shipped. Table 6.7-1 summarizes the pertinent quantitative information for each structure.

AIR FORCE STRUCTURES

Twelve structures were constructed for the Air Force portion of the Military Structures Program. Locations for these structures were specified on Engebi and Muzin Islands.

Structure 3.3.3 was also known as "Air Force Structure Type C-1.1." This structure was constructed in the form of a hangar with three open-sided 78-foot 8-inch bays. Sixteen special built-up columns supported 27 prefabricated trusses which in turn supported a 2-inch plank deck roof with three structural steel skylights provided with steel sash. The skylights and outside trusses were covered with corrugated metal

TABLE 6.7-1. CONCRETE UNITS COMPLETED & SENT TO JOBSITE

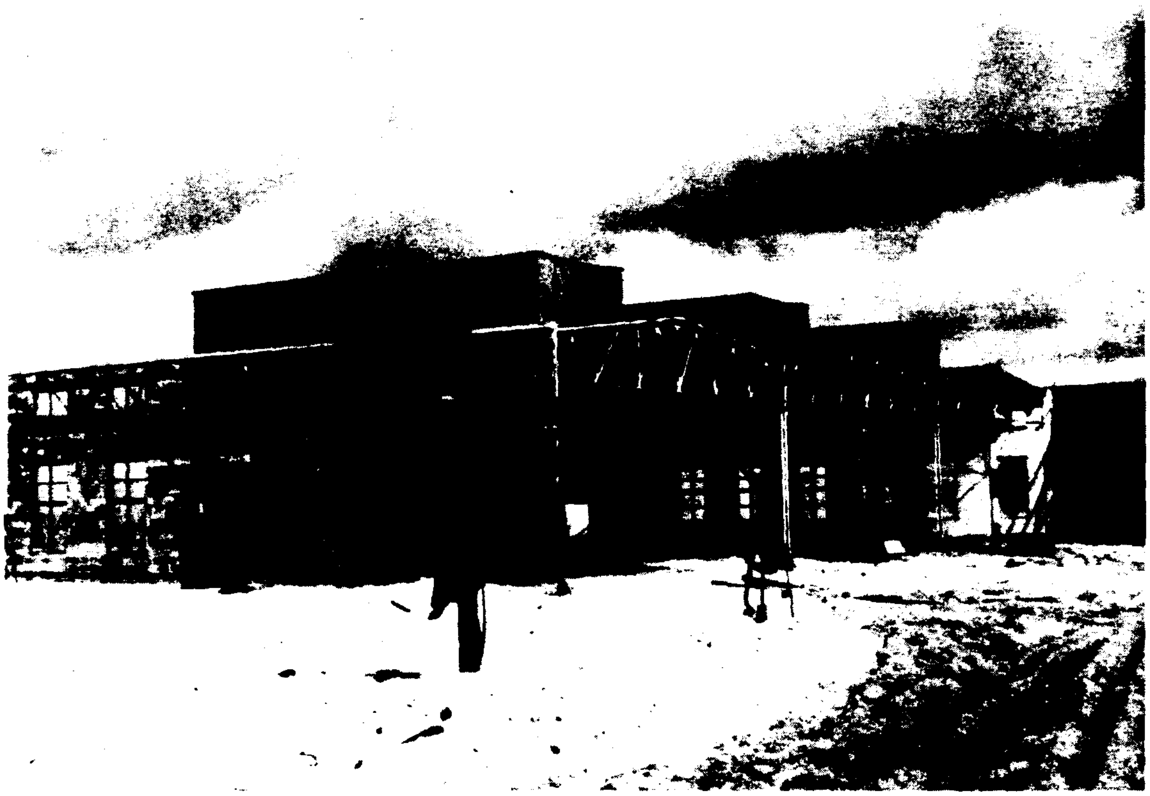
QUANTITY	SPARES	MARK	LOCATION
STRUCTURE 3.2.1b			
203	-	-	Cells (Large)
STRUCTURE 3.2.2a			
12	2	A	Roof
2	1	Air	Roof
2	1	A1L	Roof
2	1	A2R	Side
2	1	A2L	Side
8	1	A3	Side
2	1	A4R	Side
2	1	A4L	Side
11	2	B	End
4	1	B1	End
1	1	C	End
1	1	C1	Column
1	-	C2	Column
1	-	C3	Column
1	-	C4	Column
1	-	C5	Column
1	-	C6	Column
1	1	TP1	Beam
1	-	TP2	Beam
1	-	TP3	Beam
1	-	-	Door
STRUCTURE 3.2.2b			
14	2	A	Roof
2	1	A1	Roof
28	3	B	Side
2	1	B1	Side
2	1	B2	Side
11	2	B3	End
1	1	C	End
2	1	C1	End
2	1	C2	End
1	-	-	Door
STRUCTURE 3.2.3a			
5	1	P1	Roof
2	1	P2	Roof
13	3	P3	Side & End
2	1	P3a	Side
2	1	P3b	Side
2	1	P4	End
2	1	P5	End
1	1	P6	End
932	-	C1	Cells
42	-	C2	Cells
STRUCTURE 3.2.3b			
5	-	P1	Roof
2	-	P2	Roof
13	-	P3	Side & End
2	-	P3a	Side
2	-	P3b	Side
2	-	P4	End
2	-	P5	End
1	-	P6	End
932	-	C1	Cells
42	-	C2	Cells
STRUCTURE 3.2.4a			
1	1	A	Rear
1	1	B	Rear
1	1	B1	Rear
1	1	C	Front
1	1	D	Front
1	1	D1	Front
1	1	E	Front
1	1	E1	Front
1	1	F	Front
1	1	F1	Front
1	1	G	Front
1		G1	Front
1	-	H	Front
1	-	H1	Front
1	1	J1	Floor
1	-	J2	Floor
1	-	J3	Floor

TABLE 6.7-1 (Continued)

QUAN-TITY	SPARES	MARK	LOCATION	QUAN-TITY	SPARES	MARK	LOCATION
STRUCTURE 3.2.4a (Continued)							
1	-	J4	Floor	1	-	J6	Floor
1	-	J5	Floor	1	-	J7	Floor
1	-	J6	Floor	1	-	J8	Floor
1	-	J7	Floor	1	-	J9	Floor
1	-	J8	Floor	1	-	J10	Floor
1	-	J9	Floor	8	1	R	Roof
1	-	J10	Floor	2	1	R1	Roof
1	1	K	Front	8	1	R2	Roof
20	2	R2	Roof	2	1	R2b	Roof
STRUCTURE 3.2.4b				STRUCTURE 3.2.6			
1	1	A	Rear	1	1	A1	Top
1	1	A1	Front	1	1	A2	Top
1	1	B	Rear	1	-	A3	Top
2	1	B1	Front & Rear	1	-	A4	Top
1	1	B2	Front	1	-	A5	Top
1	1	J1	Floor	1	-	A6	Top
1	-	J2	Floor	1	-	A7	Top
1	-	J3	Floor	1	-	A8	Top
1	-	J4	Floor	1	-	A9	Top
1	-	J5	Floor	1	-	A10	Top
1	-	J6	Floor	1	-	A11	Top
1	-	J7	Floor	1	-	A12	Top
1	-	J8	Floor	1	-	A13	Top
1	-	J9	Floor	1	-	A14	Top
1	-	J10	Floor	1	-	A15	Top
1	1	L	Front Door	1	-	A16	Top
8	1	R	Roof	1	1	B1	Top
2	1	R1	Roof	1	1	B2	Top
8	1	R2	Roof	1	-	B3	Top
2	1	R2B	Roof	1	-	B4	Top
				1	-	B5	Top
STRUCTURE 3.2.5				1	-	B6	Top
				1	-	B7	Top
2	1	P1R	Front & Rear	1	-	B8	Top
2	1	P1L	Front & Rear	1	-	B9	Top
1	1	P2	Rear	1	-	B10	Top
1	1	P2a	Front	1	-	B11	Top
1	1	P3	Front	1	-	B12	Top
1	1	J1	Floor	1	-	B13	Top
1	-	J2	Floor	1	-	B14	Top
1	-	J3	Floor	1	-	B15	Top
1	-	J4	Floor	1	-	B16	Top
1	-	J5	Floor	1	1	C1	Top

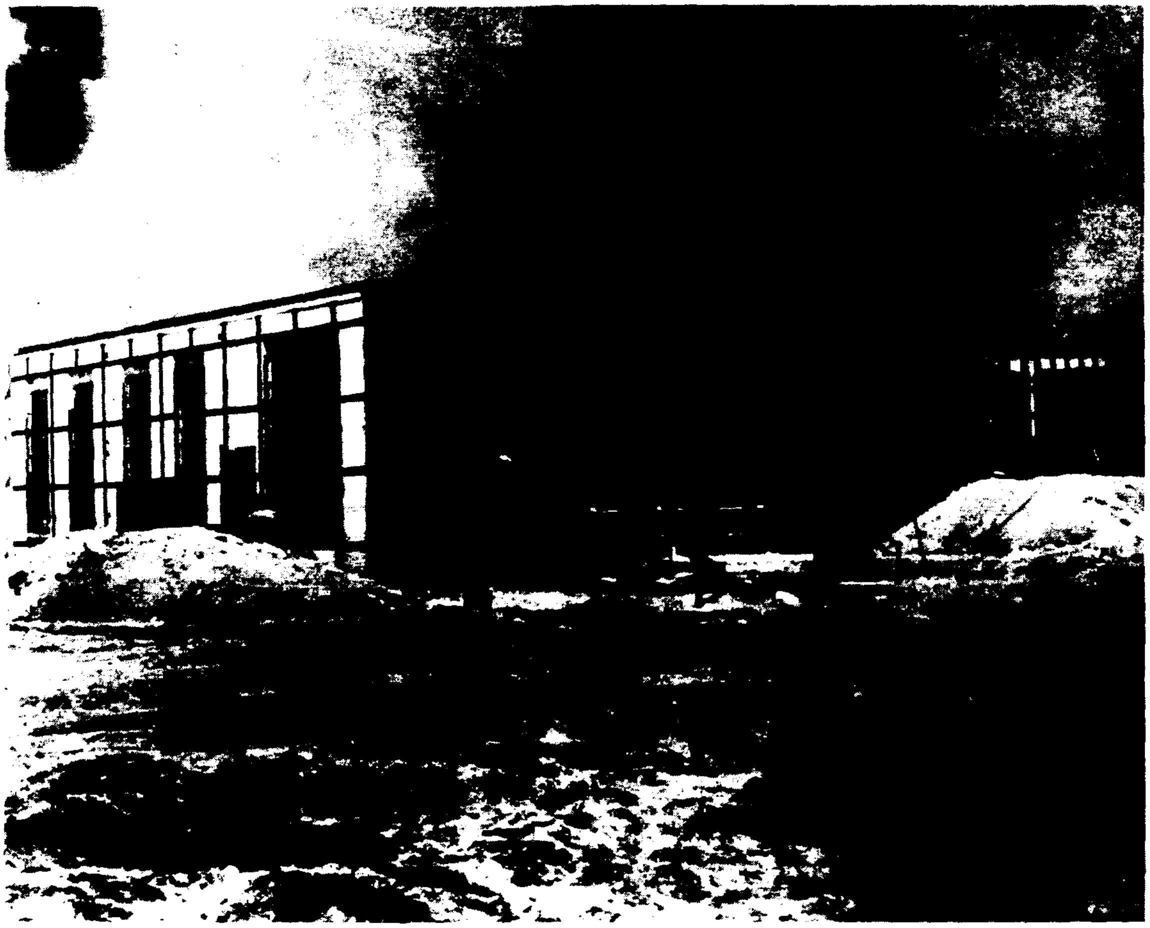
TABLE 6.7-1 (Continued)

QUAN-TITY	SPARES	MARK	LOCATION	QUAN-TITY	SPARES	MARK	LOCATION
STRUCTURE 3.2.6 (Continued)							
1	1	C2	Top	1	1	D2	Top
1	-	C3	Top	1	-	D3	Top
1	-	C4	Top	1	-	D4	Top
1	-	C5	Top	1	-	D5	Top
1	-	C6	Top	1	-	D6	Top
1	-	C7	Top	1	-	D7	Top
1	-	C8	Top	1	-	D8	Top
1	-	C10	Top	1	-	D10	Top
1	-	C11	Top	1	-	D11	Top
1	-	C12	Top	1	-	D12	Top
1	-	C13	Top	1	-	D13	Top
1	-	C14	Top	1	-	D14	Top
1	-	C15	Top	1	-	D15	Top
1	-	C16	Top	1	-	D16	Top
1	1	D1	Top	1	1	-	Top Unit



Military Structures Program, Station 3.3.8h (¼ Scale Model of Station 3.3.) (Air Force) on Muzin.

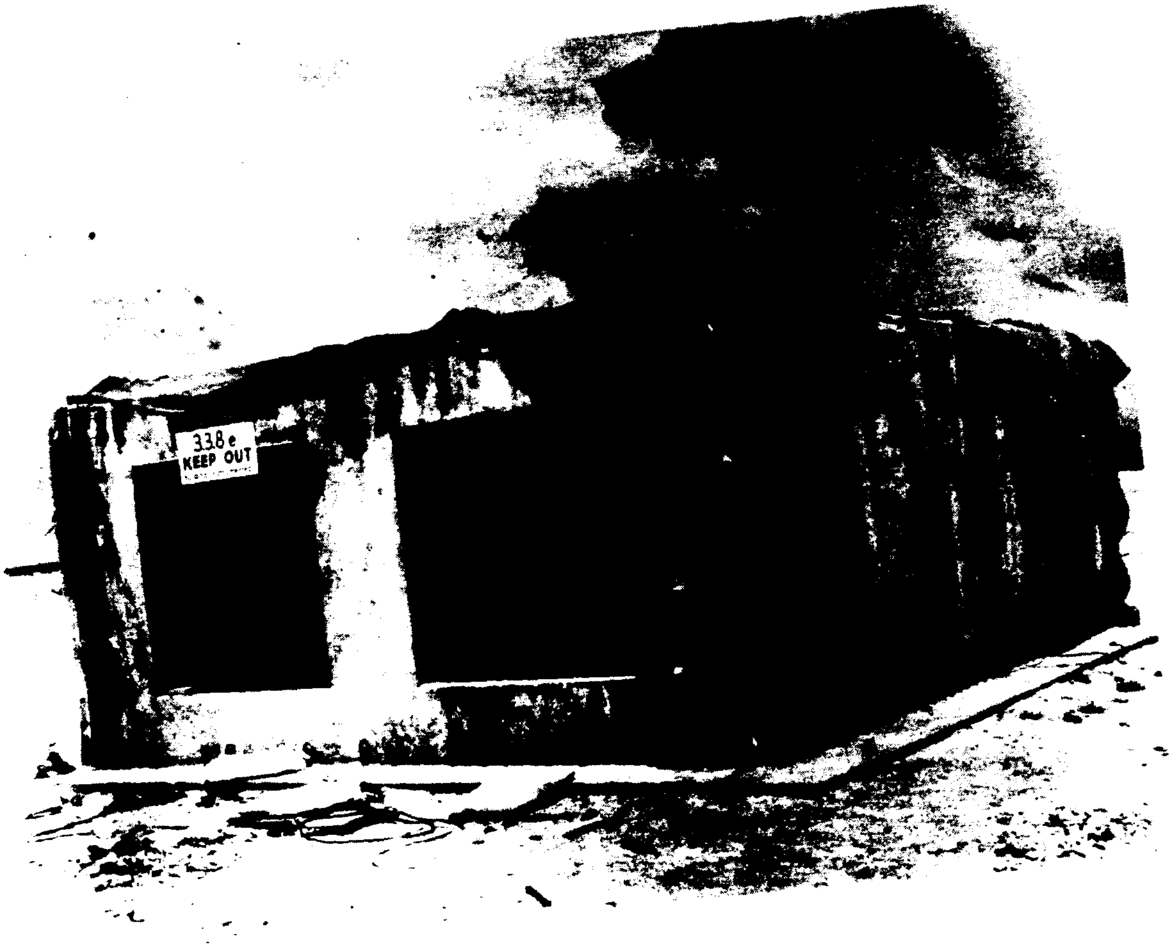
Military Structures Program, Station 3.3.8h (Air Force) in Foreground. Station 3.3.3 (Air Force) in Background.



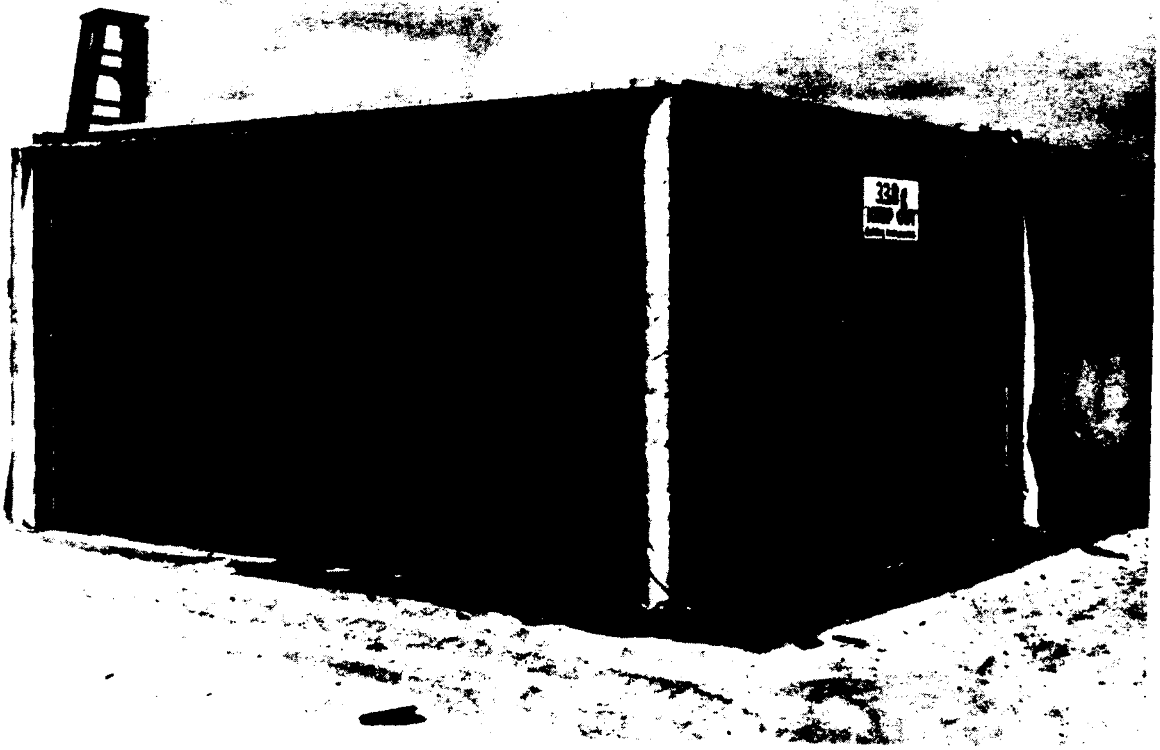
End of Hangar Toward Zero, Military Structures Program, Station 3.3.4 (Air Force) on Muzin.

Front Elevation of Brick House, Military Structures Program,
Station 3.3.5a (Air Force) on Engebi.

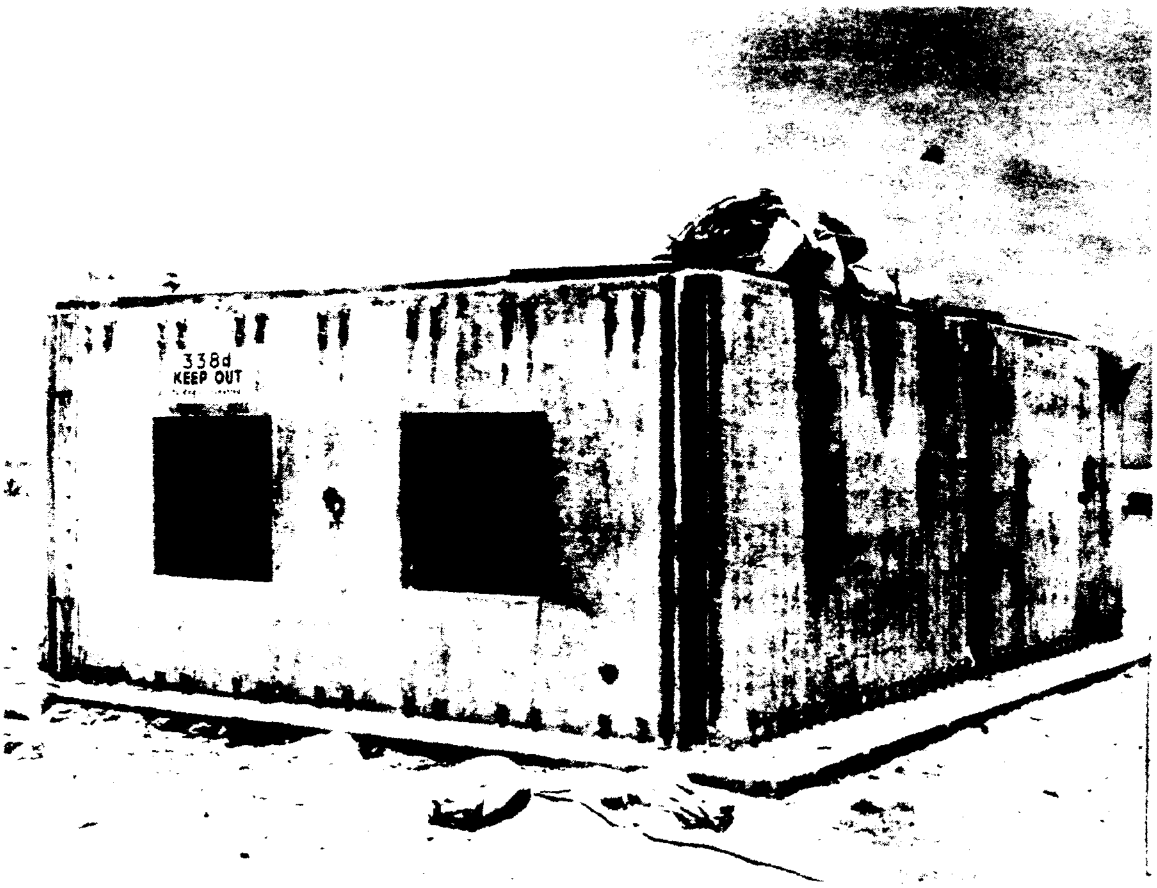
Air Force Station 3.3.8b, Precast Wall Sections.



Air Force Station 3.3.8e.



Air Force Station 3.3.8g, Precast Wall Sections.



Air Force Station 3.3.8d, Precast Wall Sections.

siding. The two end walls were constructed of concrete blocks with brick end sections. Steel sash windows were set into each end wall. A total of 16 footings were provided for column supports and varied in size from 2-feet 10-inches to 3-feet 8-inches deep and from 1-foot 10-inches to 2-feet 6-inches square with pads up to 2-feet 6-inches deep and 8-feet square, all reinforced. The dimensions of this structure were 238-feet 8-inches long by 120-feet 8-inches wide by 52-feet 4-inches height above grade. Structural steel wing walls, covered with corrugated metal siding, extended on each side of one of the end walls. These wing walls were 38-feet 4-inches above grade and were 40-feet 6-1/2 inches long, making the over-all width of one end of the structure 201-feet 9-inches.

Structure 3.3.4 was also known as "Air Force Structure Type A-2.1." This structure had four 26-foot open sided bays. There were 16 reinforced concrete columns on footings 5-feet deep. The roof of this structure consisted of laminated 2 x 6's covered with built-up roofing and supported by reinforced concrete bents. There were two monitors in the roof which comprised a structural steel framework with steel sash and covered with corrugated metal siding with the exception of the openings for the lights. The two ends of Structure 3.3.4 were constructed of brick and provided approximately 720 square feet of windows with steel sash and lights. The structure was approximately 106-feet long, 56-feet wide, and 25-feet high. Structural steel wing walls, covered with corrugated metal siding, extended on each side of one of the end walls. These wing walls were each 19-feet 2-1/4 inches high and 20-feet 6-1/2 inches long, making the over-all width of one end of the structure approximately 100-feet.

Structure 3.3.5a and b were also known as "Air Force Structures Type F-2." Structures 3.3.5a and b were identical. This structure was a two-story brick dwelling-type building with a sheet metal covered gable roof, and was erected on concrete foundation walls 1-foot 4-1/2 inches thick and 5-feet 1-inch deep. There were five brick masonry interior fireplaces. All interior walls were covered with metal lath. Finished plaster covered ceilings, walls and partitions with the exception of the entrance and stair halls. This structure was 42-feet 1-inch long, 33-feet 4-inches wide, and approximately 35-feet high. The first floor was composed of a 6-inch layer of sand, a 3-inch layer of bitumuls concrete, sleepers, and tongue-and-groove flooring. The second floor was composed of 2 x 10 inch joists with tongue-and-groove board nailed to the bottom and covered by tongue-and-groove flooring. A sand fill was placed between joists in the floor and ceiling of the second story.

Structures 3.3.8a, b, c, d, e, and g were also known as "Air Force Idealized Models". All six structures were similar and varied mainly in dimensions of wall openings and sizes of columns. These structures were constructed of structural steel framework with reinforced concrete walls and roof slabs. All joints and openings were completely closed by means of fiberglass sealing strips. Four 3-1/2 inch extra strong pipe struts connected the two side walls of each structure. Two 1/2 inch rods were connected to the flanges of each pipe strut at the wall and were anchored to hooked anchors set in the concrete floor slab under each pipe strut. These structures were 21-feet long, 15-feet 10-inches wide and 7-feet 2-inches above grade.

Structure 3.3.8f was also known as the "1/4 Scale Idealized Model". This structure was a 1/4 scale model of the 3.3.8 idealized model. Welded wire mesh was used as reinforcing for this structure. Three of the four walls were 2-1/2 inches thick. The roof slab and the rear wall were 2-inches thick. All joints and openings were completely closed by means of fiberglass sealing strips. The floor slab was 6-inches thick and had a 1-inch square by 3-inches thick concrete pad at each corner and at the center of each side. This structure was constructed of specially milled structural steel framework and reinforced concrete floor, roof and side slabs. This structure was 5-feet 3-inches long, 4-feet 1-inch wide, and 1-foot 1/2-inches above grade.

Structure 3.3.8h was also known as the "Model Structure Type C-1.1." This structure was a 1/4 scale model of Structure 3.3.3 and was constructed in the form of a hangar with three open-sided 19-foot 8-inch bays. Sixteen special built-up columns supported 27 prefabricated trusses which in turn supported a 1/2-inch plank deck roof. Three structural steel skylight monitors with steel sash were provided in the roof. The monitors and outside trusses were covered with corrugated metal siding. The two end walls were constructed of concrete brick. Steel sash windows were set into each end wall. A total of 16 pyramidal footings were provided for column supports, varying in size from 1-inch square to 2-inches square and 5-feet 1-inch deep. This structure was 59-feet 8-inches long, 30-feet 2-inches wide, and 13-feet in height above grade. Structural steel wing walls, covered with corrugated metal siding, extended on each side of one of the end walls. The wing walls were 9-feet 8-1/2 inches above grade and were 10-feet 2-1/2 inches long, making the over-all width of one end of the structure 50-feet 7-1/2 inches.

Piers for displacement gauges were provided for Structures 3.3.3 and 3.3.4. Six piers were provided for Structure 3.3.3 all constructed of heavily reinforced concrete supported by a 7-foot by 9-foot 6-inch, 2-foot thick pad. These piers were pyramid shaped, 25-feet high and 4-feet 6-inches by 3-feet at the base. Two piers were provided for Structure 3.3.4 and were constructed of heavily reinforced concrete supported on a 3-foot by 4-foot, 9-inch thick pad. These piers were pyramid shaped, 10-feet high and 1-foot 9-inches by 2-feet 9-inches at the base.

From the descriptions given above, it would seem that none of the Air Force structures presented a formidable construction problem. However, examination of the details involved in each of the structures reveals, among other things, that construction practices were called for which were unusual when compared to normal practice in the United States. On this score, indoctrination of personnel charged with the supervision of the work in the philosophy that these structures were, in essence, test instruments for experimental purposes soon alleviated any difficulties. For this reason, and others which are presented hereinafter, the Air Force Structures are good illustrative examples of the many ramifications entailed in the construction of test structures of this type at an off-shore isolated base. It is not the purpose of this report to repeat in detail all of the instances which bear on this point inasmuch as detailed reports have been submitted in answer to questions raised by the various groups concerned. However, in order to indicate the scope and number of the factors which must be considered in evaluating this construction effort, a few significant examples are presented which show the impact on construction of changing requirements respecting location, changes in design, time-consuming liaison channels, and firm construction deadlines to meet test operation schedules.

Location requirements for all structures were received through channels described above and, in due course, drawings were issued to the Jobsite Construction Department specifying exact locations for all items of construction at Eniwetok Atoll including the Air Force structures under discussion. In the case of the group of structures, including Structures 3.3.3, 3.3.4, and 3.3.8g, located on Muzin Island, locations were established and work on foundations had progressed almost to completion when a change in location was ordered at the request of the Air Force, shifting all three structures 150 feet. The abandonment of the work already done, while important to remember, should not have interfered greatly under normal conditions with the progress of construction. However, in this case work was stopped and almost a month elapsed before the new location was specified. This required rescheduling of other construction work in order to best utilize the men and equipment made available by the work stoppage. In addition, when the new location was specified, it was found that part of the concrete poured for the earlier foundation for the 3.3.3 structure interfered with the placement of the new foundations and had to be torn out.

In the case of structure 3.3.8h, the quarter-scale model of structure 3.3.3, a substantial portion of the structural steel and sash required had to be milled to cross-sectional dimension because standard stock sizes did not satisfy the scale requirements. As a consequence, difficulties in procurement were experienced which were enhanced when, at a late date, design changes were introduced.

Problems were encountered in fabrication of the trusses required for the structure and particularly in the tension and compression members which were made of angle steel machined to cross-sectional dimension. In the course of machining the required angle steel, H&N inspectors raised the question as to whether the dimensional criteria specified were being met. The problem was referred to the group responsible for design of the structure for resolution and clarification of the specifications. In due time an interpretation was received which would permit acceptance of the machined parts as within specified tolerances. On the other hand it was apparent that such acceptance would have, as an inherent result, a danger of distortion during subsequent riveting steps. As a consequence, a new interpretation of specifications was requested. As a result of the second request a representative of the Air Force inspected the machined steel at the fabricator's yard and firm decisions were finally reached in which tension members thus far fabricated would be accepted and compression members would be rejected. New machining methods were then established by the supplier and the job completed in accordance with the interpretation of plans and specifications finally obtained.

With respect to the required steel sash, shop drawings were prepared and approved and subsequently a sample sash in accord with the approved drawings was submitted to the Air Force design group. On October 10, 1950, this group notified H&N that a design change was desired due to the fact that the design embodied in the sample submitted was too strong in comparison with the remainder of the structure. The redesign was ultimately forthcoming and fabrication and shipment to the Jobsite followed.

From the above examples it is apparent that consideration must be given in construction of this type to the precise technical nature of the structure, to the changes that are invariably encountered in dealing with experimental requirements, and to the difficulties attendant upon the establishment of small tolerances for fabrication. When, in addition to such consideration, one remembers that a deadline had to be met by construction forces, the complexities mentioned become matters of serious concern. Thus, in connection with the 3.3.8 structures, in order to meet deadline dates, the decision had to be made on whether to require the structural steel fabricator to deliver perfect structural steel elements (which could not be done in time to meet construction schedules) or to accept somewhat less than perfect, but usable, elements and complete the work on time. The latter course was chosen, but not without repercussion. The fabricator had been chosen (in accordance with standard practice) on the basis of a low bid and qualifications to do the required work. However, during the course of the work (which had finally been initiated after a series of design changes), the H & N inspector noted that deviations existed between webs and flanges of mating structural steel components. This condition was brought to the attention of the fabricator and work was stopped. It was soon apparent that new steel could not be obtained in time to permit fabrication and shipment to the Jobsite in time to meet schedules and this condition was thoroughly explored and confirmed by the H & N Procurement Department. On careful examination of the parts on hand, it was determined that matching elements could be found for some of the components, and the decision was made, in order to save time, that where components did not match, the webs should be aligned and a mismatch permitted on the flanges where mismatching was due to mill tolerance variation of not more than 3/8 inch. Protrusions were to be ground flush. In order to avoid any difficulty in field erection, test erection and match-marking of these components at the fabricator's yard was specified and accomplished prior to shipment to the Jobsite.

On November 14, 1950, the Air Force representative at the Jobsite advised that the structural steel thus fabricated was unsatisfactory for final field erection. This rejection was based upon visual inspection and measurements made of steel before erection. However, in order to permit a full determination of the factors involved, structural steel for one of the 3.3.8 structures were erected. A survey made at this time indicated that some discrepancies in beam connections were present and minor variations existed in the beam and column connections. These discrepancies after erection, were found to be much less than those reported before erection and no difficulty was experienced during the final erection of these structures, which was authorized[1] by the AEC on December 5, 1950.

Just prior to completion of the structures, a change was introduced calling for bars to be welded on both flanges and on both sides of the beam web at all splices in Structures 3.3.8a, b, c, d, and e for the purpose of strengthening the beams in question, thus closing the incident.

INSTRUMENTATION

Early in 1950 the Sandia Corporation had been given the responsibility for instrumenting the structures involved in the Military Structures Program. In order to avoid major staff increases in the Sandia Corporation, the proposal was made that Holmes & Narver supply auxiliary technical services in the form of a technician pool operating under the supervision of Sandia Personnel. After studying the proposal, H & N expressed its willingness to undertake such a program and, subsequently, on March 14, 1950, Work Authorization No. 50-507-9 was issued formally authorizing the following:

> "3. Instrumentation - All instruments and connecting wire required will be furnished to you by the Sandia Corporation. Your participation in this portion of the program consists of the design (in accordance with information furnished by Sandia Corporation), procurement and installation of all mounting fixtures and all conduit required to install, calibrate and read all instruments and measurement points under the supervision of representatives of the Sandia Corporation. You will not be required to interpret any of the reading or measurements resulting from the test. Also, prior to the test, you will obtain from the Sandia Corporation representative a signed certification that the installation, calibration, and initial readings or measurements are approved. It is understood that the instrumentation work will be performed by a special group of workmen under a separate Holmes and Narver supervisor under the direction of Sandia Corporation representative with respect to technical and operational matters only."

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[1] Ref TWX SD 6418

Original estimates of cost for the instrumentation program had been submitted on February 8, 1950 and totaled $665,095 including the services of 74 men who would work under the supervision of Sandia Corporation personnel. This estimate was based upon the inclusion in the Structures Program of: Structures 3.1.1, 3.1.3, 3.2.1a, 3.2.1b, 3.2.2, 3.2.3a and b, 3.2.4a and b, 3.2.5, 3.2.6, 3.2.7, 3.3.3, 3.3.5a and b, and 3.3.8h. Small shelters for only twenty recorders and camera mounts were also involved. However, by April 6, 1950, the scope of the work required of Holmes & Narver was radically revised, additional structures were added to the program, and H & N's responsibilities were increased to include:

1. Design and construction of recorder shelters and conduits from the various shelters adjacent to the test structures
2. Design, procurement, and shipping of instrument mounts
3. Design and construction of camera mounts
4. Construction of instrument pedestals
5. Installation, calibration, and reading of instruments and measurement points
6. Preparation of plans showing locations of all instruments
7. Warehousing and property accountability of all instruments, wiring, and appurtenances at the Jobsite

Personnel. As a result of these changes, the estimate on the Instrumentation Program was revised upward to $1,067,060. Original planning was based upon the philosophy that the Sandia Corporation would supply all supervisory personnel required for the program and that H & N would provide a work force for all other duties. However, in order to minimize the "out-of-pocket" cost to the Department of Defense of the Instrumentation Program, the decision was reached that maximum use should be made of military personnel. As a consequence of this decision, the integrated group participating in the Instrumentation Program comprised 42 military personnel, 10 Sandia Corporation personnel and 36 H & N personnel. The H & N increment included personnel in many categories ranging from property clerks and carpenters to skilled electronic engineers. In addition to the field force mentioned above, it should be noted that at least ten expert draftsmen were assigned, under the supervision of Sandia Corporation personnel, to duties connected with the preparation of 147 drawings showing instrument locations, mount designs, and mount locations.

In order to completely integrate the personnel requirements of the program, Holmes & Narver personnel participated extensively in the interviewing and recruitment of military personnel ultimately assigned to the work. By such participation, early, definite decisions could be reached on the numbers and classifications of personnel to be recruited by H & N, thereby materially expediting the initiation of security clearance processing.

All technical personnel employed by Holmes & Narver for the overseas portion of the program were assigned directly to the Sandia Corporation Laboratories at Albuquerque, New Mexico for training. The Instrumentation Program involved an effort to attain very precise and, in some cases, novel data on structures subjected to the effects of large explosions. End instrumentation included electronic gauges, self-recording gauges, survey and Whittemore point measurements and Stimoscopes. The electronic gauges were associated with multi-channel, high precision, magnetic tape recorders. The measurements involved in the Instrumentation Program included pressures from 0 to 250 psi, strain from 0 to 10 per cent, accelerations from 10 to 350 g, displacement from 0.003 to 5.00 feet, and time of break of various panels. In view of the highly specialized nature of the work thus involved, careful training of personnel in the duties to be performed was of prime importance. A substantial portion of the training of H & N personnel assigned to the program was accomplished by the expedient of temporary duty tours at the plants engaged in the manufacture of end instruments and recorders. This phase of training proved invaluable during field operations.

Engineering Services. The designs of the various recorder stations (301 Station series) and the camera mounts (302 Station series) are discussed in Section V, Engineering, Vol. II. Briefly, the recorder shelters housed electronic recorders, timing racks, and batteries; and the camera mounts protected photographic equipment installed for the purpose of recording observations made during test detonations. Construction schedules on the Military Structures Program called for the commencement of work on this program during Aptil 1950 and, in view of the fact that instrumentation locations were scattered through all parts of the structures involved in the program, it was essential to provide the construction organization with location drawings at the earliest possible date. As noted above, ten expert draftsmen, operating under the supervision of Sandia personnel, prepared the 147 drawings involved in approximately one month. Representatives of the three services were assigned to the Los Angeles office of H & N during this period in order to expedite approval of the drawings.

In addition to the preparation of the location drawings, H & N was assigned the responsibility for collating information and preparing drawings showing the location of all survey points and Whittemore points. Each survey point was accurately fixed by 3-dimensional location. A special monument system was established and integrated into the island and atoll surveys with an accuracy of plus or minus 0.001 foot. Details of the surveys are included in Chapter 5.8, Vol II, Appendix "D".

Field Activities. The construction phase of the Instrumentation Program required a complete coordination between the instrumentation group and the construction forces. To effect this coordination, H & N assigned three inspectors whose primary duties were to assure the proper and accurate placement of all (approximately 800) instrument mounts. A weekly reporting system was established in order to keep all concerned informed on the progress of construction connected with the Instrumentation Program.

Gauge installation was started during November 1950 with the laying of all cables required for the Instrumentation Program. Thereafter, operating from a field laboratory established in Air Force Structure 3.3.5a on Engebi Island, calibration of each gauge and complete check-out of each of the 24 channels of each of the magnetic tape recorders was accomplished. Actual installation of end instruments followed in due course. During January and February 1951, Whittemore points were drilled in all exposed steel members (points located in reinforcing steel had been placed by construction forces) and survey points were established using "drive-it" markers.

The following relevant statistics are of interest in connection with the activities of the field forces engaged in the Instrumentation Program:

Electric gauges installed	621
Self-recording gauges installed	252
Survey points established	2,153
Whittemore points established	1,314
Stimoscope readings	1,249
Natural period studies	7

Upon completion of the tests, H & N personnel engaged in making the required measurements and surveys and in the recovery of data and equipment. Thereafter, H & N technical personnel were reassigned to duty at the laboratory of the Sandia Corporation at Albuquerque, New Mexico, in connection with the reduction of data, the responsibility of Sandia Corporation.

CHAPTER 6.8

SUBCONTRACTS

The use of subcontracts in performing the services required in connection with the development and operation of the Proving Ground was specifically recommended in the Reconnaissance Report as follows:

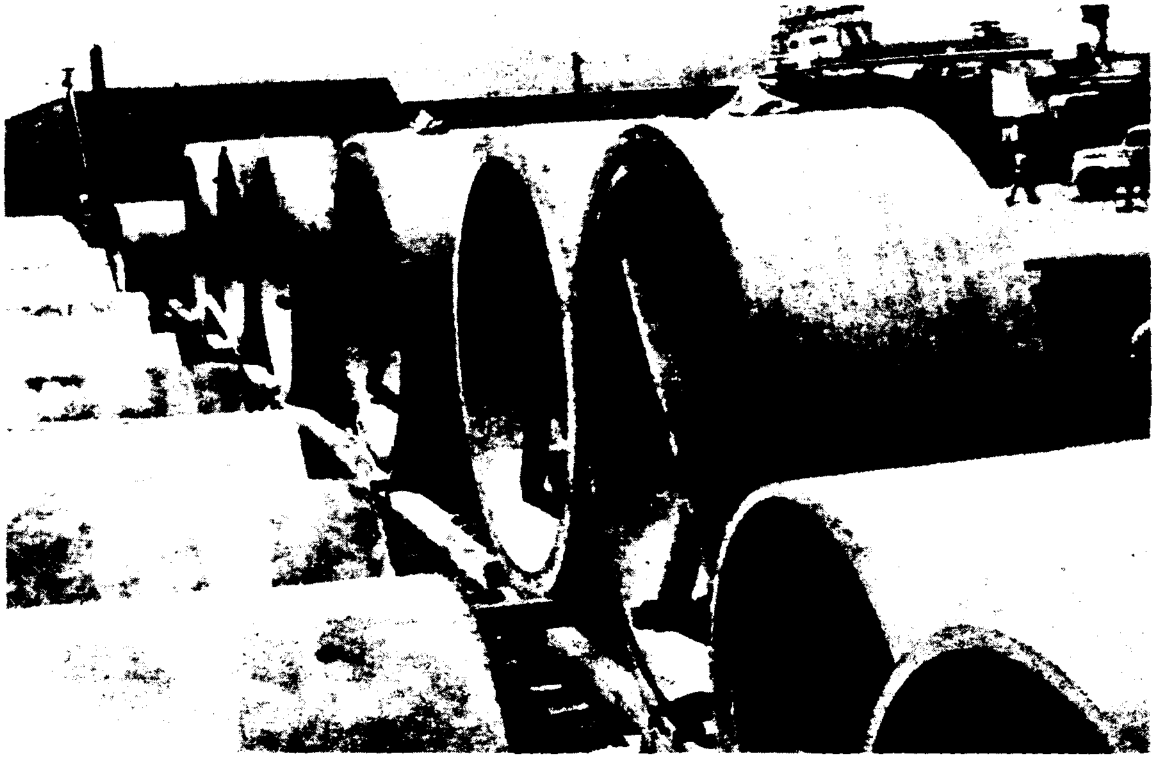
> "Various parts or sections of the work may be awarded to subcontractors for certain special reasons. The practice of awarding such subcontracts is not only common, but universal on any piece of construction work which is extensive in its nature. Under present circumstances, there are several conditions which would justify this procedure:
>
> To employ special management skills and methods.
>
> To effect hire of special skilled personnel for short time work when such personnel is not available for hire on the open market.
>
> To avoid difficulties of operating with certain trade groups or unions.
>
> To acquire the use of specialized equipment for a specific operation when purchases or rental of such equipment is not economically justified."

In the course of the Project, it was deemed expedient to minimize the amount of Jobsite subcontracting because of wage scale difficulties which would have resulted. Thus, the only portion of the Jobsite construction program for which H & N initiated a subcontract for services to be performed at the site was that involving the erection of the ten towers required, of steel erection for various structures, and of heavy rigging services and related activities requiring similar skills and experience. This subcontract involved a total expenditure of approximately $390,000 for labor, materials, equipment, etc.

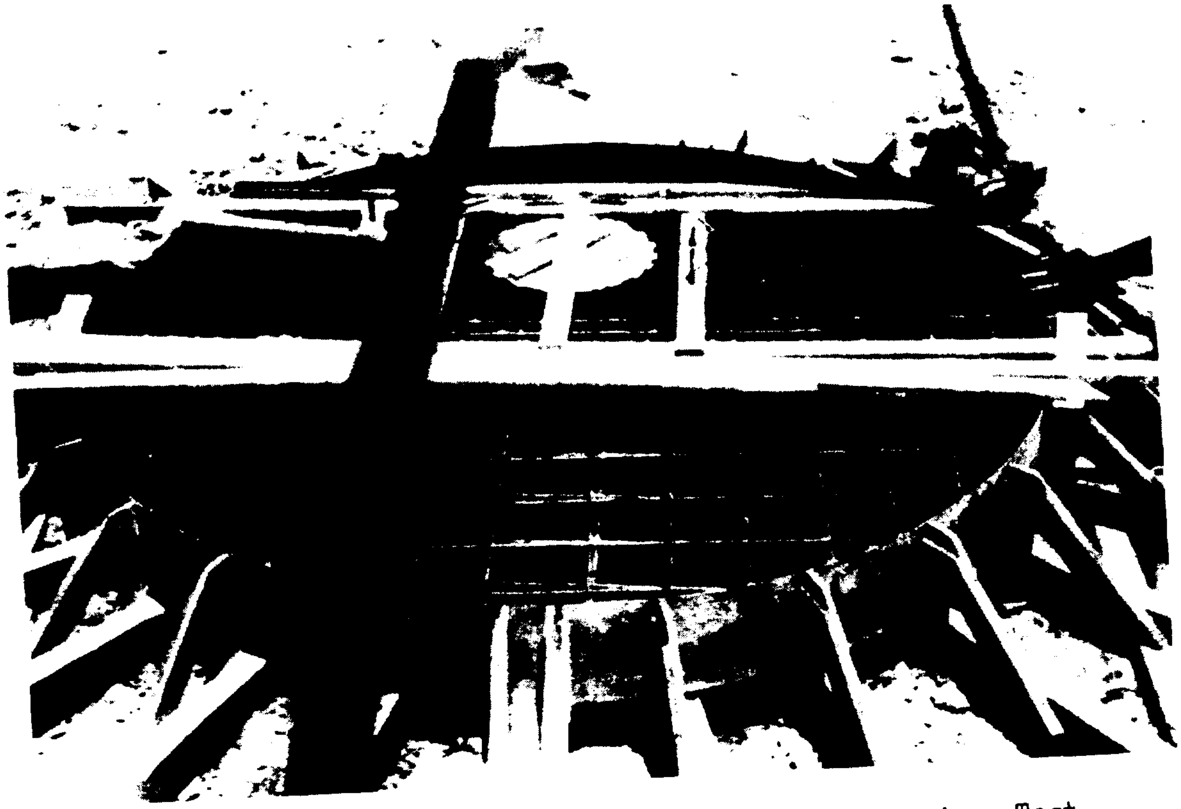
Late in 1950, when the decision had been made to institute a grouting program in connection with Structure 3.1.1 of the Military Structures Program, H & N was directed to enter into a subcontract with a designated specialized organization covering the supervision of the grouting operation and the use of patented grouting methods, materials, and equipment. In effect, Holmes & Narver were merely an administrative agency in connection with this work and served as well to make available to the subcontractor a labor pool and materials to aid in performance of the work. The determination of the adequacy of the work for the desired purposes was the responsibility of others, and to this end the AEC dispatched engineer personnel and special consultants to the Jobsite. (The details of the grouting program and the subsequent drilling exploration are discussed in connection with the construction of military structures.) The total expenditure involved in connection with the grouting subcontract (but not the whole grouting program), was approximately $251,560, including $74,545 for H & N labor and $27,449 as the proposed fixed fee to the subcontractor.

In connection with construction activities, two subcontracts were entered into covering the prefabrication in the United States, of components for the Military Structures Program. The first involved the prefabrication of reinforced concrete components for the Navy portion of the program and the second involved the prefabrication of components for a cylindrical reinforced concrete section, 8 feet, 6 inches inside diameter by 27 feet in length for the Army 3.1.3 structure. These subcontracts were considered to be desirable in view of the basic philosophy of conserving manpower at the site, the high strength specifications, close tolerances, and specialized nature of the work involved. With the aggregates available at the Jobsite, it was clear that meeting specified concrete strengths could not be considered routine. Furthermore, because of the great number of components involved, the utilization of Jobsite manpower for these tasks did not appear to be justified. In view of the difficulties experienced by the subcontractor in the fabrication of the Navy components at a San Francisco area plant, the decision to arrange a subcontract for this work was clearly in accord with the principles announced in the Reconnaissance Report.

Pipe Form Being Landed on Spinning Rollers for Army Test Structure 3.1.3, American Pipe & Construction Co., Sub-Contractor.



View of Completed Pipe for Army Test Structure 3.1.3, American Pipe & Construction Co., Sub-Contractor.



Bulkhead Form with Reinforcing Steel in Place for Army Test Structure 3.1.3, American Pipe & Construction Co., Sub-Contractor.

Concrete Plant for Pipe Manufacture for Army Test Structure 3.1.3, American Pipe & Construction Co., Sub-Contractor.

CHAPTER 6.9

HEAVY EQUIPMENT

Throughout the course of the work at the Proving Ground, emphasis was placed upon the importance of having ample heavy equipment available for all types of construction. This emphasis entailed early and continued efforts to procure construction equipment from government surplus stocks and to salvage and rehabilitate equipment found on the Atoll by the Beachhead Group and later by construction forces during the cleanup of the extensive dump area on Parry Island.

Surplus equipment and spare parts in great quantity were located at Guam, and arrangements were made for transfer to the AEC from the Corps of Engineers, and from the Navy. Transportation from Guam to Eniwetok was provided by the Navy without charge and in conjunction with the shipment by LSD of some M-boats from Sasebo, Japan. Much of this equipment was in need of repairs, some which was beyond repair was cannibalized to form a basic spare part stockpile which proved invaluable on many occasions. This particular method of procurement of construction equipment had the signal advantage of making a considerable quantity of heavy equipment available immediately at the Jobsite for use in the construction program, at a minimum expenditure of funds.

In the selection of the equipment transferred, competent heavy equipment personnel examined all items that were available and evaluated each choice on the basis of operating condition, cost of repairs, useful life expectancy, availability and cost of comparable items through other sources and like considerations.

Heavy equipment mechanics were included in the first group of H & N personnel assigned to Eniwetok, and the establishment of a heavy equipment shop was one of the missions scheduled for early accomplishment. Extraordinary atmospheric conditions and the necessity for borrowing considerable amounts of coral from underwater sources were the chief contribution to the short useful life for construction equipment used at the Atoll and to the high maintenance costs. Cyclic maintenance programs were prescribed. The frequency of maintenance depended upon usage; thus, for example, bulldozers working on the reef and subjected to the constant corrosive action of salt water were greased and coated with corrosion preventive agents as frequently as every day.

All types of equipment needed for the application of the most modern construction techniques and practices were accumulated in the equipment pool. In addition an extensive boat pool including tugs, barges and various amphibious craft was operated for the inter-island movement of mateerial, supplies, and construction personnel. The following list of types of equipment now in use or in storage at the Proving Ground is indicative of the types available and used during construction:

Crane, crawler, Model 25
Crane, crawler, Model 39A

Crane, crawler, Model 3000
Crane, crawler, Model 6WAK - with shovel
Crane, crawler, Model 655A - with shovel
Crane, crawler, Model 2000B - with shovel
Crane, crawler, Model 6WAL - with shovel
Crane, truck Model 18T-50
Crane, truck Model HC-70
Grader, road, Caterpillar, Model 12
Grader, road, Caterpillar, "Road Patrol"
Ditching Machine, B/G Model 44C
Paver, crawler, Ransome Model 34E dd
Road-roller, Model WXLC-3
Tracavator, crawler, Model T-4
Tractors, crawler, Caterpillar, Model D-7
Tractors, crawler, Caterpillar, Model D-8
Batcher, traveling, Model 534
Bodies, dumpcrete, Model 2C-2
Buckets, concrete, Model 416-L
Buckets, dragline, Page, Model 1-KC
Conveyor, belt, Model 17
Crusher, rock
Finishers, cement, Model B
Hammer, piledriver
Mixers, air-driven, Model MGB
Mixer, cement, Model 141-5
Mixers, concrete, Model 11-S
Mixers, concrete, Model 16-S
Batch-plants, w/acc.
Light-plants, 7.2Kva, Model WC4-7.55
Plant, rock-crushing, Pitmaster
Rooters, road, LeTourneau
Scrapers, carryall, LeTourneau, Model LP
Screen, vibrating, Model 1S-266
Screen, washing-unit
Sheepsfoot, 2-drum, Model 20
Trailers, dolly, Model 3D
Trailers, 4-wheel, pneumatic-tired
Trailers, full flatbed, Fruehauf Model FNN 422-SP
Trailers, lowbeds and semitanks
Trailers, tank, bituminous, Model 102
Trucks, cargo, GMC Model CCKW-353
Trucks, dump, Reo Model D-23S-B
Truck, fire
Trucks, full flatbed, Model M-5H6
Trucks, pickup, Ford Model 8HC
Trucks, tank, 800 gal
Trucks, transit-mix, Model F-226
Vehicles, motorbus, Model K-7-269
Carts, concrete, 6 cubic foot
Compressors, air, portable
Diggers, pneumatic, portable, Model 75
Drills, air, pneumatic, portable, Model 33SK

Drill, air, rotary, portable, Model 327-R500
Drill, core-cutting, portable, Model ES-48
Drills, derrick, pneumatic, Model LCM-73
Drills, sinker, dry, Model S-55-D
Generators, 75 Kw, Model D13-66
Generating Units, Model EH
Hammers, riveting
Hoists, single-drum
Hoists, hook, suspension
Machines, holeblasting
Machine, sandblasting
Vibrators, cement, electric
Welders, arc
Wrench sets, impact, pneumatic

EXHIBIT A

Memorandum of Agreement for Participation in Construction Program, Eniwetok Atoll

MEMORANDUM OF AGREEMENT FOR
PARTICIPATION IN CONSTRUCTION PROGRAM
ENIWETOK ATOLL

1. In view of the rapid approach of the time when actual construction of facilities on Eniwetok Island will begin, it was considered desirable to call a meeting between the various parties having an active interest in this construction for the purpose of final agreement as to the division of responsibility and construction activities between the Atomic Energy Commission and its contractor, Holmes & Narver; and Joint Task Force Three and the Construction Battalion. Accordingly, such a meeting was held at JTF-3 Headquarters, Washington, D.C., on January 30, 1950. The following persons were present:

JTF-3:

Lt. Gen. E. R. Quesada, Commanding
Brig. Gen. Loper
Col. Hale
Col. Tate
Capt. Pahl
Col. Stanford
Lt. Col. Alexander
Mr. Riley

7th Engr. Brigade:

Brig. Gen. Butler
Lt. Col. McCrone
Maj. Lyon
Maj. Detlie

AEC:

Col. Schlatter
Mr. Spain
Mr. LaPlante

Holmes & Narver:

Mr. Holmes
Mr. Lester Kelly

2. The following agreements were made or reaffirmed:

a. The items listed below constitute a complete listing of facilities to be constructed on Eniwetok Island for which AEC will procure materials:

Item		Bldg. No.
(1)	Power House Transmitter	3
(2)	Transmitter Building	4
(3)	Latrines	5-8
(4)	36-man Barracks	10
(5)	72-man Barracks	11-13
(6)	Dispatchers Building	14
(7)	Army Task Group Headquarters	15
(8)	Post Office and P.X.	16
(9)	Latrine	17
(10)	18-man Barracks	18-21
(11)	Ward Building	23
(12)	Dispensary	24
(13)	Fire Station	29
(14)	800-man Theatre	30
(15)	Laundry	31
(16)	Reefer Building	33
(17)	Boiler House	34
(18)	Bakery	35
(19)	Mess Hall	36
(20)	Commissary	37
(21)	18-man Barracks	38-42
(22)	Latrines	43-44
(23)	800-man Theatre	45
(24)	Latrines	51-55
(25)	Power Plant & Distillation	56
(26)	Rad. Chem. Building	57
(27)	Drone Headquarters	77
(28)	Air Operations	78
(29)	Power House, Receiver	84
(30)	Receiver Building	85
(31)	Drone Control Ramp	86
(32)	Hydrogen Shack	87
(33)	Weather Instrument Repair Building	88
(34)	Base Operations & Control Tower	89
(35)	Air Task Group Headquarters, AACS, Air Plot, Photo Operations	90
(36)	Crash Truck Shed	91
(37)	L-13 Operations	92
(38)	L-13 Maintenance	93
(39)	P.O.L. Pumphouse	94
(40)	P.O.L. Submarine Lines	--
(41)	P.O.L. Storage Tanks	--
(42)	Fresh Water Tanks	107
(43)	Latrines	109-115
(44)	Loran Station	116
(45)	NRDL 7 Chem. Corps. Area	117
(46)	Tent Slabs & Frames	As shown on Layout

Item		Bldg. No.
(47)	Cargo Pier Extension	--
(48)	Personnel Pier	--
(49)	Runway Extension & Rotation	--
(50)	Parking Areas & Taxiways (including L-13 tiedowns)	--
(51)	Roads and Streets	--
(52)	Electrical Distribution System	--
(53)	Fresh & Salt Water Distribution Systems	--
(54)	Sewage System	--
(55)	Telephone System	--
(56)	Open Air Shower	9
(57)	Ward Building	22
(58)	72-man EM Quarters	46-50
(59)	Gas Storage	95
(60)	JP 1 Fuel	96
(61)	Movie (800-man)	108
(62)	Telemeter Trailer	120
(63)	Elevated Water Storage	121
(64)	Latrines	122-123
(65)	Salt Water Pump Station	124
(66)	Latrine & Decontamination Shower	125
(67)	Latrines	127-130
(68)	Booster Pump House	131
(69)	Rehabilitation of Bldgs. 58-76, 79, 80 82a and b, 83, 98, 99, 100-106	

b. Holmes and Narver will design all facilities listed in paragraph 2a, will furnish 10 complete sets of working drawings to the Battalion, and one transparency of each building floor plan and elevation to JTF-3 Headquarters.

c. Holmes and Narver will construct the facilities in 2a(1), (2), (25), (29), (30), (40), (48), (52), and (54). The Receiving Building and Power House, Nos. 2a(29) and (30), will be constructed by Holmes and Narver after the arrival of the Battalion as a demonstration to battalion personnel of the proper method of erection of the prefabricated aluminum buildings. Item (25) will be constructed by Holmes and Narver complete except for the aluminum building shell and such assistance as the Battalion can render in layout, excavation, concrete placement, and unskilled labor. Item (52) will be constructed complete to the service drops by Holmes and Narver, utilizing such assistance as the Battalion can furnish in layout, setting poles and furnishing apprentice labor. Item (54) will be constructed by the Battalion, except that Holmes and Narver will construct the sewer outfalls from the last manhole on the beach.

d. The Battalion will construct all facilities listed in paragraph 2a except those listed in paragraph 2c above. This includes layout and staking.

e. Holmes & Narver will procure all construction materials to be incorporated into the various structures. This includes cement, commercial explosives for excavation and quarrying, and fixed equipment in the buildings, such as sinks, kitchen equipment, bakery equipment, fixed reefers, toilet fixtures, a reasonable amount of lumber and plywood for tent frames, shelving and lockers, and the like. It does not include form lumber, construction equipment and hand tools, concrete aggregate, hospital equipment other than fixed, office and quarter furnishings, mess table and chairs, crockery and silverware, tents, and special equipment such as weather equipment, shop equipment and the like. Such Holmes & Narver procurement may be from Department of Defense stocks in accordance with existing agreement. A ship will arrive at the site on or about April 7, 1950, with sufficient materials to provide for immediate full-scale construction effort on the part of the Battalion.

f. Task Group 3.2 will frunish all stevedoring services from hold to shore on Eniwetok and Parry Islands. Holmes & Narver will provide stevedoring service from lighter to shore on all other islands. Holmes & Narver will normally operate all boats, tugs, barges and lighters, but will be supplemented by boats from Task Group 3.2 (by mutual agreement) as required.

g. In order to assist the Battalion during the construction period, Holmes & Narver will furnish the following personnel:

One construction superintendent

One each craft foremen: Plumber, steamfitter, interior electrician, exterior electrician, concrete (during initial stage of construction only)

Two each craft journeyman: Plumber, interior electrician (for a 90-day period)

These men will report to the construction superintendent and will direct work only through the commissioned or non-commissioned officers in direct charge of the particular phase of work. The construction superintendent will advise and assist the Commanding General of his designated constructing Engineer and will be the representative of the AEC Resident Engineer for inspection purposes on behalf of the AEC.

h. Holmes & Narver will operate and maintain the electrical generators to the board, water distillation units to the elevated tanks, salt water pumps to the main and refrigeration units. Task Group 3.2 will operate the P.O.L. facilities and Holmes & Narver will maintain these facilities including P.O.L. Submarine Lines. Task Group 3.2 will assist Holmes & Narver in accomplishing the above by furnishing personnel as required.

i. Holmes & Narver will provide all materials and replacement parts for maintaining the building and facilities listed in paragraph 2a with the exception of item (44). This is to include installed equipment provided by Holmes & Narver from commercial sources.

3. It was agreed that all parties concerned will mutually cooperate and assist. Direct coordination and cooperation between the AEC Resident Engineer and his designees, and the Commanding General and his designees is desirable and is authorized, bearing in mind that changes in the scope of the work must have the approval of the Resident Engineer's home office. Where possible, mutual exchange of construction equipment for specialized jobs will be made, with priority of use being judged by the Resident Engineer.

Approved: /s/ E.P. Morgan, Acting
C. L. Tyler
Manager, Santa Fe Operations
U. S. Atomic Energy Commission

Approved: /s/ E. R. Quesada
E. R. Quesada, Lt. Gen.
Commanding
Joint Task Force Three

EXHIBIT B

Extracts from H & N Concrete Report

CORAL AGGREGATE CONCRETE

The following is the mix formulae used to obtain 2000 to 3500 p.s.i. concrete on the various islands.

RUNIT - SITE "C"

3500 and 3000 p.s.i.

Santa Clara Cement	658 pounds per cu. yd.
Runit Pit Sand	1300 pounds per cu. yd.
Reef Crushed Rock	1600 pounds per cu. yd.
Sea Water	6 gal. per sack

2500 and 2000 p.s.i.

Santa Clara Cement	611 pounds per cu. yd.
Runit Pit Sand	1300 pounds per cu. yd.
Reef Crushed Rock	1600 pounds per cu. yd.
Sea Water	6 gal. per sack

BIIJIRI - SITE "D"

3500 and 3000 p.s.i.

Santa Clara Cement	658 pounds per cu. yd.
Aomon Fine Sand	360 pounds per cu. yd.
Coarse Biijiri Sand	1125 pounds per cu. yd.
Site "D" Canned Crushed Rock	1330 pounds per cu. yd.
Sea Water	6 gal. per sack

2500 and 2000 p.s.i.

Santa Clara Cement	611 pounds per cu. yd.
Aomon Fine Sand	360 pounds per cu. yd.
Coarse Biijiri Sand	1125 pounds per cu. yd.
Site "D" Canned Crushed Rock	1330 pounds per cu. yd.
Sea Water	6 gal. per sack

ENGEBI - SITE "E"

3500 and 3000 p.s.i.

Santa Clara Cement	611 pounds per cu. yd.
Sand	1493 pounds per cu. yd.
Crushed Reef Rock	1396 pounds per cu. yd.
Brackish Water	6 gal. per sack

CORAL AGGREGATE CONCRETE (Continued)

2500 and 2000 p.s.i.

Santa Clara Cement	564 pounds per cu. yd.
Sand	1485 pounds per cu. yd.
Crushed Reef Rock	1330 pounds per cu. yd.
Brackish Water	6 gal. per sack

Lean Mix Concrete

Santa Clara Cement	376 pounds per cu. yd.
Beach Sand	1485 pounds per cu. yd.
Crushed Reef Rock	1330 pounds per cu. yd.
Brackish Water	8 gal. per sack

LIMONITE CONCRETE

Limonite concrete is a heavy weight, high limonite ore bearing, high cement ratio concrete using steel scrap as coarse aggregate and having good shielding value. Because of its high unit weight it was believed that the placing of limonite would be much more difficult than coral concrete. This was disproved on Runit (Site "C") and Biijiri (Site "V-D") where the limonite ore and steel scrap was placed in the hoppers of the batch plant and weighed in the same manner as coral aggregate. The limonite concrete was mixed in a transit mixer and discharged into a bucket, then lifted by a crane and placed as ordinary concrete. The water content of limonite concrete was found to be very critical in that it would go from a high to low slump very quickly; therefore, the addition of water had to be rigidly controlled. On Engebi (Site "E") limonite concrete was handled in much the same manner except that mixing was done in a stationary mixer and discharged into "Dumperete" type "bath tubs" on trucks, hauled to the site and then handled as described above. Vibrators were used vigorously to get an even distribution of scrap steel aggregate within the forms. No evidence of segregation was noted and vibration tended to eliminate objectionable pockets and voids.

There were two types of limonite concrete used on the project, high strength limonite concrete containing a fixed quantity of limonite ore and developing a compressive strength of not less than 3500 p.s.i. and high density limonite concrete for which compressive strength was not a requirement and no definite proportion of limonite ore to steel scrap was set up.

The average unit weight of high strength limonite concrete is approximately 273.5 pounds per cubic foot. This is the average of many unit weight tests taken from the loading bucket. The steel scrap boxes were labeled 3/8" to 2" and the mixture of scrap contained equal parts by weight of bullets, punchings and scrap particles.

High Strength Limonite Concrete Mix - 3500 p.s.i.

Cement - 940 pounds/cu. yd.(Santa Clara or Santa Cruz)
Limonite Ore -1880 pounds/cu. yd.
Steel Scrap -4100 pounds/cu. yd.
Water adjusted to provide proper slump (approx. 5.5 gals. per sack)

The average compressive strength of high strength limonite concrete 6 x 12 inch cylinders on a 28 day test showed a strength of 4500 p.s.i. This is predicated on all of this type of cylinder cast, on Engebi, using Santa Clara and Santa Cruz cement.

SAMPLE FROM LIMONITE

	Fine			Coarse			
Sieve Size	Total Wt.Rt.	Total % Rt.	Percent Passing	Total Wt.Rt.	Total % Rt.	Percent Passing	Passing Average
0	612.6	100		784.0	100		
200	560.2	91.6	8.4	743.6	95.0	5.0	6.7
100	530.0	86.6	13.4	713.8	90.8	9.2	11.3
50	463.8	75.7	24.3	670.0	85.4	14.6	19.5
30	358.7	58.5	41.5	602.9	76.7	23.3	32.4
16	247.6	40.4	59.6	521.6	66.5	33.5	46.6
8	21.2	3.5	96.5	283.9	36.2	63.8	80.2
4	0		100.	27.5	3.5	96.5	98.3
3/4						100.	100.
Fineness Modulus - 2.647					3.59		

High Density limonite concrete was specified in some structures, and called for a mix having a unit weight of three hundred ten pounds per cubic foot. No strength was required in the dense limonite concrete, its entire purpose being maximum unit weight. Considerably more difficulty was experienced on Runit (Site "C") and Biijiri (Site "D") in placing dense limonite concrete. Due to its great weight the transit mix could not discharge it. This situation was remedied by building a ramp and running the front of the transit mixer up the ramp until the back end was low enough to discharge. Considerably more vibration was necessary with dense limonite concrete to eliminate voids. The high density limonite concrete mix was:

6100 pounds scrap metal (3/8" to 2") per cu. yd.
1700 pounds Limonite ore per cu. yd.
658 pounds cement per cu. yd.
27 gallons of water
Gradation of ore the same as above.

The following is a suggested gradation for steel scrap. The 2" dimension quoted herein defined as meaning the greatest dimension.

Sieve Number	Percent Passing
2"	100
1½"	70 - 90
1"	50 - 70
3/4"	30 - 50
1/2"	10 - 30
3/8"	0 - 10

Considerable heat is generated by the rich (ten sacks of cement to the cubic yard) mix, but no adverse thermal effects were observed. Some hairline cracks were noted. Laboratory experiments indicate, that for high strength limonite concrete having unit weights not higher than 275 pounds per cubic foot the following mix is recommended:

5600	pounds scrap steel
1800	pounds limonite ore
8	sacks cement
30	gals. water (approx.)

These mix proportions per cubic yard may be varied depending on the gradation of the coarse aggregate.

EXHIBIT C

Location Changes, Scientific and Military Structures

LOCATION CHANGES (Continued)

STATION	RELOCATION OR REINSTATEMENT	DELETION	CANCELLATION	TOTAL CHANGES
592b	1	-	-	1
592c	2	-	-	2
592d	1	-	-	1
593a	1	-	-	1
593b	1	-	-	1
593c	1	-	-	1
178	1	-	-	1
180	1	-	-	1
78	1	1	-	2
79	1	-	-	1
95h	1	-	-	1
813	2	-	-	2
5	2	-	-	2
32b	-	1	-	1
32d	2	-	-	2
32e	-	1	-	1
32f	-	1	-	1
32g	-	1	-	1
32h	-	1	-	1
32i	-	1	-	1
32j	-	1	-	1
32k	-	1	-	1
32l	-	1	-	1
131	-	1	-	1
132a	-	1	-	1
132b	-	1	-	1
132c	-	1	-	1
132d	-	1	-	1
132e	-	1	-	1
132f	-	1	-	1
132g	-	1	-	1
133	-	1	-	1
140a	-	1	-	1
140b	-	1	-	1
141a	-	1	-	1
141b	-	1	-	1
144	-	1	-	1
142a	-	1	-	1
130	-	1	-	1
592e	-	1	-	1
142b	-	1	-	1
142c	-	1	-	1
143	-	1	-	1
Eberiru-Aomon Group				
132g	1	-	-	1
132b	1	-	-	1

LOCATION CHANGES (Continued)

STATION	RELOCATION OR REINSTATEMENT	DELETION	CANCELLATION	TOTAL CHANGES
132c	1	-	-	1
132d	1	-	-	1
132e	1	-	-	1
132f	1	-	-	1
142a	1	-	-	1
142b	1	-	-	1
142c	1	-	-	1
4218	1	-	-	1
4220	1	-	-	1
4221	1	-	-	1
4221a	1	-	-	1
812	1	-	-	1
3	3	-	-	3
32h1	-	1	-	1
42	-	1	-	1
181	-	1	-	1
Engebi				
71d	1	-	-	1
74h	1	-	-	1
80d	1	-	-	1
90e	1	-	-	1
90f	1	-	-	1
120a	1	-	-	1
120b	1	-	-	1
120c	1	-	-	1
120d	1	-	-	1
120e	1	-	-	1
121a	1	-	-	1
121b	1	-	-	1
121c	1	-	-	1
121d	1	-	-	1
121e	1	-	-	1
123	1	-	-	1
124	-	1	-	1
132a	1	-	-	1
133	2	-	-	2
134	1	-	-	1
132g	2	-	-	2
132b	1	-	-	1
132c	1	-	-	1
132d	1	-	-	1
132e	1	-	-	1
132f	1	-	-	1
141a	1	-	-	1
141b	1	-	-	1
142c	1	-	-	1

LOCATION CHANGES (Continued)

STATION	RELOCATION OR REINSTATEMENT	DELETION	CANCELLATION	TOTAL CHANGES
143	1	-	-	1
144a	1	-	-	1
144b	1	-	-	1
145	1	-	-	1
146	1	-	-	1
301i	1	-	-	1
301j	1	-	-	1
302a	1	-	-	1
302b	1	-	-	1
302c	1	-	-	1
302d	1	-	-	1
303a	1	-	-	1
321a	1	-	-	1
321b	1	-	-	1
324b	1	-	-	1
5151	1	-	-	1
5152	1	-	-	1
5161	1	-	-	1
5162	1	-	-	1
5163	1	-	-	1
6101	1	-	-	1
6102	1	-	-	1
6103	1	-	-	1
6104	1	-	-	1
6321	2	-	-	2
6322	1	-	-	1
6323	1	-	-	1
6341	1	-	-	1
6342	1	-	-	1
771	1	-	-	1
3	3	-	-	3
4	1	-	-	1
16 - o	1	-	-	1
21c	1	-	-	1
22a	1	-	-	1
22b	1	-	-	1
23a	1	-	-	1
23b	1	-	-	1
27a	1	-	-	1
27b	1	-	-	1
32a	1	-	-	1
32b	1	-	-	1
32c	1	-	-	1
32d	1	-	-	1
33a	2	-	-	2
33b	2	-	-	2
36e	1	-	-	1

LOCATION CHANGES (Continued)

STATION	RELOCATION OR REINSTATEMENT	DELETION	CANCELLATION	TOTAL CHANGES
36f	1	-	-	1
39a	1	-	-	1
39b	1	-	-	1
50a	1	-	-	1
52	1	-	-	1
592a	2	-	-	2
592c	3	-	-	3
593b	2	-	-	2
593c	3	-	-	3
160	1	-	-	1
166	1	-	-	1
811	2	-	-	2
181	-	1	-	1
142a	-	1	-	1
142b	-	1	-	1
592e	1	1	-	2
80a	-	1	-	1
5	-	1	-	1
622	-	1	-	1
621	1	1	-	2
429	1	-	-	1
2	1	-	-	1
3	1	-	-	1
4	1	-	-	1
5	3	-	-	3
8	1	-	-	1
9	1	-	-	1
10	1	-	-	1
11	1	-	-	1
12	1	-	-	1
14	2	-	-	2
15	1	-	-	1
16	2	-	-	2
17	2	-	-	2
Piiraai				
4223	3	-	-	3
Teiteiripucchi				
60	1	-	-	1
61	1	-	-	1
62	1	-	-	1
63	1	-	-	1

LOCATION CHANGES (Continued

STATION	RELOCATION OR REINSTATEMENT	DELETION	CANCELLATION	TOTALS CHANGES
4216	1	-	-	1
628	-	1	-	1
Muzin				
91e	1	-	-	1
4212a	1	-	-	1
5171	1	-	-	1
5172	1	-	-	1
80e	1	1	-	2
301d	1	-	-	1
301f	1	-	-	1
301g	1	-	-	1
302e	1	-	-	1
302g	1	-	-	1
625	-	1	-	1
302h	1	-	-	1
302j	1	-	-	1
302k	1	-	-	1
302m	2	-	-	2
302n	2	-	-	2
302p	1	-	-	1
302q	1	-	-	1
623	2	-	-	2
80	-	1	-	1
327b	1	-	-	1
333	1	-	-	1
334	1	-	-	1
335b	2	-	-	2
4211	1	-	-	1
624	2	-	-	2
Kirinian				
77	2	-	-	2
625	2	-	-	2
625b	1	-	-	1
625c	1	-	-	1
626	1	-	-	1
519	-	1	-	1
Bogombogo				
774	-	1	-	1
Eberiru-Aomon Group				
2	1	-	-	1
4	1	-	-	1
5	2	-	-	2
8	1	-	-	1
10	1	-	-	1

LOCATION CHANGES (Continued)

STATION	RELOCATION OR REINSTATEMENT	DELETION	CANCELLATION	TOTAL CHANGES
28K	1	-	-	1
30a	1	-	-	1
30b	2	-	-	2
30c	2	-	-	2
32e	1	-	-	1
36a	1	-	-	1
36c	1	-	-	1
50d	3	-	-	3
51d	3	-	-	3
173	2	-	-	2
174	1	-	-	1
70h	-	1	-	1
70i	-	1	-	1
70k	-	1	-	1
70l	-	1	-	1
70m	-	1	-	1
70n	-	1	-	1
70p	-	1	-	1
70q	-	1	-	1
70r	-	1	-	1
70s	-	1	-	1
70t	-	1	-	1
70u	-	1	-	1
70v	-	1	-	1
70x	-	1	-	1
70y	-	1	-	1
70z	-	1	-	1
71a	-	1	-	1
71b	-	1	-	1
71c	-	1	-	1
71e	-	1	-	1
71g	1	-	-	1
73a	1	-	-	1
73b	1	-	-	1
73c	1	-	-	1
73d	1	-	-	1
73e	1	-	-	1
73f	1	-	-	1
73g	1	-	-	1
73h	1	-	-	1
80a	-	1	-	1
80b	-	1	-	1
80e	-	1	-	1
120a	1	-	-	1
120b	1	-	-	1
120c	1	-	-	1
120d	2	-	-	2

LOCATION CHANGES (Continued)

STATION	RELOCATION OR REINSTATEMENT	DELETION	CANCELLATION	TOTAL CHANGES
120e	2	-	-	2
121a	1	-	-	1
121b	1	-	-	1
121c	1	-	-	1
121d	2	-	-	2
121e	2	-	-	2
123	2	-	-	2
125	1	-	-	1
132a	1	-	-	1
133	1	-	-	1
Bogon				
627	-	1	-	1
628	-	1	-	1

EXHIBIT D

Summary of Engineering Change Orders Issued at Jobsite

SUMMARY OF ENGINEERING CHANGE ORDERS ISSUED AT JOBSITE

NO.	DESCRIPTION	ESTIMATED NET COST
1	Shower Drains - 11 Buildings - Parry	$1,335
2	Change Sewer Connection - Parry	100
3	Sinks in Animal Quarters - Japtan	215
4	Floor and Curb in Mess Hall Kitchen - Parry	100
5	Relocate Underground Piping - Parry	100
6	Relocate Facilities - Brookhaven and Sandstone - Parry	855
7	Relocate Ice Machine - Parry	100
8	Relocate Ducts and Hood in Mess Hall - Parry	100
9	Patching Walk-in Reefers - Parry	775
10	Salt Water Intake - Parry	5,455
11	Lower Toilet and Shower Floors - Parry	7,455
12	Relocate Boat Repair Building - Parry	100
13	Extent 12' to Nurses Quarters - Parry	3,385
14	Drain Pans in Mess Hall Reefers - Parry	280
15	Garbage Can Wash House - Parry	3,170
16	Relocate Parking Area and Sewer Line - Parry	100
17	Cancelled	-
18	Power Plant - LLC By-pass - Parry	150
19	Substitute Aluminum Pipe for Plastic - Parry	1,240
20	Modification to Electrical Overhead Distribution - Engebi	100
21	Pipe Trench Booster Pump Station - Japton	350
22	Cancelled	-

ENGINEERING CHANGE ORDER (Continued)

NO.	DESCRIPTION	ESTIMATED NET COST
23	Alternate Piping, Power House - Parry & Japtan	$100
24	Rearrangement of Piling - The Aomon Group	8,585
25	Modification of DUKW Repair Shop - Parry	335
26	Footings, Power and Distribution Plants - Runit, The Aomon Group, Engebi	780
27	Underground Piping Waste Lines - Japtan	100
28	Transformers, Rad-Safe Building - Parry	750
29	Relocate Telephone Pole - Parry	100
30	Sewer Lines and Traps - Japtan	160
31	Revise F. M. Diesel Engine Piping - Parry	100
32	Rearrangement of Exhaust Ducts - Runit, The Aomon Group, Engebi & Japtan	100
33	Modification of Water Lines - Japtan	100
34	Modification of Trans. and Rec., Power House - Eniwetok	495
35	Rearrangement Electrical in Barracks - Parry	100
36	Relocate 3" Supply Fuel Line - Parry	100
37	Relocation of Facilities, Fire Station - Parry	370
38	Boat Repair Shop Slabs - Parry	2,390
39	Recreation Area - Parry	575
40	Protect Runways - On Causeway - The Aomon Group	1,560
41	Ground All Buildings - Parry, Runit, The Aomon Group, Engebi, Japtan	1,775
42	Receiver Building Conduit - Eniwetok	100
43	P. O. L. Dykes - Parry	100
44	Electrical Change, Infirmary - Parry	100

ENGINEERING CHANGE ORDERS (Continued)

NO.	DESCRIPTION	ESTIMATED NET COST
45	Playground Area - Parry	$455
46	Plumbing Changes - Bar and Barber Shop - Parry	100
47	Move Ice Machine and Erect Shelter - Parry	300
48	Revise Water Lay Out - Runit	1,715
49	Rearrange Piling - The Aomon Group	100
50	Snack Bar Counters, Etc. - Parry	780
51	Marine Ramp - Parry	15,445
52	Air Strip and Parking Improvements - Runit, The Aomon Group, Engebi	78,350
53	Additional Water and Sewer Services - Japtan	4,590
54	Extension to Reefer Building - Parry	12,525
55	Causeway - The Aomon Group	1,780
56	Exhaust Hood in Snack Bar - Parry	255
57	Acid Tank House and Pumps - Parry, Runit, The Aomon Group, Engebi, Japtan	9,940
58	Maintenance Warehouse - Modification Building 313 - Parry	1,355
59	Bins and Plumbing - Buildings 400 and 402 - Parry	15,180
60	Install Weather Proof Pugs - Cargo Pier - Parry	1,480
61	Camp Extension - Engebi	240,500
62	Rigging Loft Building - Parry	775
63	Relocate Mess Hall - Runit	100
64	Relocate Control Cubicle - Japtan	120
65	Small Craft Landing Float - The Aomon Group	100
66	Rip-Rap Fill - P. O. L. Area - Parry	1,745

ENGINEERING CHANGE ORDERS (Continued)

NO.	DESCRIPTION	ESTIMATED NET COST
67	Temporary Warehouse - Engebi	$17,575
68	Warning Light Panel with Horn - Parry, Runit, The Aomon Group, Engebi, Japtan	1,200
69	Alter Autopsy Building - Japtan	1,405
70	Fence Winch Bases - Runit, The Aomon Group, Engebi	385
71	Revise Footings - 75' Towers - Tower-Site Southeast of Runit, Piiraai, Bokonaarappu, Teiteiripucchi	1,940
72	Walk and Ramp - Reefer Building - Parry	1,440
73	Insulate Floor from Engine Slab - Runit & The Aomon Group	200
74	Rearrange Mess Hall Boiler House - Runit, The Aomon Group, Engebi, Japtan	915
75	Insulation in Power Houses - Parry, Runit, The Aomon Group, Engebi	100
76	Pressure Reducing Station Power House - Japtan	200
77	Garbage Storage Shed - Runit, The Aomon Group, Engebi, Japtan	1,910
78	Fuel Oil Storage - Japtan	1,075
79	Ventilation - Building 212B - Parry	100
80	Electrical Crypt Vault - Parry	440
81	Screen Pen Covers - Japtan	3,245
82	Water Storage Power House - Engebi	585
83	Covered by Work Authorization No. 50-507-13	-
84	Covered by Change Order No. 61	-
85	Finish Paint Tower - Engebi	690
86	Screen Entrance to Mess Hall - Japtan	435

ENGINEERING CHANGE ORDERS (Continued)

NO.	DESCRIPTION	ESTIMATED NET COST
87	Salt Water Outlets - Mess Hall - Japtan	$185
88	Fresh Water Connection - Mouse House - Japtan	325
89	Stand for Chlorinator Tanks - Japtan	115
90	Drinking Fountain - Power House - Japtan	385
91	Replace Submarine Cable - Runit & The Aomon Group	5,375
92	Light Proof Rad-Safe Building - Parry	555
93	Light Proof Photo Laboratory - Parry	125
94	Erect Test Laboratory - Engebi	5,185
95	Concrete Foundations - Japtan	530
96	Pier Extension - The Aomon Group	3,510
97	P. O. L. Fire Protection and Fencing - Parry	6,310
98	Ventilators in Mess Hall - Japtan	100
99	Covered by Work Authorization No. 50-507-13	-
100	Theater Shelter and Platform - Parry	3,295
101	Electrical Service to Instrument Laboratory - Parry	405
102	Salt Water Outlets - Mess Hall - Runit & The Aomon Group	125
103	Thermal Building - Japtan	580
104	Mess Hall Equipment - Runit & The Aomon Group	2,140
105	Miscellaneous Work Request - Japtan	200
106	Miscellaneous Work Request - Japtan	2,960
107	Suction Line - S. W. Pump House - Parry	590
108	Exhaust Header - Power House - Runit, The Aomon Group, Engebi	100
109	Header Piping - Power House - Runit	100

ENGINEERING CHANGE ORDERS (Continued)

NO.	DESCRIPTION	ESTIMATED NET COST
110	Salt Water Storage - Japtan	$610
111	90° L's in Vertical Tanks - Parry & Eniwetok	1,015
112	Salt Water Well - Runit	1,980
113	Salt Water Well - The Aomon Group	1,980
114	Refreshment Bar - Parry	1,345
115	Awning Extension - Animal Runs - Japtan	4,240
116	Painting Crypto Vault - Parry	205
117	Covered by Military Structures Estimate	-
118	Enlarge Door Opening - Building 322 - Parry	215
119	Screened Entrances - Mess Hall - Runit & The Aomon Group	870
120	Marine Borer Check Logs - Parry, Runit, The Aomon Group, Eniwetok	495
121	Additional Comm. Req. T. F. Building 221 - Parry	6,150
122	Causeway - Aomon to Ebiriru	53,080
123	Wash Room Facilities - Building 406 - Parry	1,115
124	Fresh Water Line - Cargo Pier - Parry	1,055
125	Water Line - Camp Office - Parry	310
126	Tin Coat Autopsy Tables - Japtan	270
127	Rev. Ad. Building 208 - Parry	785
128	Field Office - Construction - The Aomon Group	320
129	Personnel Department Quonset - Parry	5,865
130	Gym and Radio Quonsets - Parry	8,860
131	Photo Lab Revision - Parry	475
132	Repair and Relocate Nine Quonsets - Parry	45,805

ENGINEERING CHANGE ORDERS (Continued)

NO.	DESCRIPTION	ESTIMATED NET COST
133	Additional Tents - The Aomon Group	$6,455
134	Construction Road - The Aomon Group	1,015
135	Move Old Mess Hall to Biijiri - The Aomon Group	210
136	Additions to Mess Hall - Engebi	~~600~~
137	Repair Float and Light Ext. Personnel Pier - Parry	1,050
138	Protective Shelter Over Reefers - Runit & The Aomon Group	2,210
139	Relocate Station 42 - Site Eberiru to Runit The Aomon Group	490
140	Install Fencing - Warehouse Building #320 - Parry	1,245
141	Extend Intake Ducts - Power House - Runit, The Aomon Group, Engebi	1,190
142	Construct Addition to Mess Hall - The Aomon Group	1,110
143	Additional to Slab for Reefer - Mess Hall - Runit	105
144	Fire Hose Shelters - P. O. L. - Parry	80
145	Install Septic Tank - Building 329 - Parry	1,115
146	Construct Chill Storage Building - Parry	33,175
147	Covered by C. M. R. Estimate	-
148	Construct Concrete Reservoir - Parry	28,690
149	Install Salt Water Well - Engebi	3,385
150	Install (3) Transformers - Photo Lab. - Parry	1,830
151	Relocate Sink - X-Ray Building - Japtan	250
152	Construct Wood Frame Building - X-Ray Gen. - Japtan	1,420
153	Included in E-Plus Estimate	-
154	Maint. and Repair Tower - Tower-Site Southeast of Runit, Piiraai, Bokonaarappu, Teiteiripucchi, Coral Head	4,005

ENGINEERING CHANGE ORDERS (Continued)

NO.	DESCRIPTION	ESTIMATED NET COST
155	Construct New Sewer Outfall - Parry	$4,465
156	Repair Cargo Pier - Parry	2,080
157	Additional Tents - Runit	5,385
158	Tents for Housing Dry Stores - Japtan	2,155
159	Additional Tents - The Aomon Group	5,385
160	Additional Tents - Engebi	16,185
161	Install Ladders - Pier - Engebi	195
162	Rearrange Lights - Wash Rooms - Parry	450
163	Construct New Cargo Pier - Japtan	39,445
164	Add Water Cooled Condenser - Photo Lab. - Japtan	1,300
165	Move Screen - Construct New Seats - Movie - Parry	2,935
166	Add Drain Line - Mess Hall Roof Down Spouts - Parry	1,000
167	Construct Two Beach Houses - Parry	7,570
168	Install 2 25-KVA Transformers - Building 102 - Runit	1,950
169	Convert Vegetable Storage Building to Marine Parts Repair - Parry	2,425
170	Construct New Cargo Pier - The Aomon Group	19,195
171	Rehabilitate Quonsets - 404 and 405 - Warehouse 1 and 2 - Parry	16,595
172	Additional Recreation Facilities - Parry	4,845
173	Replace Insulation - Chilled Water Tank - Building 210 - Parry	475
174	Additional Telephone Facilities - Parry	850
175	Construct Navigation Air Tower - Japtan	1,070
176	Construct Shelters for Crash Jeeps - Parry, Runit, The Aomon Group, Engebi	500

ENGINEERING CHANGE ORDERS (Continued)

NO.	DESCRIPTION	ESTIMATED NET COST
177	Construct Additional P. O. L. Storage Facilities - Parry	$49,660
178	Change Air Duct Discharge - Power Houses - Runit, The Aomon Group, Engebi	270
179	Delete Latrine Doors - Barracks Buildings - Parry & Japtan	-
180	Additional Theater Seating - Engebi	2,205
181	Cancelled	-
182	Additions to Building 209 - East Wing - Parry	9,740
183	Install Air Craft Tie Down Facilities - Parry, Runit, The Aomon Group, Engebi	595
184	Install Water Cooler - Exclusion Area - Parry	440
185	Cancelled - Transferred work to Job 5	-
186	Additional Recreation Facilities - Runit	875
187	Install Locks on Dark Room Doors - Building 210 - Parry	280
188	Install Counter - Security Office - Building 205 - Parry	275
189	Covered by Scientific Structures Estimate	-
190	Install New Piping - Salt Water Pump House - Parry	810
191	Install Exhaust Ventilator - Building 51 - Japtan	705
192	Repairs to Air Strip - Parry	7,190
193	Install Lighting System - Cargo Pier - Parry	515
194	Relocate Road - Parry	190
195	Convert Steel Lockers to Hot Lockers - Parry	1,720
196	Modify Grease Rack - Japtan	535
197	Modify Grease Rack - The Aomon Group	535

ENGINEERING CHANGE ORDERS (Continued)

NO.	DESCRIPTION	ESTIMATED NET COST
198	Delete Canopy - Building 409 - Parry	-
199	Modify Existing Quonsets - Parry	$1,680
200	Erect (5) Additional Tents - The Aomon Group	5,385
201	Additions - Mess Hall Scullery - Parry	5,675
202	Auxiliary Reefer Foundations - Parry	760
203	Shielding X-Ray Room - Japtan	530
204	Construct Hot Locker and Shelving - Building 210 - Parry	415
205	Navigational Aids - Runit, The Aomon Group, Engebi	2,235
206	Construct Dispatchers Office - Parry	2,015
207	Erect Tent - Dispatchers Office - Air Strip - Runit	945
208	Erect (2) Tents - Dispatchers Office - Air Strip - Engebi	1,860
209	Additions to Mess Hall Galley - Parry	41,765
210	Remodel Quonset - Guard and Mimeograph Sections - Parry	1,285
211	Install Partition - Building 209 - Parry	420
212	Repairs to Air Strip - Engebi	990
213	Remove 100' Steel Tower - Parry	575
214	Covered by Change Order No. 177	-
215	Modify Building 209 - Parry	700
216	Modify Grease Rack - Runit	535
217	Construct Addition to Laundry - Parry	44,405
218	Construct 30 Limonite Blocks - Runit, The Aomon Group, Engebi	40,455
219	Install Evacuation Warning Sirens - Parry & Japtan	290

ENGINEERING CHANGE ORDERS (Continued)

NO.	DESCRIPTION	ESTIMATED NET COST
220	Additions to Building 204 - Parry	$16,465
221	Additions to Fraternal Hall and Beach Houses - Parry	1,980
222	Channel and Turning Basin - Engebi	48,955
223	Steel Bracing - 200' Tower - The Aomon Group	1,775
224	Cancelled	-
225	Cancelled	-
226	Covered by Job 5 Estimate	-
227	Install Additional Electric Equipment and Power Recep. - Japtan	1,900
228	Install Fresh Water Recirculating System Reefer Bank - Parry	1,685
229	Relocate Instrument Piers - Building 3.3.8h - Muzin	790
230	Temporary Distillation Units and Shed - Parry	8,680
231	Reefer Shelter - Building 210 - Parry	840
232	Primary Fuse Installation - Stations 6A and 6B - Runit	420
233	Primary Fuse Installation - Stations 6A and 6B - The Aomon Group	845
234	Install Dehumidification Equipment - Building 329 - Parry	5,435
235	Construct Camera Shelter Supports - Stations 183-184 - Runit	430
236	Covered by Change Order No. 185	-
237	Covered by Estimate for Job 5	-
238	Addition to Butcher Shop - Parry	350
239	Determine and mark M-Boat Channel to Eberiru - The Aomon Group	2,615
240	Modify Electrical Service and Wiring - Parry	4,670

ENGINEERING CHANGE ORDERS (Continued)

NO.	DESCRIPTION	ESTIMATED NET COST
241	Primary Fuse Installation - Engebi	$420
242	Relocate Stations 77 and 625 - Kirinian	2,445
243	Cancelled	-
244	Construct Garbage Can Wash House - Parry	2,275
245	Construct Power House Access Tunnel - Engebi	1,320
246	Repair Air Conditioning System - Station 69 - Engebi	445
247	Extend Airstrip and Move Dispatchers Shack - Engebi	1,430
248	Modify V-Beam Siding - Building 3.1.1 - Engebi	1,330
1A	Theater Benches - Eniwetok	100
2A	Tents - Eniwetok	100
3A	Cargo Piers - Eniwetok	4,390
4A	Sewer Lines - Eniwetok	100
5A	Sewer and Water Lines - Eniwetok	100
6A	Electrical Grounds - Eniwetok	625
7A	Buildings 18, 19, 20, and 21 - Eniwetok	100
8A	Water Storage - Eniwetok	100
9A	Building 33 - Eniwetok	100
10A	Sewer Lines, Building 16 - Eniwetok	370
11A	Telephone Circuits - Eniwetok	100
12A	Building 14 and Electrical Distribution - Eniwetok	100
13A	Mess Hall - Eniwetok	1,245
14A	Dispensary - Eniwetok	1,200
15A	Transformer Pad and Fence - Eniwetok	100

ENGINEERING CHANGE ORDERS (Continued)

NO.	DESCRIPTION	ESTIMATED NET COST
16A	Transformer Pad - Eniwetok	$250
17A	Pump House - Eniwetok	100
18A	Water System - Eniwetok	100
19A	Tank Support - Eniwetok	695
20A	Acid Tank and Pump - Eniwetok	1,895
21A	Transformers - Eniwetok	100
22A	Latrines - Eniwetok	100
23A	Power Plant Elec. - Eniwetok	245
24A	Power Plant Heat Exch. - Eniwetok	100
25A	Theater - Eniwetok	985
26A	Dispensary - Eniwetok	100
27A	Sewer Lines - Eniwetok	100
28A	Rehabilitation of Buildings - Eniwetok	7,870
29A	Ventilation Ducts - Eniwetok	100
30A	Sewer Lines - Eniwetok	100
31A	Electrical Service in Theater - Eniwetok	100
32A	Power House - Eniwetok	730
33A	Mess Hall Hood - Eniwetok	520
34A	Eave Support - Eniwetok	375
35A	Sewer System - Eniwetok	605
36A	Electrical Distribution - Eniwetok	16,050
37A	Catch Basin - Eniwetok	125
38A	Explosive Storage - Eniwetok	100
39A	Dispensary Partitions - Eniwetok	2,145

ENGINEERING CHANGE ORDERS (Continued)

NO.	DESCRIPTION	ESTIMATED NET COST
40A	Hood for Snack Bar - Eniwetok	$405
41A	Electrical Distribution - North End - Eniwetok	480
42A	Section Line - S. W. Pump - Eniwetok	590
43A	Dispensary Changes - Eniwetok	100
44A	Screened Enclosures - Eniwetok	570
45A	Ventilation - Water Heater Room Disp. - Eniwetok	100
46A	Conduit Across Runway - Construction Change - Eniwetok	18,375
47A	Exhaust Hood for Bake Oven - Eniwetok	855
48A	Construction Change - Aircraft Parking and Taxiway - Eniwetok	1,770
49A	Revision of Laundry Plan and Equipment - Eniwetok	100
50A	Pot Racks for Mess Hall - Eniwetok	590
51A	Emergency Generator Building 143 - Eniwetok	100
52A	Airstrip Paving (150' x 3000' x 2-1/2") - Eniwetok	76,240
53A	Relocation of Tank in Laundry Boiler Room - Eniwetok	345
54A	Addition of Auxiliary Boiler and Fuel Oil Tank - Eniwetok	5,850
55A	Asphalt Paving of Roads - Eniwetok	14,195
56A	Elevating Fire Hydrants - Eniwetok	100
57A	Canopies for Electrical Panel Boards and Drip Pans for Refrigerators - Eniwetok	100
58A	Power and Water Distillation Plant - Eniwetok	4,115
59A	Asphalt Paving of Roads - Eniwetok	16,560
60A	Mess Hall Reefer Boxes - Eniwetok	110
61A	Sub. Larger Transformers - Eniwetok	4,400

ENGINEERING CHANGE ORDERS (Continued)

NO.	DESCRIPTION	ESTIMATED NET COST
62A	Install Water Sprayers - Laundry - Eniwetok	$590
63A	Delete Latrine Doors - Eniwetok	-
64A	Additional Water Storage - Laundry - Eniwetok	100
65A	Increase Laundry Stacks - Eniwetok	420
66A	Salt Water Pump Station - Eniwetok	260
67A	Electrical Distribution System - Eniwetok	4,530
68A	Additions and Alterations to TG 3.4 Conference Room - Eniwetok	2,125
69A	Auxiliary Salt Water Pump Station - Eniwetok	3,825
70A	Alterations to Loran Station - Building 116 - Eniwetok	100
71A	Extend Truck Fill Arms in P. O. L. Area - Eniwetok	-
72A	Ground S. W. Service Lines - Eniwetok	-
73A	Adjust Manholes to Grade - Sewer System - Eniwetok	100
74A	Construct Landing Stage at Personnel Pier - Eniwetok	395
75A	Install (5) Fresh Water Tanks - Eniwetok	34,710
76A	Install (3) Warning Sirens - Eniwetok	365
77A	Alterations to Building 90 - Eniwetok	775
78A	Pave 110,000 square feet of Warm-up Area - Eniwetok	3,080
79A	Construct Camera Housing - Building 90 - Eniwetok	150
80A	Add Showers - Building 125 - Eniwetok	765
81A	MSQ-1 Radar Sites - Eniwetok	490

EXHIBIT E

Drawing Record of Military Structures

DESIGN DRAWINGS

ARMY SPECIAL MILITARY STRUCTURE~~S~~ 3.1.3--UNDERGROUND SHELTER
Drawing Number 60-09-11, Sheets 1 to 3, Inclusive

ARCHITECT - ENGINEER: Ammann & Whitney, New York City, New York

SHT. NO.	DATE 1950	REV. NO.	DATE 1950	DATE RECD BY H & N	DESCRIPTION
1	1-24	--	--	1-30-50	Underground Test Shelter - General Plans, Sections and Details.
		A	3-17	3-20-50	Added two Air Locks, removed recess for Filter Frame and Exhaust.
		B	7-6	7-11-50	Added Reinforcing Bars in Parapet.
2	1-24	--	--	1-30-50	Underground Test Shelter - Concrete and Reinforcing Details.
		A	3-17	3-20-50	Added Air Lock Details.
		B	4-20	4-26-50	Increased quantity of Reinforcing Bars in walls, roof and floor.
		C	7-6	7-11-50	Changed Air Lock construction from Douglas Fir to Plywood.
		D	7-28	7-30-50	No Structural change.
3	1-24	--	--	1-30-50	Underground Test Shelter - Door Details.
		A	3-17	3-20-50	Changed Hinge Straps. Specified Latch and Hinges.
		B	7-6	7-11-50	Revised Welding at Door Sill and Lintel.

DESIGN DRAWINGS

ARMY SPECIAL MILITARY STRUCTURE 3.1.1 — MULTI-STORY BUILDING
Drawing Number 60-09-06, Sheets 1 to 13, inclusive

ARCHITECT - ENGINEER: Ammann and Whitney, New York City, New York

SHT. NO.	DATE 1950	REV. NO.	DATE 1950	DATE RECD BY H & N	DESCRIPTION
1	1-24	—	—	1-30-50	Key plans and elevations of Multi-Story Building.
		A	3-17	3-20-50	Revised foundations of Buildings 1,2,6 and 7.
		B	7-6	7-11-50	Corrected error in dimension of Building 4.
2	1-24	—	—	1-30-50	Buildings 1 and 7 - Concrete plans and details.
		A	3-17	3-20-50	Revised edge of footing at line 17 of Building 7, Extended
					keyway for full length of wall on line 17 of Building 7.
		B	7-6	7-11-50	Changed length of column base bolts from 3'-3" to 2'-3" on line
					20 of Building 7.
3	1-24	—	—	1-30-50	Buildings 1 and 7 - Interior wall elevations, sections and
					details.
		A	3-17	3-20-50	Deleted alternate 5/8"0 horizontal bars at sides of access
					openings in rear walls of Buildings 1 and 7. Deleted 2'-0" from
					width of footing at line 4 of Building 1 and line 17 of
					Building 7.
		B	7-6	7-11-50	Added details showing method of fastening corrugated asbestos
					siding at side and rear of Building 7.
4	1-24	—	—	1-30-50	Building 1 - Test panels, elevations and details.
		A	5-19	7-11-50	Added details showing method of fastening V-beam siding at
					front of Building 7.

DESIGN DRAWINGS

SHT. NO.	DATE 1950	REV. NO.	DATE 1950	DATE RECD. BY H & N	DESCRIPTION
5	1-24	—	--	1-30-50	Building 7 - Test Panels, Elevations and Details.
		A	7-6	7-11-50	Changed Spacing of Anchor Bolts to correspond to
					Corrugation Intervals in Asbestos Siding of Building 7.
					Noted size of Wall Dowels at Lines D and 20 of Building 7.
6	1-24	—	—	1-30-50	Buildings 2 & 6 - Concrete Plans and Details.
		A	3-17	3-20-50	Revised Footing in Buildings 2 & 6 to eliminate Transverse
					Beams and deepen entire Footing from 3'-0" to 5'-0".
					Revised spacing of Anchor Bolts to avoid interference with
					Column Flanges and permitted Substitution of Reinforcing
					Bars of equivalent area and bond.
		B	5-6	5-9-50	Deleted Anchor Bolt Sleeves in Buildings 2 & 6. Revised
					spacing of Bottom Steel in Buildings 2 & 6.
		C	7-6	7-11-50	Changed size of Anchor Bolt Bar. Changed spacing of Column
					Bolts at 2nd and 3rd Floors.
7	1-24	—	—	1-30-50	Buildings 2 & 6 - Structural Sections and Details.
		A	3-17	3-20-50	Increased size of Steel Columns and Beams.
		B	7-6	7-11-50	Changed size and thickness of Stiffener Plates.
8	1-24	—	—	1-30-50	Buildings 2 & 6 - Wall Elevations, Sections and Details.
		A	3-17	3-20-50	No Structural Changes.
		B	7-6	7-11-50	No Structural Changes.
9	1-24	—	--	1-30-50	Buildings 3 & 5 - Concrete Plans and Details.
		A	3-17	3-20-50	Revised Spacing and Lap of top and bottom Steel in 2nd and

DESIGN DRAWINGS

SHT. NO.	DATE 1950	REV. NO.	DATE 1950	DATE RECD. BY H & N	DESCRIPTION
					3rd floor and Roof Slabs of Buildings 3 & 5. Changed
					size and quantity of Steel in Floor Girders.
		B	7-6	7-11-50	Added access opening in 2nd and 3rd Floor Slabs.
		C	7-28	7-30-50	Changed Stirrup Spacing in Transverse Roof Girders.
10	1-24	—	—	1-30-50	Building 4 - Concrete Plans and Details.
		A	7-6	7-11-50	Increased size of Reinforcing Bars in foundation of
					Building 4.
		B	7-28	7-30-50	Changed Stirrup Spacing in Floor and Roof Girders.
11	1-24	—	—	1-30-50	Buildings 3,4 & 5 - Wall Elevations, Sections and Details.
		A	3-17	3-20-50	Increased size of Reinforcing Bars in wall of Building 3.
		B	5-7	5-9-50	Increased size of Reinforcing Bars in wall of Building 5.
		C	7-6	7-11-50	Added Wall Dowels in Building 5.
12	1-24	—	—	1-30-50	Buildings 3,4 & 5 - Column schedule, Wall Elevations and
					Details.
		A	3-17	3-20-50	Increased quantity of Vertical Steel in Column Reinforcing.
					Changed Stirrups from round to square core.
		B	7-6	7-11-50	Changed Radius of Bend in Column Dowels.
13	1-24	—	—	1-30-50	Location plan for Survey Points and Access Way.
		A	3-17	3-20-50	Increased size of Nails in Live Load Straps.
		B	6-9	6-12-50	Changed Survey Point Locations and Detail.
		C	7-6	7-11-50	Added Survey Points on right Elevation.

DESIGN DRAWINGS

ARMY SPECIAL MILITARY STRUCTURES PROGRAM
SPECIFICATIONS

ARCHITECT - ENGINEER: Prepared by Ammann & Whitney, New York City, New York

SHT. NO.	DATE 1950	REV. NO.	DATE 1950	DATE RECD BY H & N	DESCRIPTION
1-33	12-30	--	----	1-30-50	Specifications for Test Structures prepared under the direction
					of the Officer of the Chief of Engineers.
		1	----	7-14-50	Addendum Number 1 and Errata.

DESIGN DRAWINGS

ARMY SPECIAL MILITARY STRUCTURES
CONSTRUCTION SKETCHES

ARCHITECT - ENGINEER: Holmes & Narver, Inc. Construction Department

SHT. NO.	DATE 1950	REV. NO.	DATE 1950	DATE RECD BY H & N	DESCRIPTION
6	4-5	—	—	—	Reinforcing Substitution - Bars in Footings.
		1	4-27	6-9-50	
14	8-15	—	—	8-28-50	Reinforcing Substitution - Bars in Columns.
21	12-26	—	—	—	Fiberglass Sealing Strips.
22	12-27	—	—	—	Fiberglass Sealing Strips.
					NOTE: Drawings 21 & 22 were initiated and approved by
					Holmes & Narver Construction Department.

SHOP DRAWINGS

ARMY SPECIAL MILITARY STRUCTURE 3.1.3 — UNDERGROUND SHELTER
DESIGN DRAWING 60-09-11, Sheet 3 of 3

SUB-CONTRACTOR: Concolidated Western Steel Corp.: A.J. Bayer Co., Sub-sub-contractor

PURCHASE ORDER NUMBER: 4249 **DATE ISSUED:** 3-20-50

MATERIAL: Hollow Metal Door

DRWG. NO.	DATE 1950	REV. NO.	DATE 1950	DATE APP BY A-E	DESCRIPTION
S-1	5-12	—	——	7-17-50	Hollow Metal Door.

SHOP DRAWINGS

ARMY SPECIAL MILITARY STRUCTURE 3.1.3

SUB-CONTRACTOR: American Pipe & Construction Co., Oakland, Calif.

PURCHASE ORDER NUMBER: 4250 **DATE ISSUED:** 3-23-50

MATERIAL: Precast Concrete Pipe

DRWG. NO.	DATE 1950	REV. NO.	DATE 1950	DATE APP. BY A-E	DESCRIPTION
					No Drawings Required.

SHOP DRAWINGS

ARMY SPECIAL MILITARY STRUCTURE 3.1.1 — MULTI-STORY BUILDING
DESIGN DRAWING 60-09-06, Sheets 1 to 13, Inclusive

SUB-CONTRACTOR: Bethlehem Pacific Coast Steel Corp. of San Francisco, California

PURCHASE ORDER NUMBER: 4248 **DATE ISSUED:** 3-20-50

MATERIAL: Reinforcing Steel

DRWG. NO.	DATE 1950	REV. NO.	DATE 1950	DATE APP. BY A-E	DESCRIPTION
1	3-30	—	———	———	Building 1 — Foundations.
		1	4-10	———	
		2	4-24	———	
		3	5-22	6-19-50	
2	3-30	—	———	———	Buildings 2 and 6 — Foundations.
		1	4-24	———	
		2	6-23	———	
		3	6-30	7-7-50	
3	3-30	—	———	———	Buildings 3 and 5 — Foundations.
		1	4-10	———	
		2	4-24	———	
		3	5-22	6-19-50	
4	3-30	—	———	———	Building 4 — Foundations.
		1	4-10	———	
		2	4-24	———	
		3	5-22	6-19-50	
5	3-30	—	———	———	Building 7 — Foundations.

SHOP DRAWINGS

DRWG. NO.	DATE 1950	REV. NO.	DATE 1950	DATE APP. BY A-E	DESCRIPTION
		1	4-10	—	
		2	4-24	—	
		3	5-22	6-19-50	
		4	6-23	—	
		5	6-30	7-7-50	
9	4-18	—	—	—	Building 1 — First story walls.
		1	5-4	6-13-50	
10	4-18	—	—	—	Building 1 - First story walls and second floor slab.
		1	5-4	5-25-50	
		2	6-1	6-13-50	
11	4-18	—	—	—	Building 1 - Second floor slab.
		1	5-4	5-25-50	
		2	6-1	6-13-50	
12	4-18	—	—	—	Buildings 2 & 6 - Second and third floors.
		1	5-4	6-13-50	
13	4-18	—	—	—	Buildings 3 & 5 - First story walls and second floor.
		1	5-4	—	
		2	5-29	—	
		3	6-16	6-28-50	
14	4-18	—	—	—	Building 4 - First Story Walls.
		1	5-4	6-13-50	
		2	8-4	—	

SHOP DRAWINGS

DRWG. NO.	DATE 1950	REV. NO.	DATE 1950	DATE APP. BY A-E	DESCRIPTION
		3	8-23	8-31-50	
15	4-18	—	—	—	Building 7 - First story walls.
		1	5-4	5-25-50	
		1	5-4	6-13-50	
16	4-18	—	—	—	Building 7 - First story walls.
		1	5-4	6-13-50	
17	4-18	—	—	—	Building 7 - Second floor.
		1	5-4	5-25-50	
		2	6-2	6-13-50	
18	5-8	—	—	—	Building 1 - Second story walls.
		1	5-20	6-13-50	
19	5-8	—	—	—	Building 1 - Second story walls, and third floor.
		1	5-20	—	
		2	6-1	6-13-50	
20	5-8	—	—	—	Building 1 - Third floor.
		1	5-20	—	
		2	6-1	6-13-50	
21	5-8	—	—	—	Buildings 3 & 5.
		1	5-20	6-13-50	
22	5-8	—	—	—	Building 4 - Second Story Walls and third floor.
		1	5-20	6-13-50	
23	5-8	—	—	—	Building 7 - Second story walls.

SHOP DRAWINGS

DRWG. NO.	DATE 1950	REV. NO.	DATE 1950	DATE APP. BY A-E	DESCRIPTION
		1	5-20	6-13-50	
24	5-8	—	——	———	Building 7 - Second story walls.
		1	5-20	6-13-50	
25	5-8	—	——	———	Building 7 - Third floor.
		1	5-20	———	
		2	6-2	6-13-50	
26	5-8	—	——	———	Building 1 - Third story walls.
		1	5-20	6-13-50	
27	5-8	—	——	———	Building 1 - Third story walls, and roof.
		1	5-20	———	
		2	6-6	6-13-50	
28	5-8	—	——	6-13-50	Buildings 2 & 6 - Roof.
29	5-8	—	——	———	Buildings 3 & 5 - Third story walls and roof slab.
		1	5-20	6-13-50	
		2	7-14	7-21-50	
		3	8-7	8-18-50	
30	5-8	—	——	———	Building 4 - Third story walls and roof.
		1	5-20	———	
		2	6-13	6-28-50	
		3	7-20	7-21-50	
		4	8-7	8-18-50	
31	5-8	—	——	———	Building 4 - Roof slab.

SHOP DRAWINGS

RWG. NO.	DATE 1950	REV. NO.	DATE 1950	DATE APP. BY A-E	DESCRIPTION
		1	5-20	6-13-50	
32	5-8	--	----	--------	Building 7 - Third story walls.
		1	5-20	6-13-50	
33	5-8	--	----	-------	Building 7 - Third story walls.
		1	5-20	6-13-50	
34	5-8	--	----	-------	Building 7 - Roof.
		1	5-20	-------	
		2	6-6	6-13-50	
10A	6-1	--	----	6-13-50	Building 1 - Second floor slab - Bars at access openings.
		1	6-16	-------	
		2	7-7	7-11-50	
17A	6-2	--	----	6-13-50	Building 7 - Second floor slab - Bars at access openings.
		1	6-16	--------	
		2	7-7	7-11-50	
19A	6-1	--	----	6-13-50	Building 1 - Third floor slab - Bars at access openings.
		1	6-13	-------	
		2	7-7	7-7-50	
		3	7-19	7-21-50	
25A	6-2	--	----	6-13-50	Building 7 - Third floor slab - Bars at access openings.
		1	6-13	-------	
		2	7-7	7-7-50	
27A	6-6	--	----	6-13-50	Building 1 - Roof slab-bars at access openings.

SHOP DRAWINGS

DRWG. NO.	DATE 1950	REV. NO.	DATE 1950	DATE APP. BY A-E	DESCRIPTION
		1	6-13	6-30-50	
34A	6-6	--	----	6-13-50	Building 7 - Roof slab - Bars at access openings.
L-1	7-7	--	----	7-12-50	Building 1 - Second floor slab - Placing plan.
		1	8-16	8-31-50	
		2	9-8	9-15-50	
L-2	7-10	--	----	7-12-50	Buildings 2 & 6 - Second and third floor slabs - Placing
					plan.
		1	8-4	8-18-50	
L-3	7-10	--	----	7-12-50	Buildings 3 & 5 - Second and third floors - Placing plan.
		1	7-21	7-21-50	
		2	8-4	8-18-50	
		3	8-16	8-31-50	
L-4	7-12	--	----	7-12-50	Building 4 - Second floor - Placing plan.
		1	8-23	8-31-50	
L-5	7-11	--	----	7-12-50	Building 7 - Second floor slab - Placing plan.
		1	8-16	-------	
		2	9-8	9-15-50	
L-6	7-12	--	----	7-21-50	Building 1 - Elevation Line 1 - Placing plan.
		1	8-15	-------	
		2	9-8	9-15-50	
L-7	7-12	--	----	7-21-50	Building 1 - Elevation Line A - Placing plan.
		1	8-15	-------	

SHOP DRAWINGS

DRWG. NO.	DATE 1950	REV. NO.	DATE 1950	DATE APP. BY A-E	DESCRIPTION
		2	9-8	9-15-50	
L-8	7-12	—	———	7-21-50	Building 1 - Elevation Line D - Placing plan.
		1	8-15	———	
		2	9-8	9-15-50	
L-9	7-17	—	———	7-21-50	Buildings 1 & 7 - Elevation Walls B & C - Placing plan.
		1	8-15	8-31-50	
L-10	7-17	—	———	7-21-50	Building 1 - Walls 2,3 & 4 - Placing plan.
		1	8-15	8-31-50	
		2	9-18	9-27-50	
L-11	7-17	—	———	7-21-50	Buildings 3 & 5 - Walls A & D - Placing plan.
		1	8-4	8-18-50	
L-12	7-21	—	———	7-21-50	Building 4 - Elevation Walls A & D - Placing plan.
		1	8-7	8-18-50	
L-13	7-21	—	———	7-21-50	Building 4 - Shear Walls 9 & 12 - Placing plan.
		1	8-7	8-18-50	
L-14	7-20	—	———	7-21-50	Building 7 - Elevation Walls A & D - Placing plan.
		1	8-15	———	
		2	9-8	9-15-50	
L-15	7-20	—	———	7-21-50	Building 7 - Elevation Wall 20 - Placing plan.
		1	8-15	8-31-50	
L-16	7-20	—	———	7-21-50	Building 7 - Elevation Walls 17,18 & 19 - Placing plan.
		1	8-15	———	

SHOP DRAWINGS

DRWG. NO.	DATE 1950	REV. NO.	DATE 1950	DATE APP. BY A-E	DESCRIPTION
		2	9-8	9-15-50	
L-17	7-20	—	——	7-21-50	Building 1 - Third floor slab - Placing plan.
		1	8-16	———	
		2	9-18	9-27-50	
L-18	7-20	—	——	———	Building 4 - Third floor - Placing plan.
		1	8-7	8-18-50	
L-19	7-20	—	——	7-21-50	Building 7 - Third floor slab - Placing plan.
		1	8-16	———	
		2	9-8	9-15-50	
L-20	7-20	—	——	7-21-50	Building 1 - Roof slab - Placing plan.
		1	8-16	8-31-50	
L-21	7-19	—	——	8-18-50	Buildings 2,3,5 & 6 - Roof - Placing plan.
L-22	7-19	—	——	———	Building 4 - Roof - Placing plan.
		1	8-7	8-18-50	
L-23	7-20	—	——	7-21-50	Building 7 - Roof slab - Placing plan.
		1	8-16	———	
		2	9-8	9-15-50	
L-24	7-20	—	——	7-21-50	Buildings 3,4 & 5 - Columns - Placing plan.

SHOP DRAWINGS

ARMY SPECIAL MILITARY STRUCTURES
DESIGN DRAWING 60-09-11, Sheets 1 to 3, Inclusive

SUB-CONTRACTOR: Bethlehem Pacific Coast Steel Co., San Francisco, California

PURCHASE ORDER NUMBER: 4248 **DATE ISSUED:** 3-20-50

MATERIAL: Reinforcing Steel

DRWG. NO.	DATE 1950	REV. NO.	DATE 1950	DATE APP. BY A-E	DESCRIPTION
6	3-30	—	—	—	Underground Test Shelter.
		1	4-24	—	
		2	8-7	8-18-50	
		3	5-22	—	
		4	6-23	6-28-50	
		5	7-21	7-21-50	
7	330	—	—	—	Underground Test Shelter.
		1	4-10	—	
		2	4-24	6-19-50	
		3	8-7	8-18-50	
8	3-30	—	—	—	Underground Test Shelter.
		1	4-10	—	
		2	4-24	6-19-50	
		3	8-7	8-18-50	
L-25	7-24	—	—	—	Underground Test Shelter - Placing Plan.
		1	8-7	8-18-50	
L-26	7-24	—	—	—	Underground Test Shelter - Placing Plan.

SHOP DRAWINGS

DRWG. NO.	DATE 1950	REV. NO.	DATE 1950	DATE APP. BY A-E	DESCRIPTION
		1	8-7	8-18-50	

SHOP DRAWINGS

ARMY SPECIAL MILITARY STRUCTURE 3.1.1 — MULTI-STORY BUILDING
DESIGN DRAWING NUMBER 60-09-06, Sheets 1 to 13, Inclusive

SUB-CONTRACTOR: Consolidated Western Steel Co. of Los Angeles, California

PURCHASE ORDER NUMBER: 4249 DATE ISSUED: 3-20-50

MATERIAL: Structural Steel and Miscellaneous Iron

DRWG. NO.	DATE 1950	REV. NO.	DATE 1950	DATE APP. BY A-E	DESCRIPTION
1001	3-30	—	——	3-31-50	Buildings 2 and 6 — Anchor bolts and bars.
1002	3-30	—	——	3-31-50	Buildings 2 and 6 — Miscellaneous anchors.
1003	3-30	—	——	3-31-50	Buildings 2 and 6 — Miscellaneous anchors.
1006	5-12	—	——	6-8-50	Anchor bolts.
1007	5-12	—	——	6-28-50	Anchor bolts.
1008	5-16	—	——	6-28-50	Buildings 2 and 6 — Anchor bolts, 2nd and 3rd floor slabs.
1	4-26	—	——	6-28-50	Buildings 2 and 6 — Columns.
2	4-27	—	——	6-28-50	Buildings 2 and 6 — Columns.
3	5-1	—	——	6-28-50	Buildings 2 and 6 — Roof girders.
4	5-2	—	——	6-28-50	Building 2 — Roof beams and vertical girts.
5	4-26	—	——	6-28-50	Buildings 2 and 6 — Floor beams, roof beams and splice plates.
8	5-9	—	——	6-28-50	Buildings 1 and 7 — Posts and beams.
9	5-5	—	——	6-28-50	Building 2 — Posts.
10	5-3	—	——	6-28-50	Building 2 — Posts.
11	5-5	—	——	6-28-50	Buildings 1 and 2 — Posts.
12	5-11	—	——	6-28-50	Buildings 1,2,3,4,5,6,7 and access ways - Posts, Sealing Angles, Channels, Cover Anchors and Angles.

SHOP DRAWINGS

DRWG. NO.	DATE 1950	REV. NO.	DATE 1950	DATE APP. BY A-E	DESCRIPTION
13	5-3	—	—	6-28-50	Building 6 - Posts, 1st Tier.
14	5-4	—	—	6-28-50	Building 6 - Posts, 2nd Tier.
15	5-9	—	—	6-28-50	Building 6 - Posts, 3rd Tier.
16	5-11	—	—	6-28-50	Building 6 - Girt Beams, Front Elevation.
17	5-15	—	—	6-28-50	Buildings 2 & 6 - Girt Beams, Rear Elevation.
18	5-29	—	—	6-28-50	Buildings 1,2,6 & 7 - Anchors, Sealing Angles and Turned Bolts.
E-1	3-29	—	—	—	Buildings 2 & 6 - Anchor Bolt Setting Plan.
		1	6-26	6-28-50	Bolt Spacing changed and Survey Points added.
E-2	4-25	—	—	6-28-50	Building 6 - Erection Diagram.
E-3	4-26	—	—	6-28-50	Building 2 - Erection Diagram.
E-4	4-26	—	—	6-5-50	Building 1 - Erection and Anchor Bolt Plan.
E-5	5-1	—	—	6-28-50	Building 7 - Erection and Anchor Bolt Plan.
E-6	5-2	—	—	6-5-50	Building 7 - Erection and Anchor Bolt Plan - Elevation.
E-7	5-3	—	—	6-5-50	Building 3,4 & 5 - Erection and Anchor Bolt Plan.
E-8	5-11	—	—	6-28-50	Location Plan for Survey Points and access ways.
E-10	5-18	—	—	6-28-50	Buildings 2,6 & 7 - Anchor Bolt Plan.

SHOP DRAWINGS

ARMY SPECIAL MILITARY STRUCTURE 3.1.3 -- UNDERGROUND SHELTER
DESIGN DRAWING NUMBER 60-09-11, Sheets 1 to 3, Inclusive

SUB-CONTRACTOR: Consolidated Western Steel Co. of Los Angeles, California

PURCHASE ORDER NUMBER: 4249 DATE ISSUED: 3-20-50

MATERIAL: Structural Steel and Miscellaneous Iron

DRWG. NO.	DATE 1950	REV. NO.	DATE 1950	DATE APP. BY A-E	DESCRIPTION
1004	5-9	—	——	5-23-50	Door threshold.
1005	5-10	—	——	6-5-50	Corrugated Iron Shelter.
6	5-1	—	——	6-28-50	Door frames.
7	5-4	—	——	6-28-50	Door details and assembly.
E-9	5-11	—	——	6-28-50	Erection plan of shelters.

SHOP DRAWINGS

DRWG. NO.	DATE 1950	REV. NO.	DATE 1950	DATE APP. BY A-E	DESCRIPTION
					x 9" Jr.
1C2-8	5-10	—	—	—	1/4 Scale Idealized Model, Project No. 3.3.8f. Assembly
					Erection Plan for Angles on Fiber-Glass Seals.
		A	5-23	—	Revised in accordance with Design Drawing 100-261-3, Rev. 2.
		B	6-5	6-6-50	Corrected.
1C2-9	5-12	—	—	—	1/4 Scale Idealized Model, Project No. 3.3.8f. Structural
					Steel Details.
		A	5-23	—	Revised in accordance with Design Drawing 100-261-3, Rev. 2.
		B	6-5	6-6-50	Corrected.
1C2-10	5-12	—	—	—	1/4 Scale Idealized Model, Project No. 3.3.8f. Miscellaneous
					Details.
		A	5-23	6-3-50	Revised in accordance with Design Drawing 100-261-3, Rev. 2.
1C2-11	6-6	—	—	—	Idealized Models, Structures 3.3.8a,b,c,d,e & g. Details
					for Steel Frame and Plate.

SHOP DRAWINGS

ARMY & AIR FORCE SPECIAL MILITARY STRUCTURES

SUB-CONTRACTOR: Seaman Products, Burbank, California

PURCHASE ORDER NUMBER: 5586 & 8947 DATE ISSUED: 5-31-50 & 1-25-51

MATERIAL: Fiberglass Sealing Strips

DRWG. NO.	DATE 1950	REV. NO.	DATE 1950	DATE APP. BY A-E	DESCRIPTION
1			6-15	--------	Details for Fabrication of Fiberglass Strips.
					NOTE: This Drawing was approved by Holmes & Narver
					Construction Department.

SHOP DRAWINGS

ARMY SPECIAL MILITARY STRUCTURE 3.1.1 -- MULTI-STORY BUILDING
DESIGN DRAWING NUMBER 60-09-06, Sheets 1,3 & 5 of 13

SUB-CONTRACTOR: Western Asbestos Co., Los Angeles, California

PURCHASE ORDER NUMBER: 5622 DATE ISSUED: 5-26-50

MATERIAL: Corrugated Asbestos Siding, Drawing Number 50 - 70.

DRWG. NO.	DATE 1950	REV. NO.	DATE 1950	DATE APP. BY A-E	DESCRIPTION
A	8-29	--	----	------	Panels E-1, E-2 and E-3.
		1	8-31	-------	General revision.
		2	9-15	9-25-50	Revised as per approved drawings.
B	8-31	--	----	-------	Panels A-1, A-2, and A-3.
		1	8-31	-------	General revision.
		2	9-15	9-25-50	Revised as per approved drawings.
					Note: Drawing 50-70-A supercedes drawing 50-60-1 and
					drawing 50-70-B supercedes drawing 50-60-2.

DESIGN DRAWINGS

NAVY SPECIAL MILITARY STRUCTURES
DRAWINGS 481, 343 to 481, 361, Inclusive - Sheets 1 to 19, Inclusive

ARCHITECT - ENGINEER: Bureau of Yards & Docks, Washington, D.C.

SHT. NO.	DATE 1950	REV. NO.	DATE 1950	DATE RECD BY H & N	DESCRIPTION
1	—	—	—	2-27-50	Structure 3.2.1a - Solid Bomb Shelter, Structural Details.
		*	7-6	7-17-50	Deleted Spread Base on Footings. Added Reinforcing Trusses
					in Footing.
2	—	—	—	2-27-50	Structure 3.2.1b - Cellular Bomb Shelter, General Plans.
		*	7-6	7-17-50	Added Haunch to Footing. Added Reinforcing Trusses in Footing.
					Deleted Spread Base on Footings.
3	—	—	—	2-27-50	Structure 3.2.1b - Cellular Bomb Shelter, Truss Details.
4	—	—	—	2-27-50	Structure 3.2.1b - Cellular Bomb Shelter, Foundation Plan.
		*	7-6	7-17-50	Added Reinforcing Trusses in Footing.
5	—	—	—	2-27-50	Structure 3.2.2a - Precast Panels with Columns & Beams,
					Structural Details.
		*	7-5	7-17-50	Added 2 Concrete Struts between Footings at side.
		△	7-7	7-17-50	Corrected Dimension.
6	—	—	—	2-27-50	Structure 3.2.2a - Precast Panels with Columns & Beams,
					Structural Details.
7	—	—	—	2-27-50	Structure 3.2.2b - Precast Panels with Brick Walls & Wooden
					Roof Framing, Structural Details.
		*	7-5	7-17-50	Added 2 Concrete Struts between Footings.
8	—	—	—	2-27-50	Structure 3.2.2b - Precast Panels with Brick Walls & Wooden Roof

DESIGN DRAWINGS

SHT. NO.	DATE 1950	REV. NO.	DATE 1950	DATE RECD. BY H & N.	DESCRIPTION
					Framing, Structural Details.
		*	7-5	7-17-50	Corrected Dimension.
9	—	—	—	2-27-50	Structures 3.2.3a & b - Precast Cellular Walls & Roof,
					General Plans.
		△1	4-3	4-18-50	Added Holes in ends of Cells. Added Structure 3.2.3b.
		△2	5-9	5-19-50	Added Holes & Depressions in sides of Cells.
10	—	—	—	2-27-50	Structures 3.2.3a & b - Precast Cellular Walls & Roof,
					Joint Details.
		△1	4-3	4-18-50	Added Holes in ends of Cells. Added Structure 3.2.3b.
		$\boxed{1}$	5-9	5-19-50	Added Concrete Stop Plates. Revised Wooden Concrete Stops.
		△2	5-9	5-19-50	Added Holes & Depressions in Sides of Cells.
11	—	—	—	2-27-50	Structures 3.2.3a & b - Precast Cellular Walls & Roof, Panel
					Details.
		△1	4-3	4-18-50	Added Holes in ends of Cells. Added Structure 3.2.3b.
		$\boxed{1}$	5-9	5-19-50	Added Concrete Stop Plates. Revised Wooden Concrete Stops.
		△2	5-9	5-19-50	Added Holes & Depressions in sides of Cells.
		$\boxed{2}$	5-11	5-19-50	Added Assembly Procedure.
12	—	—	—	2-27-50	Structures 3.2.3a & b - Precast Cellular Walls & Roof, Truss
					Details.
		$\boxed{1}$	5-9	5-19-50	Added Concrete Stop Plates. Added Structure 3.2.3b.
		$\boxed{2}$	5-11	5-19-50	Added Spacer Bars to Trusses.
13	—	—	—	2-27-50	Structure 3.2.4a - Precast Panel Arch Rib with Wing Walls,

DESIGN DRAWINGS

SHT. NO.	DATE 1950	REV. NO.	DATE 1950	DATE RECD. BY H & N	DESCRIPTION
					Structural Details.
		*	7-5	7-17-50	Deleted one Floor Panel. Added Concrete Strut in Place of
					Floor Panel.
14	—	—	—	2-27-50	Structure 3.2.4a - Precast Panel Arch Rib with Wing Walls.
					Structural Details.
		*	7-5	7-17-50	Deleted one Floor Panel.
15	—	—	—	2-27-50	Structure 3.2.4b - Precast Panel Arch Rib, Plans & Details.
		*	7-5	7-17-50	Deleted 2 Floor Panels. Added 2 Concrete Struts in place
					of Panels.
16	—	—	—	2-27-50	Structure 3.2.5 - Precast Panel Igloo, Structural Details.
		1	4-17	7-17-50	Changed Type Number to 3.2.6.
17	—	—	—	2-27-50	Structure 3.2.5 - Precast Panel Igloo, Structural Details.
		1	4-18	7-17-50	Changed Type Number to 3.2.6.
18	—	—	—	2-27-50	Structure 3.2.6 - Precast Panel Quonset.
		1	4-18	7-17-50	Changed Type Number to 3.2.5.
		*	7-5	7-17-50	Deleted 2 Floor Panels. Added 2 Concrete Struts in place
					of Panels.
19	—	—	—	2-27-50	Structure 3.2.7a - Conventional Reinforced Concrete Building
					Structural Details.
		*	3-14	3-20-50	Changed Type Number to 3.2.7a & b.
		⧅	3-14	3-20-50	Added Structure 3.2.7b.
		△	7-5	7-17-50	Changed Type 3.2.7a to 3.2.7b & changed Type 3.2.7b to 3.2.7a.

DESIGN DRAWINGS

SHT. NO.	DATE 1950	REV. NO.	DATE 1950	DATE RECD. BY H & N	DESCRIPTION
					3.2.7a.
		◑	7-5	7-17-50	Added Concrete Strut between Footings.

DESIGN DRAWINGS

NAVY SPECIAL MILITARY STRUCTURES PROGRAM
SPECIFICATIONS

ARCHITECT - ENGINEER: Bureau of Yards & Docks, Washington, D.C.

SHT. NO.	DATE 1950	REV. NO.	DATE 1950	DATE RECD BY H & N	DESCRIPTION
1-8	—	—	—	3-9-50	Specifications for Test Structures.

DESIGN DRAWINGS

NAVY SPECIAL MILITARY STRUCTURES
CONSTRUCTION SKETCHES
DESIGN DRAWINGS 481, 343, -47, -48, -50, -51, -52, -53, -54, -58, -59, -61

ARCHITECT - ENGINEER: Holmes & Narver, Inc. Construction Department

SHT. NO.	DATE 1950	REV. NO.	DATE 1950	DATE RECD BY H & N	DESCRIPTION
3	3-21	--	--	--------	Miscellaneous iron details for Structures 3.2.2b, 3.2.5 and
					3.2.6.
4	3-23	--	--	--------	Steel door details for Structures 3.2.3, 3.2.6 and 3.2.7a & b.
8	6-12	--	--	--------	Shoring details for Structure 3.2.1a.
9	6-12	--	--	--------	Shoring details for Structure 3.2.2a.
10	6-13	--	--	--------	Shoring details for Structure 3.2.3.
11	6-13	--	--	--------	Shoring details for Structure 3.2.6.
					NOTE: These drawings were initiated and approved by Holmes
					& Narver, Inc. Construction Department.

SHOP DRAWINGS

NAVY SPECIAL MILITARY STRUCTURES

DESIGN DRAWINGS 481, 347 to 481, 360, Inclusive

SUB-CONTRACTOR: Barrett & Hilp, San Francisco, California

PURCHASE ORDER NUMBER: 4609 **DATE ISSUED:** 5-3-50

MATERIAL: Erection Marking Drawings

DRWG. NO.	DATE 1950	REV. NO.	DATE 1950	DATE APP. BY A-E	DESCRIPTION
ES-1	5-19	—	—	—	Structure 3.2.2a.
ES-2	5-11	—	—	—	Structure 3.2.2b.
ES-3	5-19	—	—	—	Structure 3.2.3a.
		1	6-20	—	
ES-4	5-19	—	—	—	Structure 3.2.3b.
		1	6-20	—	
ES-5	5-24	—	—	—	Structure 3.2.4a.
ES-6	5-24	—	—	—	Structure 3.2.4b.
		1	6-20	—	
ES-7	5-25	—	—	—	Structure 3.2.5
ES-8	5-25	—	—	—	Structure 3.2.6.
					NOTE: These Drawings were approved by Holmes & Narver,
					Inc. Construction Dept. and sent to the Navy for
					their information only.

SHOP DRAWINGS

NAVY SPECIAL MILITARY STRUCTURES

SUB-CONTRACTOR: Barrett & Hilp, San Francisco, California

PURCHASE ORDER NUMBER: 4609 DATE ISSUED: 5-3-50

MATERIAL: Insert Holding Details

DRWG. NO.	DATE 1950	REV NO.	DATE 1950	DATE APP BY A-E	DESCRIPTION
ID-1	5-15	—	——	———	Insert Holding Details
					NOTE: This Drawing was approved by Holmes & Narver's
					Resident Inspector on the Job & was sent to the
					Navy for their information only.

SHOP DRAWINGS

NAVY SPECIAL MILITARY STRUCTURES
DESIGN DRAWINGS 481, 343, -44, -45, -47, -50, -53, -54, -56, -59, -60

SUB-CONTRACTOR: Barrett & Hilp of San Francisco, Calif.: Ellison & King, sub-sub-contractor

PURCHASE ORDER NUMBER: 4609 DATE ISSUED: 5-3-50

MATERIAL: Crating for Precast Parts of Test Structures

DRWG. NO.	DATE 1950	REV. NO.	DATE 1950	DATE APP BY A-E	DESCRIPTION
P1	5-8	--	----	---------	This drawing is superceded by drawing P2
P2	6-24	--	----	7-7-50	Crating for Precast sections
P3	7-5	--	----	7-12-50	Crating for Precast sections
P4	7-10	--	-----	7-18-50	Crating for Precast sections
P5	7-13	--	-----	7-18-50	Crating for Precast sections

SHOP DRAWINGS

NAVY SPECIAL MILITARY STRUCTURES

DESIGN DRAWINGS 481, 347, -48, -49, -50, -52, -54, -56, -57, -58, -59, -60

SUB-CONTRACTOR: Barrett & Hilp of San Francisco, Calif.: EMPCO, sub-sub-contractor

PURCHASE ORDER NUMBER: 4609 **DATE ISSUED:** 5-3-50

MATERIAL: Miscellaneous Iron

DRWG. NO.	**DATE 1950**	**REV. NO.**	**DATE 1950**	**DATE APP. BY A-E**	**DESCRIPTION**
1	5-11	—	———	———	Bevel washers.
		1	5-25	———	
		2	8-3	———	
		3	8-21	———	
		4	10-9	10-23-50	
2	5-11	—	———	———	Bevel washers.
		1	5-25	———	
		2	8-3	———	
		3	8-21	———	
		4	9-7	9-22-50	
3	5-11	—	———	———	Bolts and nuts.
		1	5-25	———	
		2	8-3	———	
		3	8-21	———	
		4	9-7	———	
		5	10-9	10-23-50	
4	5-11	—	———	———	Bolts and washers.

SHOP DRAWINGS

DRWG. NO.	DATE 1950	REV. NO.	DATE 1950	DATE APP. BY A-E	DESCRIPTION
		1	5-25	———	
		2	8-3	———	
		3	8-21	9-22-50	
5	5-11	--	----	———	Miscellaneous plates and washers.
		1	5-25	———	
		2	8-3	———	
		3	8-21	9-22-50	
6	5-10	--	---	———	Plates, bars and bolts.
		1	5-25	———	Omitted clip angles.
		2	6-6	———	Omitted bent bars.
		3	8-3	9-22-50	Added bent bolts.
7	7-17	--	----	9-22-50	Plates, bolts and nuts.

SHOP DRAWINGS

NAVY SPECIAL MILITARY STRUCTURES
DESIGN DRAWINGS 481, 347, -48, -49, -50

SUB-CONTRACTOR: Barrett & Hilp of San Francisco, Calif.: Soule Steel Co., sub-sub-contractor

PURCHASE ORDER NUMBER: 4609 **DATE ISSUED:** 5-3-50

MATERIAL: Miscellaneous Iron

DRWG. NO.	**DATE 1950**	**REV NO.**	**DATE 1950**	**DATE APP. BY A-E**	**DESCRIPTION**
6	5-8	——	——	——	
7	5-10	——	——	——	
8	5-12	——	——	——	
					NOTE: Sheets 6,7, & 8 were superceded by Sheets 4 & 8
4	5-8	——	——	——	Plates, Angles & Channels. Structure 3.2.2a.
		1	——	——	
M4	5-8	——	——	6-28-50	Supercedes Sheet 4.
		1	——	9-22-50	
8	5-12	——	——	——	Plates & Angles. Structure 3.2.2b.
M8	5-12	——	——	——	Supercedes Sheet 8.
		1	——	——	
		2	——	——	
		3	——	9-22-50	
M10	7-10	——	——	——	Plates, Bolts, Nuts & Eye-Bolts, Structure 3.2.2a.
		1	——	9-22-50	

SHOP DRAWINGS

NAVY SPECIAL MILITARY STRUCTURES

DESIGN DRAWINGS 481, 347 to 481, 360, inclusive

SUB-CONTRACTOR: Barrett & Hilp of San Francisco, Calif.: Soule Steel Co.sub-sub-contractor

PURCHASE ORDER NUMBER: 4609 **DATE ISSUED:** 5-3-50

MATERIAL: Reinforcing Steel

DRWG. NO.	DATE 1950	REV. NO.	DATE 1950	DATE APP BY A-E	DESCRIPTION
1	4-17	—	—	—	Reinforcing for Structures 3.2.3a & b and 3.2.4a
		1	5-29	6-12-50	
2	4-18	—	—	—	Reinforcing for Structure 3.2.4a
		1	5-29	6-12-50	
3	4-19	—	—	—	Reinforcing for Structure 3.2.4b
		1	5-25	6-6-50	
4	4-20	—	—	—	Reinforcing for Structure 3.2.2a
		1	5-12	8-3-50	
5	4-21	—	—	5-2-50	Reinforcing for Structure 3.2.2a
		1	5-12	8-3-50	
6	4-24	—	—	—	Reinforcing for Structure 3.2.5
		1	5-12	8-3-50	
7	4-24	—	—	—	Reinforcing for Structures 3.2.5 and 3.2.6
		1	5-29	6-12-50	
8	4-26	—	—	—	Reinforcing for Structures 3.2.2b and 3.2.3
		1	5-25	—	
		2	7-7-	7-18-50	

SHOP DRAWINGS

NAVY SPECIAL MILITARY STRUCTURES 3.2.3 a & b

DESIGN DRAWING 481, 354

SUB-CONTRACTOR: Barrett & Hilp of San Francisco, Calif.: Soule Steel Co. sub-sub-contractor

PURCHASE ORDER NUMBER: 4609 **DATE ISSUED:** 5-3-50

MATERIAL: Steel Trusses

DRWG. NO.	DATE 1950	REV. NO.	DATE 1950	DATE APP BY A-E	DESCRIPTION
M-9	5-16	--	---	6-14-50	Steel Trusses
		1	---	-------	Added spacer bars and concrete stop plates.
		2	6-30	7-11-50	Added splice plate details.

SHOP DRAWINGS

NAVY SPECIAL MILITARY STRUCTURE 3.2.1 a

DESIGN DRAWING 481, 343

SUB-CONTRACTOR: Bethlehem Pacific Coast Steel Co. of San Francisco, California

PURCHASE ORDER NUMBER: 5489

DATE ISSUED: 5-24-50

MATERIAL: Steel Trusses

DRWG. NO.	DATE 1950	REV. NO.	DATE 1950	DATE APP BY A-E	DESCRIPTION
1	6-6-	---	----	6-15-50	Steel Trusses
2	6-6	---	----	6-15-50	Steel Trusses

SHOP DRAWINGS

NAVY SPECIAL MILITARY STRUCTURE 3.2.1b

DESIGN DRAWING 481, 345

SUB-CONTRACTOR: Nigg Engineering Corp. of Covina, California

PURCHASE ORDER NUMBER: 4251 **DATE ISSUED:** 3-28-50

MATERIAL: Steel Trusses and Miscellaneous Iron

DRWG. NO.	DATE 1950	REV. NO.	DATE 1950	DATE APP BY A-E	DESCRIPTION
1	3-30	—	—	4-7-50	Trusses T-1.
2	3-30	—	—	4-7-50	Trusses T-2.
3	3-31	—	—	4-7-50	Trusses T-3.
4	3-31	—	—	4-7-50	Miscellaneous Iron.

DESIGN DRAWINGS

AIR FORCE SPECIAL MILITARY STRUCTURES
PRELIMINARY PLANS

ARCHITECT - ENGINEER: Howard T. Fisher & Associates, Chicago, Illinois

SHT. NO.	DATE 1950	REV. NO.	DATE 1950	DATE RECD BY H & N	DESCRIPTION
1	—	—	—	2-14-50	Drawing No. 100-252, Structure Type C-1.1.
2	—	—	—	2-14-50	Drawing No. 100-252, Structure Type C-1.1.
3	—	—	—	2-14-50	Drawing No. 100-252, Structure Type C-1.1.
1	—	—	—	2-14-50	Drawing No. 100-253, Structure Type F-2.
1	—	—	—	2-14-50	Drawing No. 100-254, Structure Type D.
1	—	—	—	2-14-50	Drawing No. 100-255, Truss Bridge
2	—	—	—	2-14-50	Drawing No. 100-255, Plate Girder Bridge and Model.
3	—	—	—	2-14-50	Drawing No. 100-255, Supports for Bridges, Members and Model.
1	—	—	—	2-14-50	Drawing No. 100-256, Structure Type B-1.
2	—	—	—	2-14-50	Drawing No. 100-256, Structure Type B-1.
3	—	—	—	2-14-50	Drawing No. 100-256, Structure Type B-1.
4	—	—	—	2-14-50	Drawing No. 100-256, Structure Type B-1.
5	—	—	—	2-14-50	Drawing No. 100-256, Structure Type B-1.
6	—	—	—	2-14-50	Drawing No. 100-256, Structure Type B-1.
7	—	—	—	2-14-50	Drawing No. 100-256, Structure Type B-1.
1	—	—	—	2-14-50	Drawing No. 100-257, Structure Type A-2.1.
2	—	—	—	2-14-50	Drawing No. 100-257, Structure Type A-2.1.
3	—	—	—	2-14-50	Drawing No. 100-257, Structure Type A-2.1.
1	—	—	—	2-14-50	Drawing No. 100-258, Structure Type B-2.

DESIGN DRAWINGS

SHT. NO.	DATE 1950	REV. NO.	DATE 1950	DATE RECD. BY H & N	DESCRIPTION
2	—	——	——	2-14-50	Drawing No. 100-258, Structure Type B-2.
3	—	——	——	2-14-50	Drawing No. 100-258, Structure Type B-2.
1	—	——	——	2-14-50	Drawing No. 100-259, Model Structure Type C-1.1.
2	—	——	——	2-14-50	Drawing No. 100-259, Model Structure Type C-1.1.
3	—	——	——	2-14-50	Drawing No. 100-259, Model Structure Type C-1.1.

DESIGN DRAWINGS

AIR FORCE SPECIAL MILITARY STRUCTURES

ARCHITECT - ENGINEER: Howard T. Fisher & Associates, Chicago, Illinois

SHT. NO.	DATE 1950	REV. NO.	DATE 1950	DATE RECD BY H & N	DESCRIPTION
1	2-27	—	——	2-28-50	Drawing No. 100-252, Structure Type C-1.1. Project No. 3.3.3.
					Plans, Elevations & Structural Details.
2	2-27	—	——	2-28-50	Drawing No. 100-252, Structure Type C-1.1. Project No. 3.3.3.
					Sections and Details.
3	2-27	—	——	2-28-50	Drawing No. 100-252, Structure Type C-1.1. Project No. 3.3.3.
					Structural Details.
4	2-27	—	——	2-28-50	Drawing No. 100-252, Structure Type C-1.1. Project No. 3.3.3.
					Wing Walls.
		1	4-20	7-14-50	Changed height of Braces.
					Note: This revision was covered by letter from Fisher dated
					5-11-50.
1	2-27	—	——	2-28-50	Drawing No. 100-253, Structure Type F-2. Project No. 3.3.5a & b.
					Plans, Sections & Elevations.
		1	4-20	7-14-50	First floor joists changed from 2" x 12" to 2" x 10".
					Note: This revision was covered by letter from Fisher dated
					5-11-50.
1	2-27	—	——	2-28-50	Drawing No. 100-257, Structrue Type A-2.1. Project No. 3.3.4.
					Plans, Elevations & Sections.
1	2-27	—	——	4-25-50	Drawing No. 100-257, Structure Type A-2.1. Project No. 3.3.4.

DESIGN DRAWINGS

SHT. NO.	DATE 1950	REV. NO.	DATE 1950	DATE RECD. BY H & N	DESCRIPTION
					Plans, Elevations & Sections.
					Note: This Drawing was corrected but no Revision or Revision date indicated.
		1	4-20	7-14-50	Corrected errors in dimensions.
2	2-27	--	----	2-28-50	Drawing No. 100-257, Structure Type A-2.1. Project No. 3.3.4. Structural Details.
2	2-27	--	----	4-25-50	Drawing No. 100-257, Structure Type A-2.1. Project No. 3.3.4 Structural Details.
					Note: This Drawing was corrected but no Revision or Revision date indicated.
		1	4-20	7-14-50	Corrected errors in dimensions.
3	2-27	--	----	2-28-50	Drawing No. 100-257, Structure A-2.1. Project No. 3.3.4. Wing Walls.
		1	4-20	7-14-50	Changed height of Braces.
					Note: This Revision was covered by letter from Fisher dated 5-11-50.
1	2-27	--	----	2-28-50	Drawing No. 100-259, Structrue Type C-1.1. Model. Project No. 3.3.8h. Plans, Elevations & Structural Details.
2	2-27	--	----	2-28-50	Drawing No. 100-259, Structure Type C-1.1 Model. Project No. 3.3.8h. Details.
3	2-27	--	----	2-28-50	Drawing No. 100-259, Structure Type C-1.1 Model. Project No. 3.3.8h. Truss Details.

DESIGN DRAWINGS

SHT. NO.	DATE 1950	REV. NO.	DATE 1950	DATE RECD. BY H & N	DESCRIPTION
4	2-27	—	----	2-28-50	Drawing No. 100-259, Structure Type C-1.1 Model.
					Project No. 3.3.8h. Wing Walls.
		1	4-20	7-14-50	Changed height of Braces.
					Note: This Revision was covered by letter from Fisher
					dated 5-11-50.
1	2-27	—	----	2-28-50	Drawing No. 100-261, Simplified Structures. Project No.
					3.3.8a,b,c,d,e,f & g. Plans, Elevations, & Details.
		1	3-23	3-30-50	Omitted lower Beams. Changed size of upper Beams.
					Increased thickness of front Slab. Added drop Panels at
					Column Footings. Increased size of Reinforcing Bars in
					Walls. Changed Anchor Fastening from Bolts to Plates.
1	4-12	—	----	4-25-50	Drawing No. 100-261, Idealized Models. Project No. 3.3.8a,
					b,c,d,e & g. Plans & Elevations.
		1	4-20	4-25-50	Drawings 100-261-1, -2 & -3 dated 4-12-50 supercede Drawing
					No. 100-261-1 dated 2-27-50.
		2	5-12	5-16-50	Changed thickness of Side Walls. Reinforcing Side and Rear
					Walls, thickness of Door Plate and Overall width.
2	4-12	—	----	4-25-50	Drawing 100-261, Idealized Models. Project No. 3.3.8a,b,c,
					d,e & g. Details.
		1	4-20	4-25-50	Drawings 100-261-1, -2 & -3 dated 4-12-50 supercede Drawing
					No. 100-261-1 dated 2-27-50.
		2	5-11	5-16-50	Changed thickness of Side Walls, Reinforcing Side and Rear

DESIGN DRAWINGS

SHT. NO.	DATE 1950	REV. NO.	DATE 1950	DATE RECD. BY H & N	DESCRIPTION
					Walls, Struts, Strut Spacing and Ties.
3	4-12	—	—	4-25-50	Drawing No. 100-261, 1/4 Scale Idealized Model. Project
					No. 3.3.8f.
		1	4-20	4-25-50	Drawings 100-261-1, -2 & -3 dated 4-12-50 supercede
					Drawing No. 100-261-1 dated 2-27-50.
		2	5-10	5-16-50	Changed thickness of Side Walls, Reinforcing Side and Rear
					Walls, Struts, Length of Front Wall, etc.
1	4-12	—	—	4-25-50	Drawing No. 100-262, Piers for Displacement Gauges. Project
					No. 3.3.3 & 3.3.4.
		1	5-10	5-16-50	Added Stirrups in Shafts. Lengthened all Vertical Bars to
					extend into Footing. Deleted all Bar Splices.

DESIGN DRAWINGS

AIR FORCE SPECIAL MILITARY STRUCTURES
SPECIFICATIONS

ARCHITECT - ENGINEER: Howard T. Fisher & Associates, Chicago, Illinois

SHT. NO.	DATE 1950	REV. NO.	DATE 1950	DATE RECD BY H & N	DESCRIPTION
—	2-27	—	—	3-1-50	Specifications for Structures for Department of the Air Force.
		1	4-12	4-14-50	Addendum No. 1

DESIGN DRAWINGS

AIR FORCE SPECIAL MILITARY STRUCTURES
CONSTRUCTION SKETCHES

ARCHITECT - ENGINEER: Holmes & Narver, Inc. Construction Department

SHT. NO.	DATE 1950	REV. NO.	DATE 1950	DATE RECD BY H & N	DESCRIPTION
7	4-11	—	——	———	Anchor Bolts.
		1	10-3	———	
13	9-22	—	——	———	Straight Bar Cutting List.
		1	9-22	———	Redrawn
		2	10-3	———	
16	9-15	—	——	———	Roofing for Structure 3.3.5.
17	9-21	—	——	———	Reinforcing List for Structure 3.3.3.
		1	10-3	———	
18	9-22	—	——	———	Reinforcing List for Structure 3.3.4.
		1	10-3	———	
					Note: These Drawings were initiated and approved by Holmes
					& Narver, Inc. Construction Department.

SHOP DRAWINGS

AIR FORCE SPECIAL MILITARY STRUCTURES
DESIGN DRAWINGS 100-252-1, -2, -3 & -4 and 100-257-1, -2 & -3

SUB-CONTRACTOR: Bethlehem Pacific Coast Steel Co., Alameda, California

PURCHASE ORDER NUMBER: 4575 **DATE ISSUED:** 4-11-50

MATERIAL: Structural Steel and Miscellaneous Iron

DRWG. NO.	DATE 1950	REV. NO.	DATE 1950	DATE APP. BY A-E	DESCRIPTION
1	4-26	—	——	6-7-50	Structure Type C-1.1, Project No. 3.3.3. Trusses.
2	4-20	—	——	6-7-50	Structure Type A-2.1, Project No. 3.3.4. Columns Bracing
					and Girts, Wing Wall.
3	4-25	—	——	6-7-50	Structure Type C-1.1, Project No. 3.3.3. Columns Bracing,
					Wing Wall.
4	5-3	—	——	6-7-50	Structure Type C-1.1, Project No. 3.3.3. Columns.
5	5-4	—	——	6-7-50	Structure Type C-1.1, Project No. 3.3.3. Columns.
6	5-11	—	——	———	Structure Type C-1.1, Project No. 3.3.3. Monitor.
		1	6-14	6-7-50	
7	5-13	—	——	6-7-50	Structure Type A-2.1, Project No. 3.3.4. Monitor Framing.
8	4-28	—	——	6-7-50	Structure Type C-1.1, Project No. 3.3.3. Trusses.
9	4-28	—	——	6-7-50	Structure Type C-1.1, Project No. 3.3.3. Truss Sections.
10	5-2	—	——	6-7-50	Structure Type C-1.1, Project No. 3.3.3. Trusses.
11	5-1	—	——	6-7-50	Structure Type C-1.1, Project No. 3.3.3. Trusses.
12	5-12	—	——	———	Structure Type C-1.1, Project No. 3.3.3. Monitor.
		1	6-14	6-15-50	
13	5-9	—	——	———	Structure Type C-1.1, Project No. 3.3.3. Purlins and Eave

SHOP DRAWINGS

DRWG. NO.	DATE 1950	REV. NO.	DATE 1950	DATE APP. BY A-E	DESCRIPTION
					Struts.
		1	6-7	6-7-50	
14	5-6	--	----	-----	Structure Type C-1.1, Project No. 3.3.3. Diagonals, Struts
					& Strut Plates.
		1	6-7	6-7-50	
15	5-13	--	----	6-7-50	Structure Type A-2.1, Project No. 3.3.4. Girts, Lintels
					& Door Headers.
16	5-8	--	----	6-7-50	Structure Type A-2.1, Project No. 3.3.3. Lintels.
E-1	4-19	--	----	6-7-50	Structure Type C-1.1, Project No. 3.3.3. Anchor Bolt Plan.
E-2	4-14	--	----	6-7-50	Structure Type A-2.1., Project No. 3.3.4. Anchor Bolt Plan.
E-3	4-20	--	----	6-7-50	Structure Type C-1.1, Project No. 3.3.3. Elevations and
					Bottom Chord Plan.
E-4	4-20	--	----	6-15-50	Structure Type C-1.1, Project No. 3.3.3. Monitors and
					Bottom Chord Plan.
E-5	4-28	--	----	6-7-50	Structure Type C-1.1, Project No. 3.3.3. Truss Diagrams.
E-6	4-28	--	----	6-7-50	Structure Type A-2.1, Project No. 3.3.4. Erection Plan.
K-1	--	--	----	6-29-50	Index to Marks.
K-2	--	--	----	6-29-50	Index to Marks.
SR-1	6-15	--	----	6-29-50	Rivet List.
CB1	5-17	--	----	6-29-50	Plates.
M 1	5-17	--	----	6-29-50	Rod List.

SHOP DRAWINGS

AIR FORCE SPECIAL MILITARY STRUCTURES
DESIGN DRAWINGS 100-259-1, -2, -3 & -4

SUB-CONTRACTOR: Jumbo Steel Products Co., Azusa, California

PURCHASE ORDER NUMBER: 4576 **DATE ISSUED:** 4-13-50

MATERIAL: Structural Steel and Miscellaneous Iron

DRWG. NO.	DATE 1950	REV NO.	DATE 1950	DATE APP BY A-E	DESCRIPTION
1C1-1	4-20	--	----	--------	Model Structure Type C-1.1, Project No. 3.3.8h. Foundation
					Bolts - Layout. Dimension changed.
		A	4-24		Dimension changed.
		B	5-10	6-3-50	Changed Section A-A .
1C1-2	---	--	---	------	Model Structure Type C-1.1, Project No. 3.3.8h. Erection
					Diagram.
		A	5-10	-------	General Revision.
		B	6-3	6-6-50	Marks corrected.
1C1-3	4-21	--	---	------	Model Structure Type C-1.1, Project No. 3.3.8h. Erection
					Diagram.
		A	5-18	-------	Reversed L and R.
		B	6-3	6-6-50	Changed dimension line.
1C1-4	4-22	--	---	5-19-50	Model Structure Type C-1.1, Project No. 3.3.8h. Details
					Wing Wall.
		A	5-15	6-3-50	General Revision.
1C1-5	4-27	--	---	------	Model Structure C-1.1, Project No. 3.3.8h. Detail Truss T-3.
		A	5-17	6-3-50	General Revision.

SHOP DRAWINGS

DRWG. NO.	DATE 1950	REV. NO.	DATE 1950	DATE APP. BY A-E	DESCRIPTION
1C1-6	5-3	—	—	—	Model Structure Type C-1.1, Project No. 3.3.8h. Detail
					Truss T-2.
		A	5-17	6-3-50	General Revision.
1C1-7	4-27	—	—	—	Model Structure Type C-1.1, Project No. 3.3.8h. Detail
					Trusses T4A, T4B & T4C.
		A	5-16	—	Plates changed.
		B	6-3	6-6-50	Hole added.
1C1-8	5-1	—	—	—	Model Structure Type C-1.1, Project No. 3.3.8h. Trusses
					T1A, T1B, T1C, T1D & T1E.
		A	5-16	6-3-50	Strips changed.
1C1-9	5-1	—	—	—	Model Structure Type C-1.1, Project No. 3.3.8h. Details
					of Purlins.
		A	5-11	—	Revised P-8.
		B	5-26	—	General Revision.
		C	6-3	6-6-50	Changed Dimensions and Bill of Material.
1C1-10	5-8	—	—	—	Model Structure Type C-1.1, Project No. 3.3.8h. Girts
					and Diagonals.
		A	5-18	—	Nuts changed.
		B	6-3	6-6-50	Column connection.
1C1-11	5-8	—	—	—	Model Structure Type C-1.1, Project No. 3.3.8h. Details
					of Monitor Frames.
		A	5-18	—	General Revision.

SHOP DRAWINGS

DRWG. NO.	DATE 1950	REV. NO.	DATE 1950	DATE APP. BY A-E	DESCRIPTION
		B	6-3	6-6-50	Changed Dimensions and added Material.
1C1-12	5-8	—	—	—	Model Structure Type C-1.1, Project No. 3.3.8h. Column
					Details.
		A	5-17	—	General Revision.
		B	5-26	—	Dimensions Changed.
		C	6-3	6-6-50	Changed Columns A4 & G4 and Bill of Material.
1C1-13	5-9	—	—	—	Model Structure Type C-1.1, Project No. 3.3.8h. Column
					Details.
		A	5-17	—	General Revision.
		B	5-26	—	Changed Dimensions.
		C	6-3	—	Column A Face Changed.
		D	6-6	6-6-50	Angle Clip omitted on Face A.
1C1-14	5-8	—	—	—	Model Structure Type C-1.1, Project No. 3.3.8h. Struts,
					Gussets and Diagonals.
		A	5-18	—	Nuts changed and Note added.
		B	6-3	6-6-50	Changed D4, D5, DP2, DP5 & DP8.
1C1-15	9-21	—	—	6-3-50	Model Structure Type C-1.1, Project No. 3.3.8h. Sash
					Details.
		C	9-21	—	Redrawn.
		D	10-3	—	Changed Dimension.
		E	10-4	10-10-50	Changed Dimension.
1C1-16	5-9	—	—	—	Model Structure Type C-1.1, Project No. 3.3.8h.

SHOP DRAWINGS

DRWG. NO.	DATE 1950	REV. NO.	DATE 1950	DATE APP. BY A-E	DESCRIPTION
					Corrugated Metal Details.
		A	5-18	6-3-50	General Revision.

SHOP DRAWINGS

AIR FORCE SPECIAL MILITARY STRUCTURES
DESIGN DRAWINGS 100-261-1, -2 & -3

SUB-CONTRACTOR: Jumbo Steel Products Co., Azusa, California

PURCHASE ORDER NUMBER: 4577 DATE ISSUED: 4-14-50

MATERIAL: Structural Steel and Miscellaneous Iron

DRWG. NO.	DATE 1950	REV. NO.	DATE 1950	DATE APP. BY A-E	DESCRIPTION
1C2-1	4-20	—	—	—	Idealized Models, Project No. 3.3.8a.b,c,d,e & g. Erection
					Plans and Elevation.
		A	4-28	—	Changed Name, Pipe Sleeves, Markings and Pipe Bracing.
		B	5-8	—	Deleted Wall Ties.
		C	5-19	—	Revised in accordance with Design Drawing 100-261-2, Rev. 2.
		D	5-26	—	Revised in accordance with corrections.
		E	6-5	6-6-50	Corrected.
1C2-2	4-25	—	—	—	Idealized Models, Project No. 3.3.8a,b,c,d,e & g. Erection
					Plan for Roof and Wall Angles.
		A	5-1	—	Changed Hole Spacing to clear Horizontal Bolts and Pipe
					Sleeves.
		B	5-19	—	Revised in accordance with Design Drawing 100-261-2, Rev. 2.
		C	5-26	6-3-50	Revised in accordance with corrections.
1C2-3	4-27	—	—	—	Idealized Models, Project No. 3.3.8a,b,c,d,e & g.
					Miscellaneous Details and Corner Columns.
		A	5-9	—	Washers Changed.
		B	5-19	—	Revised in accordance with Design Drawing 100-261-2, Rev. 2.

SHOP DRAWINGS

DRWG. NO.	DATE 1950	REV. NO.	DATE 1950	DATE APP. BY A-E	DESCRIPTION
		C	5-26	6-3-50	Added Turned Pins and Cotter Pins to Bill of Material.
1C2-4	5-1	—	——	———	Idealized Models, Project No. 3.3.8a,b,c,d,e & g. Column
					and Beam Details.
		A	5-4	———	Added Note on Welding.
		B	5-19	———	Revised in accordance with Design Drawing 100-261-1, Rev. 2.
		C	5-26	6-3-50	Revised in accordance with corrections.
1C2-5	5-2	—	——	———	Idealized Models, Project No. 3.3.8a,b,c,d,e & g. 4"
					Column Details.
		A	5-4	———	Added Note on Welding.
		B	5-19	———	Revised in accordance with Design Drawing 100-261-1, Rev. 2.
		C	5-26	6-3-50	Revised in accordance with corrections.
1C2-6	5-3	—	——	———	Idealized Models, Project No. 3.3.8a,b,c,d,e & g. Details
					of 3½" Pipe Struts, Cables and Anchors.
		A	5-19	———	Revised in accordance with Design Drawings 100-261-1, -2,
					Rev. 2.
		B	5-26	6-3-50	Revised in accordance with corrections.
1C2-7	5-8	—	——	———	1/4 Scale Idealized Model. Project No. 3.3.8f. Assembly
					Erection Plans.
		A	5-12	———	Added Erection Marks.
		B	5-22	———	Revised in accordance with Design Drawing 100-261-3, Rev. 2.
		C	6-5	———	Corrected.
		D	6-6	———	Removed Horizontal Weld on Stiffener and Web of 10" x 2-3/4"

SHOP DRAWINGS

DRWG. NO.	DATE 1950	REV. NO.	DATE 1950	DATE APP. BY A-E	DESCRIPTION
					x 9" Jr.
1C2-8	5-10	—	—	—	1/4 Scale Idealized Model, Project No. 3.3.8f. Assembly
					Erection Plan for Angles on Fiber-Glass Seals.
		A	5-23	—	Revised in accordance with Design Drawing 100-261-3, Rev. 2.
		B	6-5	6-6-50	Corrected.
1C2-9	5-12	—	—	—	1/4 Scale Idealized Model, Project No. 3.3.8f. Structural
					Steel Details.
		A	5-23	—	Revised in accordance with Design Drawing 100-261-3, Rev. 2.
		B	6-5	6-6-50	Corrected.
1C2-10	5-12	—	—	—	1/4 Scale Idealized Model, Project No. 3.3.8f. Miscellaneous
					Details.
		A	5-23	6-3-50	Revised in accordance with Design Drawing 100-261-3, Rev. 2.
1C2-11	6-6	—	—	—	Idealized Models, Structures 3.3.8a,b,c,d,e & g. Details
					for Steel Frame and Plate.

SHOP DRAWINGS

ARMY & AIR FORCE SPECIAL MILITARY STRUCTURES

SUB-CONTRACTOR: Seaman Products, Burbank, California

PURCHASE ORDER NUMBER: 5586 & 8947 **DATE ISSUED:** 5-31-50&1-25-51

MATERIAL: Fiberglass Sealing Strips

DRWG. NO.	DATE 1950	REV. NO.	DATE 1950	DATE APP. BY A-E	DESCRIPTION
1			6-15	-------	Details for Fabrication of Fiberglass Strips.
					NOTE: This Drawing was approved by Holmes & Narver
					Construction Department.

SHOP DRAWINGS

AIR FORCE SPECIAL MILITARY STRUCTURES
DESIGN DRAWINGS 100-252-1 & -2 and 100-257-1 & -2

SUB-CONTRACTOR: Sould Steel Co., Los Angeles, California

PURCHASE ORDER NUMBER: 5371 **DATE ISSUED:** 5-12-50

MATERIAL: Steel Sash

DRWG. NO.	DATE 1950	REV. NO.	DATE 1950	DATE APP BY A-E	DESCRIPTION
4318	5-19	—	—	—	Sheet No. 1 of 2. Steel Sash Layout for Structures Type
					C-1.1, Project No. 3.3.3 and Type A-2.1, Project No. 3.3.4.
		1	7-6	7-17-50	Anchor Bolt Locations.
4318	5-19	—	—	—	Sheet No. 2 of 2. Steel Sash Details for Structures Type
					C-1.1, Project No. 3.3.3 and Type A-2.1, Project No. 3.3.4.
		1	7-6	—	Clip Angle Locations.
		2	7-25	—	Flashings added.
		3	8-23	9-19-50	Flashings Removed.

SHOP DRAWINGS

AIR FORCE SPECIAL MILITARY STRUCTURES
DESIGN DRAWING 100-259-2

SUB-CONTRACTOR: E.K. Wood Lumber Co., Oakland, California

PURCHASE ORDER NUMBER: 5584 DATE ISSUED: 6-6-50

MATERIAL: Millwork

DRWG. NO.	DATE 1950	REV. NO.	DATE 1950	DATE APP BY A-E	DESCRIPTION
1	--	---	----	7-17-50	Model Structure Type C-1.1, Project No. 3.3.8h.
					Door Details.
2	6-14	---	----	7-17-50	Model Structure Type C-1.1, Project No. 3.3.8h. Nailers.

SHOP DRAWINGS

AIR FORCE SPECIAL MILITARY STRUCTURES
DESIGN DRAWING 100-253-1

SUB-CONTRACTOR: E.K. Wood Lumber Co., Oakland, California

PURCHASE ORDER NUMBER: 6120 DATE ISSUED: 7-7-50

MATERIAL: Millwork

DRWG. NO.	DATE 1950	REV. NO.	DATE 1950	DATE APP. BY A-E	DESCRIPTION
1	7-10	--	----	8-16-50	Structure Type F-2, Project No. 3.3.5a & b. Enterance Door Details.
2	7-10	--	----	8-16-50	Structure Type F-2, Project No. 3.3.5a & b. Typical Window Details.
3	7-10	--	----	8-16-50.	Structure Type F-2, Project No. 3.3.5a & b. Inside Door Details.
4	7-27	--	----	8-16-50	Structure Type F-2, Project No. 3.3.5a & b. Stair Details.

SHOP DRAWINGS

AIR FORCE SPECIAL MILITARY STRUCTURES
DESIGN DRAWINGS 100-252-2 and 100-257-1

SUB-CONTRACTOR: E.K. Wood Lumber Co., Oakland, California

PURCHASE ORDER NUMBER: 6301 DATE ISSUED: 7-5-50

MATERIAL: Millwork

DRWG. NO.	DATE 1950	REV. NO.	DATE 1950	DATE APP BY A-E	DESCRIPTION
1	7-5	—	——	7-17-50	Structure Type C-1.1, Project No. 3.3.3. Doors and Frames.
					Structure Type A-2.1, Project No. 3.3.4. Doors
2	7-5	—	——	7-17-50	Structure Type A-2.1, Project No. 3.3.4. Door Frames.

EXHIBIT F

Minutes of Los Alamos Meetings of
June 18 and 19, 1950

SD 2548

HNS 1079
10 July 1950

LAB J-1139

RESUME OF PROGRAM THREE MEETING
28 and 29 June 1950
Los Alamos, New Mexico

List of Participants

Mr. Sherwood B. Smith	Director Program 3
LCDR William H. Rowen, USN	Deputy Director, Program 3
Mr. Martin D. Kirkpatrick	Project 3.1 Officer
Lt. C. L. Hayen (CEC) USN	Project 3.2 Officer
Mr. Louis A. Ness	Project 3.3 Officer
Mr. Robert J. O'Brien	Armour Research Foundation, Project 3.3
Mr. Harlan E. Lenander	Project 3.4 Officer, Field Instrumentation
Dr. Byron F. Murphy	Project 3.4
Mr. Luke Vortman	Project 3.4
Col. R. E. Jarmon, USAF	CTU 3.1.3
Dr. Thomas N. White	TU 3.1.5
Maj. Leonard Eddy, USAF	TU 3.1.7
Mr. Loris Gardner	CTU 3.1.6
Mr. Courtney D. Scott	TU 3.1.7
Dr. Jack C. Clark	TG 3.1 Operations
Mr. William R. Adair	TG 3.1 Security
Mr. Andrew W. Schoolmaster	Holmes & Narver, Construction
Mr. C. L. East	Holmes & Narver, Fiscal

The various participants were introduced, the agenda presented, and the primary purpose of the meeting stated to be the preparation of an operation plan covering the forward-area operations or the Program.

As a preparatory measure to the integrated effort of drafting an operation plan the following were accomplished:-

1. The organization of the Program was discussed with the aid of an organization-chart that was distributed.

2. Procedures necessary for coordinated action in the Program were cited with special reference to a directive relating to correspondence, SD, 2391.

3. A revised listing of predicated peak overpressures at the test structure locations, SD 2390, was distributed and confirmed as satisfactory for the test by each of the Project Officers. A map of the Program structure sites, HN drawing 17E234, Revised 21 June 1950, was distributed for information and comment.

Film badges
Pocket dosimeters
Shoe covers
Respirators
Coveralls and gloves as necessary.

Monitors will be provided where required. In general they will accompany all groups penetrating into dangerously radioactive regions. In addition they will be furnished to monitor as necessary within areas less highly contaminated where work is in progress. It will be necessary for groups working on the post-shot islands to be under the operational control of designated individuals furnished by the appropriate program. Such individuals shall be free from the distractions of having to personally perform details tasks and shall devote their efforts to direction of the operations under their control. They shall also be prepared to forecast operations in order to permit effective use of available monitors. The monitors will have the responsibility of advising the program operation control officers of any radiological dangers that may or that are attending the operations. The operation control officers shall be charged with enforcing precautions necessitated by the advice of the monitors.

Indoctrination of personnel in rad-safety procedures and problems will be conducted in October 1950. It was considered worthwhile to have some Program Three Personnel attend this indoctrination.

Mr. Loris Gardner of TU 3.1.6 discussed the documentary photography plans and procedures and supplied the meeting with the following information:

1. Present Operation Plans indicate the assignment of six photographers for post-shot coverage needed by Program Three.

2. Camera equipment now planned follows:

   Deardorff 8 x 10 Cameras with 14", 10", 8 1/2" lenses

   Linhoff Technica 4" x 5" Cameras with 8 1/2", 5 1/4", 3 1/2" lenses

   Pacemaker Graphic 4", x 5" with 8 1/2", 5 1/4", 3 1/2" lenses

   Tripods and other accessories included with each kit.

3. It will be possible to process negatives and furnish check prints if proper facilities (dark room, equipment, water, etc.) are provided near-by. Requirements for proof prints must be forwarded.

4. In lieu of slating each photograph, a form will be filled out as each shot is made identifying the film pack and film number and noting the description of the subject photographed as furnished by the person directing the photographer. The photographer will immediately supply the former with a carbon of this form. Further damage notes may be made on the carbon if desired. Prints of the

The meeting then proceeded to discuss the following subject:

The question of making measurements of the angle between girders and columns after the test was discussed with the purpose of determining whether this should be done directly by the DOD Project Officers or whether it should be done on a general basis by the Instrumentation Officer. It was agreed that this would be done by the DOD Project Officers.

The status of plans was discussed and Mr. Vortman indicated that all plans had been furnished to Holmes and Narver for redrawing in accordance with an understanding with Mr. David Narver. It is true that the shelters for the cameras have not been formally approved although indications are that they are acceptable both to Sandia and to EGG.

There was a brief discussion of the requirements for the preliminary and final reports required of Program Three and estimates were obtained by LCDR Rowen as to the number of volumes required for the final reports. The format of such reports has not been definitely established as yet.

A general statement was made by the Program Director with regard to the responsibilities in the accomplishment of construction. He pointed out that the plans and specifications were prepared by the DOD Project Officers and the responsibilities for such plans remained with them. However, it appeared to be the position of Holmes and Narver, that the firm was a contracting agency and had no engineering responsibility with respect to the construction of the test structures. It was pointed out that a gap existed in view of the fact that certain actions required engineering judgment and that these cases could not be controlled directly by the DOD Project Officers. The Program Director stated that it was his opinion that since the Scientific Director has assumed responsibility for the construction in accordance with the plans furnished by the Project Officers, it was his responsibility to assure that engineering judgment be used in handling those matters not specifically covered by the specifications or arising because of change of conditions which were not foreseen in the specifications. It was further pointed out that in view of the fact that Holmes and Narver was providing the inspection of construction for the Program, it was particularly important that Holmes and Narver assume some engineering responsibility rather than take the position that they are simply a contracting agency without any responsibility for the necessary engineering judgment in those cases where it may be required. This situation will be improved to some extent when the DOD Project representatives are on the site. However, it will still be the responsibility of the Scientific Director and the AEC agencies supporting him to construct the buildings in accordance with specifications. All tests of the materials will be made by [illegible] H&N inspection force rather than by the Service representative and the same responsibility will therefore be entailed even after the Service representatives are present on the site insofar as the ordinary requirements for good construction is concerned.

At the meeting on 28 June, the matter was discussed further with the Project Officers and they agreed to the proposal to send Dr. Davis out with rather broad authority to work out the best solution on the ground. Mr. Schoolmaster of H&N stated that in his opinion the action being taken was based on assumptions which might or might not be true. He was assured that there was no intention of taking drastic action unless it were required; rather it was intended to send someone fully qualified out to determine what action, if any, might be needed. If remedial action, such as grouting or providing additional solidified material on top of the coral, were indicated he would be in a position to advise as to the best method of handling the problem. Mr. Schoolmaster suggested Mr. Dames of Dames and Moore as another consultant. The matter was discussed with the Project Officers and it was agreed that the decision as to whether Mr. Dames would accompany Dr. Davis be left up to Mr. Cole. The DOD Project Officers were advised that the date of the meeting and location was firm and that they were to provide for representation at that meeting.

/s/ W. H. ROWEN
Deputy Director

DISTRIBUTION:
Copy 1 of 25A, S. B. Smith
Copies 2 and 3 of 25A, M. D. Kirkpatrick
Copies 4 and 5 of 25A- C. L. Hayen
Copies 6 and 7 of 25A- B. E. Pettit
Copies 8 and 9 of 25A- E. F. Cox
Copy 10 of 25A - T. N. White
Copy 11 of 25A - L. Gardner
Copy 12 of 25A - J. C. Clark
Copy 13 of 25A - W. R. Adair
Copy 14 of 25A - P. W. Spain
Copy 15 of 25A - A. C. Graves
Copy 16 of 25A - A. W. Schoolmaster
Copy 17 of 25A - C. L. East
Copies 18, 19, 20, 21, 22, 23, 24, and 25 of 25A - W. H. Rowen

EXHIBIT G

Test Reports of Materials, Military Structures

ARMY SPECIAL MILITARY STRUCTURE 3.1.3
CONCRETE COMPRESSION TEST DATA

DESCRIPTION	CYLINDERS			ULTIMATE STRENGTH, P.S.I.	
	LAB. NO.	PLACED 1950	SLUMP INCHES	7 DAY	28 DAY
First Bulkhead, l. to r.	20067	7-6	3¼	2325	3919
First Pipe Halves, l. to r.	20068	7-7	2½	4235	5182
Second Bulkhead, l. to r.	20069	7-10	2½	2634	3436
Second Pipe Halves, l. to r.	20070	7-10	3/4	3981	5308
Third Bulkhead, l. to r.	20359	7-13	--	3288	5011
Third Pipe Halves, l, to r.	20358	7-13	--	3938	5122
				Av. 3400	Av.4663

ARMY SPECIAL MILITARY STRUCTURES
REINFORCING STEEL TEST DATA

DESCRIPTION	ULTIMATE STRENGTH P.S.I.	YIELD POINT P.S.I.	BEND TEST
1-1/8" Square, BPCS.	75590	49610	O.K.
1" Square, BPCS.	75000	49800	O.K.
1" Round, Deformed.	74900	49430	O.K.
7/8" Round, Deformed.	85190	56570	O.K.
3/4" Round, Deformed.	77490	46950	O.K.
5/8" Round, Deformed.	75570	48050	O.K.
1/2" Round, Deformed.	75510	46680	O.K.
3/8" Round, Deformed.	75910	50910	O.K.
1/4" Round, Plain.	78430	57840	O.K.
3/8" Round, Plain.	60810	40540	O.K.
	Av. 75440	Av. 49638	

ARMY SPECIAL MILITARY STRUCTURES STRUCTURAL STEEL TEST DATA			
DESCRIPTION	HEAT NUMBER	YIELD POINT P.S.I.	TENSILE STRENGTH P.S.I.
Angle, 4" x 4" x 1/2".	22116	41600	66200
Angle, 4" x 4" x 3/8".	62286	43200	65400
Angle, 4" x 3" x 3/8".	81930	44500	67200
Bar, 1" Round.	44109	42200	65650
Bar, 4" x 5/8".	12694	43300	64250
Angle, 2½" x 2½" x 5/16".	12436	42050	66100
12" x 19#B.	53P305	48770	65400
16" x 36#B.	273230	45850	65010
12" x 22#B.	213235	50480	66390
Plate, 7/8".	751649	38710	68780
10" x 25#B.	353508	49020	64600
24" x 84#B.	303595	42190	67500
Angle, 6" x 4" x 1/2".	21963	38000	65500
Bar, 3" x 3/8".	12614	43200	65000
Angle, 5" x 3½" x 3/8".	72220	41500	67200
Angle, 6" x 4" x 5/8".	61982	38000	63400
Angle, 8" x 4" x 1/2".	248553	38450	66480
Plate, 7" x 1/2".	62308	36090	64300
5" x 10#B.	22813	43750	61720

ARMY SPECIAL MILITARY STRUCTURES
STRUCTURAL STEEL TEST DATA

DESCRIPTION	HEAT NUMBER	YIELD POINT P.S.I.	TENSILE STRENGTH P.S.I.
6" x 12.5#B.	91377	45900	64900
10" x 25.4#B.	12582	49070	68530
Angle, 3½" x 2½" x 5/16".	32927	40100	62250
Angle, 3" x 2½" x 5/16".	32950	40750	63500
Bar, 5/8" Round.	86128	41700	65700
Bar, 2½" x 1/4".	23689	41900	63750
Plate, 1¼".	121296	37090	64420
Angle, 2½" x 2½" x 1/4".	33941	42450	65600
Bar, 3" x 1/4".	13269	43550	61500
Bar, 3" x 1/2".	44904	43000	65750
Bar, 1¼" x 1/4".	03140	46250	72000
Bar, 3" x 5/8".	13125	42200	67450
Bar, 3" x 3/8".	24979	44200	62350
Bar, 3½" x 5/8"	24843	41800	65100
Bar, 3/4" Round.	44271	41800	66400
Bar, 7/8" Round.	44931	40750	63100
Bar, 1/2" Round.	44688	43000	61800
Bar, 2" x 1/4".	34228	40500	61700
Plate, 1/4".	71939	46000	67500

ARMY SPECIAL MILITARY STRUCTURES
STRUCTURAL STEEL TEST DATA

DESCRIPTION	HEAT NUMBER	YIELD POINT P.S.I.	TENSILE STRENGTH P.S.I.
Plate, 3/8".	41684	43000	69100
Angle, 4" x 3" x 5/8".	41383	37700	66110
Angle, 3½" x 2½" x 5/16".	12563	44150	71000
Angle, 2" x 1½" x 3/16".	12484	-----	-----
Bar, 3" x 1".	12553	44600	68550
Bar, 4" x 5/8".	12522	45600	71400
Angle, 2½" x 2" x 5/16".	33426	43300	68600
Angle, 3" x 2½" x 5/16".	33332	42550	64950
Bar, 3½" x 5/16".	33164	44500	65150
Bar, 3½" x 3/8".	33164	41450	64500
Angle, 3" x 3" x 5/16".	12446	41050	71750
Angle, 2½" x 2" x 3/8".	24188	40900	67000
Plate,7/16".	22080	46900	71500
Angle, 3½" x 3½" x 5/16".	32111	46500	67600
27" x 145#B.	53A314	43390	62840
21" x 127#B.	53A243	44670	67780
Bar, 2¼" Round.	4K278	41000	66750
5" x 3¼" x 17.9# x 30' Zees.	269800	37970	67560
Bar, 3½" Round.	32728	33200	63500

ARMY SPECIAL MILITARY STRUCTURES
STRUCTURAL STEEL TEST DATA

DESCRIPTION	HEAT NUMBER	YIELD POINT P.S.I.	TENSILE STRENGTH P.S.I.
Bar, 3½" Round.	12616	33100	60500
Bar, 3" Round.	3W088	33000	64000
Bar, 3" Round.	31W078	34000	62000
Channel, 3" x 6#.	962628	44080	67770
Beam, 24" x 120#.	55A348	44230	65660
Plate, 3/16".	82269	42700	61400
Plate, 1½".	62622	33200	68400
Angle, 5" x 3½" x 5/16".	42397	43000	65400
Channel, 8" x 11.5#.	82284	47000	62200
Channel, 4" x 5.4#.	12134	49500	68200
Channel, 4" x 5.4#.	42418	53400	71600
Channel, 8" x 13.75#.	82165	44600	63100
Plate, 7/16".	91995	38100	63500
Channel, 12" x 25#.	31982	36700	64100
Plate, 5/8".	32208	42300	67200
Plate, 1/2".	82045	36800	68700
Plate, 3/4".	22219	35300	63300
Angle, 6" x 4" x 3/8".	42137	39600	60500
Channel, 5" x 9#.	62350	42900	68700

ARMY SPECIAL MILITARY STRUCTURES
STRUCTURAL STEEL TEST DATA

DESCRIPTION	HEAT NUMBER	YIELD POINT P.S.I.	TENSILE STRENGTH P.S.I.
Channel, 15" x 33.9#.	42118	40100	61700
Angle, 3½" x 3" x1/2".	51859	39400	60300
Plate, 1".	423631	40370	66780
Plate, 3/8".	383492	40820	64610
18" x 60#B.	283548	42660	70860
24" x 76#B.	393622	43740	66300
14" x 68#B.	333642	41500	65680
Plate, 1½".	473848	36770	69660
Angle, 8" x 6" x 5/8".	259164	33420	65260
Angle, 8" x 8" x 1/2".	293905	38170	63400
36" x 230# CB.	313788	41270	65160
18" x 50#B.	343456	45800	67760
143 x 68# CB.	283797	39610	63500
146 x 246# CB.	383590	33700	64220
145 x 127# CB.	273807	35560	64420
146 x 150# CB.	323800	36380	69100
143 x 61# & 74# CB.	273836	47570	68320
142 x 43# CB.	293826	42140	65570
146 x 246# CB.	313774	33970	70320

ARMY SPECIAL MILITARY STRUCTURES
STRUCTURAL STEEL TEST DATA

DESCRIPTION	HEAT NUMBER	YIELD POINT P.S.I.	TENSILE STRENGTH P.S.I.
Bar, 2" x 1¼".	66L393	36630	64310
Angle, 8" x 4" x 7/16".	332753	40580	67730
Plate, 3/8".	41538	39450	65300
24" x 100#B.	53K500	47990	70910
Bar, 5" x 3/8".	2H237	38600	62500
Bar, 1-3/4" Round.	1Y225	38640	61380
Angle, 1" x 1" x 1/8".	19783	-----	-----
Bar, 2" x 3/16".	21502	-----	-----
24" x 94#B.	361593	39620	62240
Bar, 7" x 7/16".	50941	39140	66840
Angle, 4" x 3½" x 5/16".	555575	40220	69340
		Av. 41332	Av.65814

NAVY SPECIAL MILITARY STRUCTURE 3.2.1a
CONCRETE COMPRESSION TEST DATA

DESCRIPTION	CYLINDERS			ULTIMATE STRENGTH, P.S.I.	
	LAB NO.	PLACED, 1950	SLUMP, INCHES	7 DAY	28 DAY
Small Cells.	19273	6-20	7	4156	6593
Small Cells. *	20368	7-19	2-3/4	4050	8414
				Av. 4103	Av. 7504
* Indicates 3-3/8" x 6-1/4" Test Cylinders.					
All others 6" x 12".					

NAVY SPECIAL MILITARY STRUCTURE 3.2.1b
CONCRETE COMPRESSION TEST DATA

DESCRIPTION	CYLINDERS			ULTIMATE STRENGTH, P.S.I.	
	LAB NO.	PLACED, 1950	SLUMP, INCHES	7 DAY	28 DAY
Large Cells.	18889	6-8	2-1/2	4048	5704
Large Cells.	18973	6-9	---	3792	6007
Large Cells.	20365	7-11	3-1/4	4498	5900
				Av. 4035	Av.5870
All Test Cylinders 6" x 12".					

NAVY SPECIAL MILITARY STRUCTURE 3.2.2a
CONCRETE COMPRESSION TEST DATA

DESCRIPTION	CYLINDERS			ULTIMATE STRENGTH, P.S.I.	
	LAB NO.	PLACED, 1950	SLUMP, INCHES	7 DAY	28 DAY
Roof Panels.	20020	7-7	5-1/4	2934	4013 —
Roof Panels.	20594	7-25	3	4857	6702
Columns & Beams. *	20740	7-28	2-1/2	4839	8821
Left Side Panels. (No. 1).	21264	8-10	2-3/4	4310	6838
Columns & Beams *	21266	8-10	2-3/4	3776	6022
Panels. (No. 2). *	21267	8-11	3-1/2	3709	5812
Front & Rear Panels.	21559	8-18	3	6307	8360
Right Side Panels.	21672	8-23	3-1/2	4067	6961
Extra Panels.	22251	9-7	3	5329	7748
Extra Panels.	22252	9-11	2-1/2	6678	8839
				Av.4681	Av.7012
* Indicates 3-3/8" x 6-1/4" Test Cylinders.					
All others 6" x 12".					

NAVY SPECIAL MILITARY STRUCTURE 3.2.2b
CONCRETE COMPRESSION TEST DATA

DESCRIPTION	CYLINDERS			ULTIMATE STRENGTH, P.S.I.	
	LAB NO.	PLACED, 1950	SLUMP, INCHES	7 DAY	28 DAY
Side Panels.	19590	6-28	3-3/4	2914	4096 —
Roof Panels.	19730	6-30	3	3143	4639 —
Roof Panels. (No. 1).	20366	7-18	3-1/4	2773	4105 —
Roof Panels.	20738	7-27	2	4816	8077
Front & Rear Panels.	20838	7-28	4	4329	6669
Roof Panels. (No. 2).	21264	8-10	2-1/4	4269	7084
Extra Panels.	22251	9-7	3	5329	7748
				Av.3939	Av.6060
All Test Cylinders 6" x 12".					

NAVY SPECIAL MILITARY STRUCTURE 3.2.3a
CONCRETE COMPRESSION TEST DATA

DESCRIPTION	CYLINDERS			ULTIMATE STRENGTH, P.S.I.	
	LAB NO.	PLACED, 1950	SLUMP, INCHES	7 DAY	28 DAY
Roof Panels, Extra.	22247	9-12	3-1/2	5246	8251
				Av.5246	Av.8251
All Test Cylinders 3-3/8" x 6-1/4".					

NAVY SPECIAL MILITARY STRUCTURE 3.2.3b
CONCRETE COMPRESSION TEST DATA

DESCRIPTION	CYLINDERS			ULTIMATE STRENGTH, P.S.I.	
	LAB NO.	PLACED, 1950	SLUMP, INCHES	7 DAY	28 DAY
Roof Panels, Extra.	22247	9-12	3-1/2	5246	8251
				Av.5246	Av.8251
All Test Cylinders 3-3/8"x6-1/4".					

NAVY SPECIAL MILITARY STRUCTURE 3.2.4a
CONCRETE COMPRESSION TEST DATA

DESCRIPTION	CYLINDERS			ULTIMATE STRENGTH, P.S.I.	
	LAB NO.	PLACED, 1950	SLUMP, INCHES	7 DAY	28 DAY
Floor Panels.	19132	6-14	4-1/2	3672	5041
Floor Panels.	19133	6-15	----	4266	5828
Rear Panels.	19273	6-20	4-1/2	3431	5792
Floor Panels.	19729	6-29	3	3713	5086
Rib Section (No. 1, 9:10 A.M.)	19895	7-5	6	3620	4740 —
Rib Section (No. 2, 10:50 A.M.)	19895	7-5	1-3/4	3436	5001
Floor Panels (No. 3, 2:00 P.M.)	19895	7-5	1	3071	4129 —
Front, Right End (No. 1).	20115	7-10	2-1/4	3135	3968 —
Front, Left End (No. 2).	20115	7-10	4-3/4	3346	4420 —
Rib Sections (No. 1).	20593	7-21	2-1/2	5003	7699
Rib Sections (No. 2).	20593	7-21	4-3/4	4670	7622
Rear Panels, Extra (No. 2).	20737	7-26	2-1/2	4603	7270
Rib Sections.	21154	8-9	3-1/2	4520	6792
Roof Panels. *	21894	8-31	2-1/4	5460	5902
				Av.3996	Av.5671
* Indicates 3-3/8" x 6-1/4" Test Cylinders.					
All others 6" x 12".					

NAVY SPECIAL MILITARY STRUCTURE 3.2.4b
CONCRETE COMPRESSION TEST DATA

DESCRIPTION	CYLINDERS			ULTIMATE STRENGTH, P.S.I.	
	LAB NO.	PLACED, 1950	SLUMP, INCHES	7 DAY	28 DAY
Rib Sections. (No. 1).	20019	7-6	1-1/4	3054	4284 —
Rear Panels. (NO. 2).	20116	7-11	3	3023	3953 —
Floor Panels.	20463	7-14	3	3168	4661 —
Rib Sections - Down. (No. 1).	20464	7-20	3-1/2	5036	6351
Floor Panels. (No. 3).	20593	* 7-21	1-3/4	4418	7965
Rib Sections - Down.	21030	8-7	2-1/2	4679	6896
Rear Panels, Extra	21153	8-8	3	4411	7145
Rib Sections - Up.	21155	8-9	3-3/4	4761	7753
Rib Sections - Down.	21671	8-23	2-1/2	4990	7570
Rib Sections - Up.	21745	8-25	3	4424	7371
Front Panels.	21892	8-29	3	5016	6943
Roof Panels, Extra *	21894	8-31	2-1/4	5460	5902
Rib Sections - Down. *	22242	9-1	2-1/2	4023	5297
Front Panels, Extra. *	22244	9-8	3-1/2	4180	6432
Rib Sections - Down, No Cross Ribs. *	22245	9-11	2	4298	5575
Rib Sections - Up, No Cross Ribs. *	22246	9-11	2-1/2	4268	6239
* Indicates 3-3/8" x 6-1/4" Test Cylinders.				Av.4326 = 69 %	Av.6271
All others 6" x 12".					

NAVY SPECIAL MILITARY STRUCTURE 3.2.6
CONCRETE COMPRESSION TEST DATA

DESCRIPTION		CYLINDERS			ULTIMATE STRENGTH, P.S.I.	
		LAB NO.	PLACED, 1950	SLUMP, INCHES	7 DAY	28 DAY
Right Side Panels.		20300	7-14	—	3171	4705 —
B Panels.		20367	7-19	3	3388	5437
C Panels. (No. 2).		20464	7-20	2-3/4	4044	7332
D Panels. (No. 3).		20464	7-20	4-1/2	5048	7657
A Panels.	*	20465	7-20	3-1/2	3343	6847
Top Panel.	*	20739	7-27	2	4140	7869
A & B Panels.	*	20840	7-31	3	3860	----
C & D Panels.		21029	8-3	3-1/2	3634	6710
A&B Panels. (No. 1).	*	21267	8-11	3	3881	5199
C & D Panels.	*	21557	8-17	2-1/4	4085	6245
A & B Panels.	*	21746	8-25	2-1/2	2968	6594
C & D Panels.	*	21893	8-29	2-1/2	3711	5716
A & B Panels.	*	22243	9-7	3	4083	5096
C & D Panels.	*	22248	9-12	2	4272	5917
					Av.3831 = 61±% of	Av.6256
* Indicates 3-3/8" x 6-1/4" Test Cylinders.						
All others 6" x 12".						

NAVY SPECIAL MILITARY STRUCTURES
WIRE MESH TEST DATA

DESCRIPTION	LAB NO.	GAUGE NO.	ACTUAL DIA.	YIELD POINT P.S.I.	TENSILE STRENGTH P.S.I.	CHARACTER OF FRACTURE
2" x 2" No. 1	18640	8	.160	55660	85980	In Weld
2" x 2" No. 1	18640	10	.133	67590	96340	In Weld
2" x 2" No. 1	18640	12	.105	36800	69000	In Weld
2" x 2" No. 2	18640	8	.163	39320	69940	In Weld
2" x 2" No. 2	18640	10	.132	68970	91680	In Weld
2" x 2" No. 2	18640	12	.105	52640	77700	In Weld
2" x 2" No. 1	18758	12	.105	62070	82760	In Weld
2" x 2" No. 2	18758	12	.105	56550	76320	In Weld
2" x 2" No. 1	18758	8	.161	70780	81760	In Wire
2" x 2" No. 2	18758	8	.161	90880	97060	In Weld
2" x 2" No. 1	20422	10	.135	90840	95740	In Weld
2" x 2" No. 2	20422	10	.136	71030	93780	In Weld
2" x 2" No. 3	20422	10	.133	83450	97840	In Weld
2" x 2" No. 4	20422	10	.135	82460	99230	In Weld
2" x 2" No. 5	20422	10	.135	89440	100630	In Weld
Planet Mfg. Co. No. 1	—	10	—	—	82793	—
Planet Mfg. Co. No. 2	—	10	—	—	91433	—
Planet Mfg. Co. No. 3	—	10	—	—	85673	—
				Av. 67899	Av. 87536	

NAVY & AIR FORCE SPECIAL MILITARY STRUCTURES
REINFORCING STEEL TEST DATA

DESCRIPTION	YIELD POINT P.S.I.	TENSILE STRENGTH P.S.I.	BEND TEST
Reinforcing Bar, 1¼" Square	48300	85700	O.K.
Reinforcing Bar, 1-1/8" Square	41200	71500	O.K.
Reinforcing Bar, 1" Square	45550	77340	O.K.
Reinforcing Bar, 1" Round	46700	76200	O.K.
Reinforcing Bar, 7/8" Round	48400	75900	O.K.
Reinforcing Bar, 3/4" Round	50000	75100	O.K.
Reinforcing Bar, 3/4" Round	47170	75680	O.K.
Reinforcing Bar, 5/8" Round	46000	74500	O.K.
Reinforcing Bar, 1/2" Round	47100	74000	O.K.
Reinforcing Bar, 3/8" Round	57200	80200	O.K.
	Av. 47762	Av. 76612	

NOTE: This steel used in foundations only of Navy and Air Force Structures.

NAVY SPECIAL MILITARY STRUCTURES
REINFORCING STEEL TEST DATA

DESCRIPTION	LAB NO.	HEAT NO.	YIELD POINT P.S.I.	TENSILE STRENGTH P.S.I.	CHARACTER OF FRACTURE	COLD BEND TEST
1"Ø, Deformed	18619	10272	45390	62320	Silky	O.K.
7/8"Ø, Deformed	18619	16558	45000	64740	Silky	O.K.
3/4"Ø, Deformed	18619	47040	41740	65300	Silky	O.K.
1/2"Ø, Deformed	18619	44960	44960	59980	Silky	O.K.
3/8"Ø, Deformed	18619	82989	47280	72190	Silky	O.K.
1/4"Ø, Plain	18619	4477	52360	66690	Silky	O.K.
			Av. 46122	Av. 65203		
NOTE: This steel used in pre-cast panels only.						

AIR FORCE SPECIAL MILITARY STRUCTURE 3.3.3
CONCRETE BLOCK TEST DATA

DESCRIPTION	LAB NO.	SAMPLE NO.	COMPRESSIVE STRENGTH P.S.I.	ABSORPTION LBS/CU.FT.
7-3/4"x 15-3/4"x 7-3/4", Hollow.	22390	1	1334	6.31
		2	916	6.12
		3	1005	6.41
		4	1254	7.95
		5	943	7.28
7-3/4"x 15-3/4"x 7-3/4", Hollow.	22391	1	1399	8.54
		2	1160	8.14
		3	1157	8.36
		4	1163	8.24
		5	1112	7.85
7-3/4"x 15-3/4"x 7-3/4", Hollow.	22392	1	903	9.67
		2	1184	10.56
		3	1216	12.89
		4	1109	8.65
		5	1416	8.97
			Av. 1159	Av.8.40

NAVY & AIR FORCE SPECIAL MILITARY STRUCTURES
REINFORCING STEEL TEST DATA

DESCRIPTION	YIELD POINT P.S.I.	TENSILE STRENGTH P.S.I.	BEND TEST
Reinforcing Bar, 1¼" Square	48300	85700	O.K.
Reinforcing Bar, 1-1/8" Square	41200	71500	O.K.
Reinforcing Bar, 1" Square	45550	77340	O.K.
Reinforcing Bar, 1" Round	46700	76200	O.K.
Reinforcing Bar, 7/8" Round	48400	75900	O.K.
Reinforcing Bar, 3/4" Round	50000	75100	O.K.
Reinforcing Bar, 3/4" Round	47170	75680	O.K.
Reinforcing Bar, 5/8" Round	46000	74500	O.K.
Reinforcing Bar, 1/2" Round	47100	74000	O.K.
Reinforcing Bar, 3/8" Round	57200	80200	O.K.
	Av. 47762	Av. 76612	
NOTE: This steel used in foundations only of both Navy and Air Force Structures.			

AIR FORCE SPECIAL MILITARY STRUCTURES 3.3.3 & 3.3.4
STRUCTURAL STEEL TEST DATA

DESCRIPTION	HEAT NO.	YIELD POINT, P.S.I.	TENSILE STRENGTH P.S.I.	BEND TEST
Angle, 6" x 4" x 7/16".	K040	38070	60050	O.K.
Angle, 6" x 4" x 7/16".	K006	40560	63340	O.K.
Angle, 6" x 4" x 3/8".	K009	40930	61250	O.K.
Bar, 2½" x 5/16".	2K258	44820	65010	----
Angle, 2½" x 2" x ¼".	3J420	46220	67160	----
Angle, 2½" x 2½" x 5/16".	4K086	42630	64960	O.K.
Angle, 2½" x 2½" x 5/16".	3J630	42750	63770	O.K.
Bar, 3½" x 7/8".	3K967	33750	60650	O.K.
Bar, 3½" x 3/4".	3K967	36550	60330	O.K.
Bar, 3½" x 5/8".	3K967	40220	60780	O.K.
Angle, 1½" x ½" x 3/16".	4K297	43720	65300	O.K.
Channel, 5" x 6.7#.	3K987	51600	65480	O.K.
Angle, 3" x 2½" x 5/16".	5J770	41290	61440	O.K.
Angle, 2½" x 2" x ¼".	3J420	46220	67160	----
Angle, 2½" x 2" x ¼".	5J744	44830	64390	----
Angle, 2½" x 2" x ¼".	2J879	45920	69020	----
Angle, 5" x 3½" x ½".	3J435	41050	67620	----
Angle, 5" x 3½" x ½".	5K116	39760	64580	----
Angle, 4" x 3" x ½".	4J833	37430	65430	-----

AIR FORCE SPECIAL MILITARY STRUCTURES 3.3.3 & 3.3.4
STRUCTURAL STEEL TEST DATA

DESCRIPTION	HEAT NO.	YIELD POINT, P.S.I.	TENSILE STRENGTH P.S.I.	BEND TEST
Angle, 3½" x 3" x 5/16".	3K958	40530	62320	----
Angle, 3½" x 3" x ¼".	3K961	41870	61160	----
Angle, 3" x 2½" x ¼".	3K056	44880	67790	O.K.
Channel, 6" x 8.2#.	3K024	45500	61250	O.K.
Angle, 3" x 2½" x ¼".	3K056	44880	67790	O.K.
Angle, 4" x 3" x ¼".	3K043	41670	62300	----
Channel, 4" x 5.4#.	3K067	41670	60930	O.K.
Beam, 3" x 5.7#.	2K445	41340	61220	O.K.
Channel, 3" x 4.1#.	5K259	44530	63970	O.K.
Beam, 12" x 27#.	36A357	47020	66040	O.K.
Beam, 12" x 27#.	46A338	41780	64760	O.K.
Light Beam, 10" x 15#.	36A363	48250	67660	O.K.
Beam, 10" x 21#.	38A363	45890	66310	O.K.
Light Beam, 10" x 15#.	36A363	48250	67660	O.K.
Light Column, 6" x 15.5#.	44A272	37180	62540	O.K.
Light Column, 6" x 15.5#.	36A367	38590	64230	O.K.
Light Column, 6" x 15.5#.	40A471	38370	63300	O.K.
Beam, 24" x 84#.	34A299	41320	64880	O.K.
Beam, 12" x 27#.	55A474	45700	69350	O.K.

AIR FORCE SPECIAL MILITARY STRUCTURE 3.3.8

STRUCTURAL STEEL TEST DATA

DESCRIPTION	HEAT NO.	YIELD POINT P.S.I.	TENSILE STRENGTH P.S.I.
Light Beam, 10" x 15#.	55A274	48540	71350
Light Beam, 10" x 15#.	41A309	46740	66580
Joist, 8" x 10#.	41A316	52690	64510
Joist, 8" x 10#.	44A077	54000	67310
Joist, 8" x 10#.	31A069	57540	65280
Bar, 2½" x 3/8".	16715	47000	68400
Beam, 8" x 58#.	535273	38300	67840
Plate, 3/4".	43994	39190	61170
I Beam, 3" x 5.7#.	13230	42350	69500
Beam, 12" x 79#.	51A233	40030	69540
Angle, 1/2" x 1/2" x 1/8".	3K910	47370	64470
Channel, 3/4" x 3/8" x 1/8".	5K171	46050	63160
Angle, 2" x 2" x 1/8".	10285	52000	66000
Angle, 1/2" x 1/2" x 1/8".	3K910	47370	64470
Bar, 3" x 5/8".	1EA836	41600	68480
Channel, 3/4" x 3/8" x 1/8".	SK171	46050	63160
Angle, 2" x 2" x 1/8".	10285	52000	66000
Angle, 1½" x 1½" x 1/8".	4K294	42670	67240
Channel, 1½" x ½" x 1/8".	4K228	47660	67280

AIR FORCE SPECIAL MILITARY STRUCTURE 3.3.8

STRUCTURAL STEEL TEST DATA

DESCRIPTION	HEAT NO.	YIELD POINT P.S.I.	TENSILE STRENGTH P.S.I.
I Beam, 3" x 5.7#.	3H067	45020	68580
Bar, 2" x 1/2".	E41149	41710	63670
Bar, 4" x 3/8".	44903	42300	61500
Plate, 1/2" x 72" x 120".	63563	40080	66580
Bar, 2" x 1/4".	1EA724	44440	65320
Bar, 2" x 3/8".	03543	42100	67700
Bar, 1" x 1/2".	03087	41600	68350
Bar, 2" x 1/4".	13725	41420	63170
Plate, 1/4" x 72" x 360".	53845	46320	67850
Plate, 1/2" x 36" x 144".	33963	43850	66310
Pipe Flanges, 3/4" x 10" O.D.	63304	39050	63950
Bar, 3" x 3/4".	33674	42490	66490
Plate, 1/2" x 48" x 48".	33963	43850	66310
Plate, 1/2" x 36" x 144".	33963	43850	66310
Junior Beam, 10" x 9#.	555785	44260	66080
Bar, 3/4" Round.	16749	43300	67300
Angle, 4" x 3" x 1/4".	62413	45100	66200
Angle, 4" x 4" x 3/8".	22116	41600	66200
Angle, 3" x 2½" x 5/16".	23788	43700	71000

EXHIBIT H

Inspection Report, Army Structures

To: Mr. Charles T. Cooper
A.E.C. Resident Engineer

Date: 16 June 1950

From: Mr. Christian Beck
Office, Chief of Engineers
Department of the Army
Eniwetok Atoll

Subject Inspection Report - Army Structures

1. There is enclosed a report of my inspection of the Army structures and the results of my discussions and consultations with Dr. Carlson, A.E.C. and Holmes & Narver personnel.

2. It is urgently requested that the recommendations inthe enclosed report be followed.

3. It is also requested that Lt. D. C. Iselin, Navy be consulted regarding the Army structures until the O.C.E. representatives arrive here, scheduled about 1 July 1950.

CHRISTIAN BECK
OFFICE, CHIEF OF ENGINEERS

CB:fjb:jk

1 Incl.
Insp. Rep't - Army Struct's

* *

16 June 1950

INSPECTION REPORT - ARMY STRUCTURES

1. MULTI-STORY BUILDING (Project 3.1.1)

a. Borings - Test borings at this site indicated dangerously weak subfoundation condition. A more or less solidified dry coral sand and gravel shelf, varying in thickness from 2' to 6' is generally encountered approximately 6' below ground level. Underlying this layer of good foundation material there seems to be nothing by wet to saturated sand, in some cases apparently large voids, down to a depth of approximately 20', i.e. to maximum depth of borings. A 20'-0" x 1/2" dia. steel rod was used to probe existing holes. In no case did this rod meet resistance in the saturated sand. Conditions seem to be particularly dangerous at the rear of the building where the load on the foundation is the heaviest, and a large void is encountered at the most critical point of Building Section 7, i.e., at the rear corner adjoining Section 6.

b. Bearing Tests - Load bearing tests were made on top of the rock or solidified gravel slab, loading the bearing plate in 2 ton increments up to 12 T/Sq. ft. as defined in the specifications. Apparently the data shown by the stress-strain curves and time deflection curves for constant maximum load indicate that the foundation sub-grade complies with the specifications. However, due to the peculiar sub-foundation condition of soft underlying material, the test data appear dangerously misleading. The bearing test is made on a relatively small area, on a 20" diameter plate, the load is spread out by the rock slab over a relatively large area, so that the actual bearing on the wet underlying material may not exceed more than possibly .5 ton/sq. ft. It appears important to know how much this underlying material will carry, to determine exactly what measures should be taken to remedy the condition. The distribution of the whole building load on the soft sub-soil will, of course, be proportionally much less than for the 2" diameter bearing plate test.

c. Pressure Grouting - The undersigned consulted Dr. Roy Carlson and a scheme of pressure-grouting the soft subgrade was tentatively formulated for consideration. The scheme was discussed in detail at a meeting in Mr. Cooper's office on the morning of 15 June 1950. Present were Messrs. Curtis, Cooper, Kohl and Beck, Drs. Carlson and Stephenson and Lt. Iselin. It was generally agreed that something should be done to increase the foundation bearing area on the underlying wet material. At this stage of construction a scheme of pressure-grouting outside the footing, say 2' to 5' from the outside edge, need not interfere with, nor delay construction operations. The discussion brought out the need for particularly careful pressure-grouting operations, possibly at relatively low pressure. Considerable experimenting with equipment and procedures will undoubtedly be necessary before grouting at the actual job-site. Grouting should be done all along the rear of the building, with grout holes at say 10' c.c about 2' to 5' from footing edge. Particular care should be taken where borings or probings indicate large voids, in order not to spend an excessive amount of cement. It was generally agreed by all concerned that the Army Specifications cover the above measures and, therefore, no change order will be required to cover this work. It was also agreed that bearing tests be made to determine the bearing capacity of the wet underlying material. This will require excavation and cutting through the solidified upper crust.

d. Inspection - Because of the experimental nature of the building and the many different elements of the building being investigated, it is particularly important that:

(1) Construction follows the design drawings as closely as possible; adding material to gain more strength than called for is just as bad as reduction in material;

(2) "As-built" construction be carefully recorded, and whenever possible the inspector should be present during concrete pouring to record any particular conditions which may be of interest for the post-blast test design analysis;

(3) Test specimen be obtained as called for in the specifications and wherever substitute material, as approved, is being used.

If a satisfactory concrete beam testing equipment can be rigged up, it is recommended that a number of the beams (not to exceed 1/4 of the total number of beams called for) be tested at the jobsite for control. The other beams and the concrete cylinders which are to be shipped to the States, shall be field cured to proximate condition of the element of the building represented by this sample. Until advised differently, any test specimen sent to the States shall be shipped to:

Director of South Pacific Division Laboratory
Corps of Engineers, U.S. Army
Sausalito, California

(4) Erection drawings, as checked by Ammann and Whitney should be available at the jobsite in order to simplify interpretation of drawings and to insure that construction is accomplished exactly as planned and indicated on the design drawings. Mr. Curtis suggested that the undersigned stop over at Los Angeles to duscuss with Mr. Schoolmaster, Holmes & Narver, this and other problems encountered in connection with the Army structures.

The two Corps of Engineers' representatives, who are scheduled to be out here from about 1 July to end of construction period, are expected to help out with the inspection in addition to giving advice in regard to interpretation of drawings and specifications. They will act as authorized representatives of the Army Project Officer, and as such will apprive necessary changes. Any major changes may require approval by the Project Officer in Washington.

(e) Soil Pressure Gages - Dr. Carlson advised the undersigned about the method which is being used in installing the pressure gages. This method, requiring no sand bed under the footings, removes the danger of sliding on the lean concrete foundation.

2. BURIED SHELTER (Project 3.1.3)

The above considerations and recommended measures apply equally to the shelter structure. The foundation conditions should be explored as indicated above and foundation strengthened to support an estimated load of 5 Tons/sq. ft. of floor slab. The Army Specifications possibly give the impression of referring principally to the Multi-story building. They do, of course, apply equally to the shelter structure.

3. SUMMARY OF RECOMMENDATIONS

a. Multi-story Building - It is recommended that:

(1) Bearing test should be made near the site to determine the bearing capacity of the wet underlying foundation materials;

(2) pressure grouting should be accomplished along the rear of the building to increase the foundation bearing area on the underlying wet material. Loading test (see (1) above) should indicate area required for safe bearing;

(3) construction, testing and inspection be more accurate and in accordance with specifications and drawings, because of the experimental nature of the building;

(4) erection drawings, as checked by Ammann and Whitney, should be available at the jobsite;

(5) "as-built" construction should be carefully recorded; and

(6) top of lean concrete foundation shall be roughened sufficiently to insure proper friction against horizontal sliding.

b. Buried Shelter - It is recommended that:

(1) Borings and load bearing tests be made to insure safe foundations bearing, and if necessary accomplish pressure grouting as outlined above;

(2) construction, testing and inspection be as accurate as possible, in accordance with design and specifications.

Christian Beck
Auth. Representative of Project Officer
Dept. of the Army Structures Program

CB:fjb:jk

EXHIBIT I

Minutes of Meeting of August 2, 1950

3 August 1950

MINUTES OF MEETING

On the evening of August 2, 1950 at 8:00 PM, the following met to discuss the memorandum of Dr. Raymond E. Davis, Consultant, of even date, on foundation grouting. In addition, some review was made of the remaining exploration program.

D. Lee Narver, Acting Project Manager, HN
Lester J. Kelley, Director of Procurement, HN
A. R. Sedgley, Resident Manager, HN
Fred Jordan, Construction Manager, HN
H. C. Kohl, Engineering Manager, HN
F. M. Hines, Asst. Construction Manager, HN
Dr. Raymond E. Davis, Consultant to AEC & the Armed Services
R. E. Cole, Director, Eng. & Const., SFOO, AEC
John Ranttila, Asst. to Resident Engineer, AEC

1. Alex Hawkins of Prepakt Inc. can be released until new contract made with Prepakt for larger crew at time materials will be available.

2. Sample cylinders being made which will be used to determine the time test drilling of grouted area should be performed. Dr. Davis says this should not exceed 30 days.

3. Dr. Davis confirmed his statement that foundation for building 3.1.1 could be adequately strengthened by grouting and that this method was the most economical method of accomplishing the reinforcement of the foundation. Dr. Davis pointed out that with proper equipment and personnel the efficiency of the grouting could be greatly increased.

4. Dr. Davis feels there is no question of getting specified unit weight on limonite concrete by grouting. Holmes & Narver will run laboratory tests and submit request to AEC for approval of this method.

5. Oil coated punchings should not be used in concrete.

6. Dr. Davis stated it would be better not to try to set grout pipes in floor slab but to drill through floor slab when proper time comes.

7. It was agreed that cement for grouting would be procured in barrels. This would not be necessary for grouting limonite.

8. Dr. Davis will compute quantities of fly ash and intrusion agent required per cu. yd. of limonite concrete.

9. Holmes & Narver will proceed immediately to procure the necessary materials and equipment for the grouting program and will arrange with Prepakt Inc. to procure the necessary key personnel. In general Holmes & Narver will purchase the necessary equipment instead of renting. It was confirmed that two grouting crews were necessary.

10. Remaining program for exploration for structures has been laid out by Dr. Davis, Mr. Ranttila, and Lt. Iselin and is acceptable to Dr. Davis.

11. Mr. Dickey of Dames & Moore will go first to Bogallua to try to get soil samples to a greater depth and to get some undisturbed samples if possible.

/s/ R. E. Cole

EXHIBIT J

Letter Authorizing Further Foundation Investigations

2 August 1950

To: Mr. C. T. Cooper, AEC Resident Engineer

From: Raymond E. Davis

Subject: FOUNDATION GROUTING, BUILDING 3.1.1

1. Reference is made to those portions of the July 24 memorandum (MC #20 CTC) having to do with increasing the rigidity and stability of the foundations of building 3.1.1 by grouting.

2. To determine the practicability of grouting the coral sand underlying the coral conglomerate, an area 125 feet southwest of the building was selected for experiment. In this area holes, on three foot centers in each direction, were drilled through the conglomerate and one inch grout pipes were jetted into the underlying coral sand to a depth of five feet.

3. The grouting materials were portland cement, which contained numerous small lumps, a fly ash of high fineness and low carbon content (branded "Alfesil"), and a chemical admixture(branded "Intrusion Aid") which acts to hold the solids in suspension and produce a grout which will penetrate small channels and voids without plugging.

4. The equipment included a single stage centrifugal pump for water jetting, a simplex grout pump, an air driven grout mixer (badly underpowered) which was hastily improvised on the job (using an old steel drum and an air driven portable drill. For grouting, regular air hose was employed, which limited the pressures to about 100 psi. (High pressure grout hose and various other small fittings for grouting were not available)

5. The grouting operations, and all work related thereto, were under the expert supervision of Alex Hawkins, a superintendent in the organization of Intrusion Prepakt Inc. He was assisted by a green crew of four laborers.

6. On August 1, after a slow and disappointing start, 46 batches of grout, containing 51 sacks of portland cement and 46 sacks of fly ash were pumped through one inch group pipes into 13 holes, when the supply of fly ash was exhausted. After proper techniques were developed it was found that the group could be pumped as readily at the five foot depth as at the higher levels. As the pumping of each hole proceeded, the group pipe was lifted until its lower end was at the base of the coral conglomerate.

7. For most of the work the grout mix was in the proportions of 1 sack cement; 1 sack fly ash; 2 1/2 pounds Intrusion aid; 20 gallons of water. However, near the end of the work after starting the hole with 1:1 mix it was found that grouting could be successfully continued with a mix

composed of 2 sacks of cement, 1 sack fly ash, 2 1/2 pounds Aid and 20 gallons of water, and finally the water content of this mix was reduced to 18 gallons.

8. Making allowance for grout wastage, it is estimated that on the average the grouted mass of sand in the test areas contains about four sacks of cementing material (cement plus flyash) per cu.yd. By reducing the water content of the grout, as was done near the end of the test, the quantity of cementing material per cu.yd. of sand would be increased to five sacks per cu.yard.

9. Considering the unfavorable conditions under which the test was carried out (lumpy cement, inadequate equipment, green crew) there is no question concerning the practicability of grouting the foundation of building 3.1.1 to a depth as much as 20 feet if such depth is required, using materials and methods employed in the test, provided adequate equipment is made available, key men experienced in such grouting are employed, and portland cement free from lumps is furnished.

10. For the foundation of Building 3.1.1 it appears that it will be desirable to grout a strip along the rear wall, extending under the building for a distance of perhaps 20 feet and outside the building for a width of perhaps 25 feet. Final decision as to width, depth and proportions of this strip, which may be considered as an extension of the present concrete footings of the building, must await the results of laboratory tests on grouted specimens and analyses for foundation stability and deformations.

11. From observations made during the field tests it appears that to be on the safe side, grout holes ought to be spaced about three feet apart in each direction over a transverse distance of nine feet under the building and twelve feet outside the building. The remaining holes which would be at more shallow depths might be spaced four feet in each direction. However, it is believed that the spacing should be adjusted as seems necessary to allow for conditions encountered as the work progresses.

12. The volume of the mass to be grouted is presently unknown but possibly may amount to as much as 3000 cu.yds. The grouting operations may require as much as 8000 sacks of portland cement (to be shipped in drums), 6000 sacks of fly ash and 7 1/2 tons of Intrusion Aid.

13. As many as 800 grout holes may be required. Because of the factor of time, equipment and labor for two grouting crews seem necessary. Also experienced jack hammer equipment must be provided.

14. John Ranttila and the writer observed and discussed together all phases of the experimental work.

15. Decisions with respect to the grouting techniques to be employed were made by Hawkins and the writer.

16. Fieldtests of the grouted mass will be limited to permeability through drill holes, and the recovery of five inch cores. These cores will be examined and tested at 28 and 90 days for compressive strength and stress strain characteristics. Ranttila will supervise this work and report thereon.

17. There is attached a suggested organization chart and list of equipment for the proposed work.

/s/ RAYMOND E. DAVIS

RED:fjb

SUPT. - I.P. Man

2 Timekeepers

1 Shop Man (I.P.)

Shift #1

7:00 AM to 5:30 PM
Operations
Drill Holes, Jet and Grout

Personnel

1 Shift Foreman (IP Man)
1 Key Man " "
8 Drillers
1 Comp Oper
2 Water Pump Oper
2 Grout Pump Oper
2 Mixer Oper
2 Mixer Helper
2 Insert Men
4 Insert Helpers

Shift #2

6:30 PM to 3:00 AM
Operations
Drill holes and Jet

Personnel

1 Shift Foreman (IP Man)
1 Key Man " "
8 Drillers
1 Comp Oper
2 Water Pump Oper
4 Laborers

Note: It has been proposed to use, two 9-hour shifts, so that the grouting under the structure can be completed in the minimum amount of time. Intrusion-Prepakt personnel should not be less than 1 Superintendent, 2 Shift Foremen, 2 Key Men and 1 Timekeeper

GROUTING UNDER MULTI-STORY BUILDING

EQUIPMENT LIST

2 - 315 C.F.M. Gardner Denver Air Compressors.
    Note: 1 - 315 C.F.M. Compressor on the island, but this is not always available.
1 - 3" Bull Hose
2 - Manifolds
200' - CalCo Pipe 3"
2 - 90 degree ells for CalCo pipe
600' - 3/4" Air Hose
2 - Dead ends for CalCo pipe
12 - 3/4" C.P. Fittings (Male)
12 - 3/4" " " (Female)
12 - 3/4" " " (Hose)
12 - 3/4" Nordstrom Cocks
6 - 3/4" Three-way fittings
    Note: Critical spare parts for compressors to be left to "Bud Koss", be sure to send plenty as none available.

4 - 73 Jack Hammer (with plenty of spare parts, including pawls, springs, etc) (None available)

DRILL STEEL

8 - 2'; 8 - 4'; 8 - 6'; 6 - 8'; 6 - 10'; 6 - 12'; 6 - 14'; lengths to fit #73 hammers.

14 - lengths of sectional drill steel 4'

DRILL BITS

100 - 2 1/2"; 100 - 2 1/4; 100 - 2"; 150 - 1 3/4"; 100 - 2 3/4"

2 - Double mixers (gas driven complete with water tank)
2 - Extra gear box and shaft complete
4 extra spider connectors
2 extra molasses gates (3")

2 - Simplex (Air Driven pumps) 2 1/2" piston.
    Note: 1 pump available on island.

6 Extra 2 1/2" pistons
3 Extra 2 1/2" sleeves
2 sets, valve seats (extra)
2 extra sets valves
2 extra sets valve springs

2 Grout funnels to fit Simplex pumps (Note: none on island)

24 ' - 1/8" screen, 36" wide
3 gages for pumps
3 - 1 1/4" cocks
4 oilers for pumps and hammers
500' grout hose 1"
4 by-pass hoses

PIPE

200 lengths 1" x 20' pipe; 50 lengths 2" x 20' pipe
20 lengths - 3/4" x 20' pipe
10 lengths - 1/2" x 20' pipe

PIPE FITTINGS

200 - 1" couplings: 100 - 1" unions; 6 - 1 1/4" unions; 6 - 1 1/4" nipples; 24 - 1" to 3/4" bell reducers; 12 - 1" to 1/2" bell reducers; 12 - 3/4", 90 degree ells; 24 - 1" nipples
600' - 3/4" or 1" water hose (1" preferred)

2 - Jet pumps 4-Stage (one jet pump on island but is only single stage) Capacity of pumps should be 300 gals. at 200 PSI, CH & E, Jet pump preferred.

2 Sound power telephone sets
2 - 6" well points
24 - 1" Nordstrom cocks
100 Tapered stoppers to fit 1" pipe and 2" hole
24 tarps
12 flood lights, current on island

TOOLS

1 Cutting torch and welding tips; 1 set pipe dies 2" to 1/2"; 1 pipe cutter; 1 pipe reamer; 1 stay put hose clamp machine; 150 hose clamps for 1" and 3/4" hose; 1 hacksaw; 24 H.S. blades; 2 sets wrenches for Simplex pumps; 4 - 24" pipe wrenches; 4 - 18" pipe wrenches; 4 - 12" pipe wrenches; 4 - 8" pipe wrenches; 4 - 16" Crescent; 4 - 12" crescent; 4 - 10" crescent wrenches; 4 extra large pliers; 4 side cutters; 6 large screw drivers; 6 - 2# hammers; 2 claw hammers; 2 cut off saws (hand); 20# 3/16" brass rod; 2 cans flux; 6 - 6' rules; 1/2" bolt dies.

E-1
SD-6207

October 13, 1950

Holmes and Narver, Engineers
824 South Figueroa Street
Los Angeles 14, California

Subject: PROGRAM FOR FURTHER FOUNDATION INVESTIGATIONS
AT ENIWETOK ATOLL - Contract No. AT-(29-1)-507

Gentlemen:

There are attached hereto the following documents:

a. Letter to R. E. Cole from Dr. Raymond E. Davis dated September 11, 1950 — subject, "Program for Further Foundation Investigations at Eniwetok Atoll."

b. Memorandum to Lt. Cmdr. Rowen from Sherwood B. Smith dated August 22, 1950 — subject, "Program for Project 3.3 Structures" with enclosures.

c. Letter to P. W. Spain from Sherwood B. Smith dated October 4, 1950.

d. Memorandum from H. L. Meek to D. T. Robbins dated October 2, 1950 — subject, "Soil Exploration Drilling Equipment and Accessories."

You are informed that the exploration program as proposed by Dr. Davis is approved by this office with the exception that we have not yet firmly settled on the deep hole and the geophysical work. Dr. Davis and Mr. Rantilla will direct this program at the Jobsite and you are requested to inform this office in sufficient time before drilling operations start so that Dr. Davis may proceed to the Jobsite. In general the program proposed herein is in addition to certain tests and borings desired by the various project officers of Program 3.

With reference to enclosure "d" you are advised that we approve the use of Mr. V. C. Mickle's services as superintendent for the drilling operations. This enclosure also makes reference to the possibility of representatives of the Office of Naval Research being present at the jobsite to observe drilling operations and perhaps perform geophysical tests. This has the approval of this office in so far as it does not interfere with the drilling program as outlined herein and does not require any additional work.

At a later date we will give you information as to the drilling of the deep hole and the performance of geophysical work by others.

Very truly yours,

P. W. Spain
Contract Administrator

Enclosures:
4 as indicated.

Distribution, as noted on copy to Mr. Trent Dames:

1 & 2 to Holmes & Narver w. encls.
3 J-6
4 J-Division Files
5 Trent Dames, c/o Holmes & Narver, w. encls.
6 C. T. Cooper, w. encls.
7 Dr. Raymond E. Davis, w. encls.
8 R. E. Cole, w. encls.
9 John Rantilla, with encls.
10 J-Division Sequence Files
11 AEC Mail and Records

HN-S-1273

Los Angeles, California
September 11, 1950

Mr. R. E. Cole, Director
Office of Engineering & Construction
U. S. Atomic Energy Commission, SFOO
Los Alamos, New Mexico

Subject: PROGRAM FOR FURTHER FOUNDATION INVESTIGATIONS AT ENIWETOK ATOLL.

Dear Mr. Cole:

On September 10, I conferred with Mr. Trent R. Dames in Los Angeles, concerning a program for further investigations at Eniwetok Atoll. As a result of our discussions, which gave consideration to the probable needs of those who will interpret the structural behavior of building in the present atomic experiment, and to the likelihood of similar future experiments in the same general location, I make the following recommendations with which Mr. Dames is in accord:

(1) Borings. On the supposition that the drilling equipment mentioned in your letter of September 2, is capable of advancing deep borings into rock, it is believed that a boring should be carried into the underlying bed rock at the following zero locations: Engebi, Ebriru, Aomon, Runit, and Bogallua. At Engebi the boring should be extended to a depth of approximately 2000 feet; at other zero locations the borings should be extended into rock of uniform character for a distance of not less than 30 feet.

Further, it is considered desirable to make six additional borings on Engebi and three on Muzin to a depth of 100 feet or to solid rock if encountered at a lesser depth. The borings should be so located as to give general coverage to these islands.

Undisturbed samples should be taken with sufficient frequency to provide adequate information concerning the character of and variations in the foundation soils and rock formations. It is presumed that the average interval between samples will increase with depth. Perhaps ten samples should be taken within the first 100 feet; for the deep boring on Engebi the sampling interval might progressively increase to as much as 100 feet near the bottom of the hole.

The boring operations should be under the continuous supervision of a technically qualified and experienced person familiar with the purposes for which the work is being undertaken, who should exercise his judgment in selecting the depths at which undisturbed samples will be taken. If it can be arranged, it is suggested that Mr. Dickey, of Dames and Moore, be employed for this purpose.

(2) Geophysical Investigations. It is considered desirable to determine by geophysical methods the configuration of the underlying rock formation on Engebi and Muzin, and if possible also to determine wave velocities in the various media encountered in the boring operations. This will require the services of an expert in this field.

(3) Testing of Samples. The following tests should be made on undisturbed soil samples:

Density
Particle-size distribution
Compressibility under static load
Shearing strength under static load
Frictional value on piling materials under static load

While the desirability of conducting the latter three tests under dynamic loading conditions is recognised, apparatus and methods for such loadings have not been developed. It is hoped that the results of static tests may be correlated with the results of future investigations of dynamic behavior.

Samples of rock cores should be tested to determine the following:

Density
Modulus of elasticity and Paisson's ratio under static load
Compressive strength under static load
Wave velocity propagated by dynamic load

A few selected soil and rock samples should be subjected to petrographic analysis.

It is suggested that the testing of all samples be delegated to Dames and Moore, Los Angeles, because of their knowledge of, and experience with the materials under investigation.

(4) Research in the Dynamic Behavior of Soils. At present little is known concerning the behavior of soils under dynamic loading. With the object of providing basic information in this field, which would be of value to those engaged in the future design of structures that are required to withstand the forces of atomic bombs, not only on Eniwetok Atoll, but elsewhere, it is believed to be of prime importance that a long-range research program be undertaken. It seems obvious that the details of such a program can only be determined after the completion of rather extensive exploratory tests involving the development of apparatus and methods for subjecting soils to desired conditions of dynamic loading, and for measuring the effect of such loading. It is suggested that those in authority consider the desirability of creating a board of experts to study this problem.

Very truly yours,

RAYMOND E. DAVIS

NATIONAL MILITARY ESTABLISHMENT
Armed Forces Special Weapons Project
P. O. Box 2610
Washington, D. C.

SWPEF/3c 22 August 1950

MEMORANDUM FOR: Lieutenant Commander William H. Rowe, USN,
J-10 Group, J-1 Division, Los Alamos Scientific
Laboratory, P. O. Box 1663, Los Alamos,
New Mexico.

SUBJECT: Soils Program for Project 3.3 Structures.

1. There is enclosed a copy of memorandum from Project Officer, Project 3.3 on the above subject, with enclosure entitled, "Soil Program, Air Force Structures, 3.3," in duplicate.

2. It is requested that the necessary action be taken to have the indicated work accomplished.

3. It is assumed that the cost of this work will be included in an item to be set up in construction estimates to cover foundation investigations and corrective action.

/s/ Sherwood B. Smith,
Director, Program Three

2 Encls.:
1. Memo fr Maj. Pettitt dtd 17 Aug 50.
2. Encl. to above memo "Soil Program,
AF Structures, 3.3"

cc: Major Bert E. Pettitt.

MCAIXP/LAN/bob

17 August 1950

MCAIXP

MEMORANDUM FOR: Mr. Sherwood B. Smith, P. O. Box 2610,
Washington, D.C.

SUBJECT: Recommended Soils Program for Project 3.3 Structures

1. As stated in our teletype, file MCAIXP-8-18-E of 4 August 1950, we are enclosing herewith, in triplicate, soils program which we recommend should be carried out for the 3.3 structures. We believe that the program is clear and the items contained therein are self-explanatory.

2. In the course of preparation of this program we received the proposed soils program recommended by Mr. Dames and Dr. Davis as an enclosure to your memorandum of 9 August 1950.

3. We have checked it over carefully and while we make no criticisms of the program as an expedient method of obtaining foundation design data in a short time, we cannot concur in its use as the final and complete soils program for the 3.3 structures.

4. We feel that our program is necessary to ensure having at hand adequate soil data that will enable us to make estimates and investigations with a reasonable degree of certainty of any aberrations that may develop in the test behavior. We consider our program in the nature of highly important and very cheap insurance to a successful analysis of the problem following the test. The Davis and Dames program falls far short of ensuring reasonable data for making such post-test investigations as might be necessary.

5. The Davis and Dames program requires use if cable-tool drills and contemplates taking both disturbed and undisturbed samples out of the holes. Our program in effect merely calls for a greater number of holes and consequently a greater amount of laboratory work. It is felt that the cost of drilling extra holes and performing additional laboratory work involved in our program is relatively small compared to the costs already incurred on this investigation and to the costs of bringing over the necessary equipment. Once these possible costs are furthermore measure against the losses that might be sustained by a failure to have at hand adequate data for the interpreting test results, it is

felt that our program is not only completely justifiable but also highly desirable.

6. We therefore urgently recommend that the program we have submitted herewith be carried out. As we have pointed out this need not jeopardize the construction program since we are willing to go along with the present footings or such modifications as are agreed to in the field by our Mr. Thomas or such other ones as we may suggest without jeopardizing the construction program. This matter is considered of sufficient importance by us to earmark a limited amount of funds out of such allotments as are presently available to the project.

7. We will appreciate an early consideration of this matter.

Bert E. Pettitt
Major, USAF
Project Officer, 3.3
Air Force Structures Program

1 Encl:
Soil Program

cc: (Memo & Encl)
Mr. R. J. O'Brien (ARF)
Mr. Sargent White (HQ USAF)

SOIL PROGRAM

AIR FORCE STRUCTURES, 3.3

I. General: In studying the soil conditions and in considering the dynamic loads which will be applied to the soil, the program described below will give valuable information which will greatly assist the final evaluation of the test. Concurrence is given to the plan to proceed with construction and concurrently accomplish the soil exploration program. Since a number of the Air Force Structures have been moved to new sites, it is desirable that the soil profile within each structure be consistent, e.g., all footings to be on sand with fairly uniform density, on sand with strata of coral beneath at uniform depth and thickness or on lean concrete on coral strata underlain by sand, gravel, etc. If such conditions are not found or believed to exist, large differential settlement within a structure may occur and seriously affect final analysis and evaluation. It is realized that uniform soil conditions cannot be found but can in many instances be attained by appropriate construction. Also, the term, "uniformity," as used above is used in the sense of "within certain limits," and it is up to the field soil consultants to determine the limits of uniformity wherever differential settlement would be tolerable. These tolerances are as follows:

3.3.3 - Maximum allowable differential settlement between any two adjacent main columns not to exceed 1 inch.

3.3.4 - Maximum allowable differential settlement between the columns of any bent not to exceed 3/8 inch and between the same columns in adjacent bents not to exceed 3/4 inch.

3.3.8h - Maximum allowable differential settlement between any two adjacent main columns not to exceed 1/4 inch.

II. "A" and "B" information, as described below, is required on the soil beneath footings of structures 3.3.3, 3.3.4 and 3.3.8h. The points at which the information is desired are shown on Figures I and II. These points indicate the general vicinity only. The depth to which soil will be explored and the number of samples to be taken will be determined by the soil consultants.

A. "A" information, undisturbed samples at different depths at each test hole.

1. Determine if soil:

   a. Classification of material.

   b. Angle of internal friction.

c. Dry density.

d. Water content.

e. Mechanical analysis.

f. Settlement vs. load and time.

g. Load-carrying capacity with respect to footing size.

2. Determine if rock:

a. Unconfined compression strength.

b. Dry density.

c. Load-carrying capacity with respect to size of footing.

B. "B" information, disturbed samples (not wash boring samples) at different depths at each test hole.

1. Determine if soil:

a. Classification of materials.

b. Mechanical analysis.

c. Relative density by calibrated penetration test or other means.

2. Determine if rock:

a. Thickness of strata.

b. Relative density.

III. Structures 3.3.8a - g, 3.3.5a and b, one test hole in the vicinity of each structure and obtain "B" information.

IV. In the event "B" information at any test hole varies very widely from "A", information will be obtained at these points.

V. In evaluating the behavior of the foundations on the basis of the limits specified in Section I, consideration should be given by the soil consultants to the affect large dynamic loads of short duration will have on the soils investigated. Further consultation between the soil consultants and the Project Officer is considered necessary on this matter.

Bert E. Pettitt
Major, USAF
Project Officer, 3.3

HNs-1379

DEPARTMENT OF DEFENSE
Armed Forces Special Weapons Project
P. O. Box 2610
Washington, D.C.

SWPEF/3c 4 October 1950

Mr. Paul W. Spain
Contract Administrator
Santa Fe Operations Office
Los Alamos, New Mexico

Dear Mr. Spain:

Reference is made to your letter of 15 September 1950, Subject, "Program for Further Investigation on Eniwetok Atoll."

In accordance with our agreement after discussion with Dr. Davis on 29 September, it is my understanding that a revised program of foundations investigations will be prepared after review of requirements stated by DOD Project Officer. Thus, it is hoped that a complete program for foundations investigations will be made available, including all requirements of the DOD Project Officers in so far as may be practical.

In general, the program submitted to me by the above referenced letter appears to be satisfactory, if used in conjunction with the investigations specified by Project Officers, Projects 3.1, 3.2, and 3.3.

The deep borings and velocity measurements recommended by Dr. Davis are considered to be beyond the scope of Program Three. As indicated to you in our discussion, measurements of this type were made during the Bikini Resurvey. Also, it is understood that the Scripps Institution is conducting similar investigations on other Atolls in the Pacific. In this respect, I believe we agree that the character of the coral below 100 feet from the ground surface is not material with respect to structural performance.

Very sincerely yours,

/s/ SHERWOOD B. SMITH
Director, Program Three

To: Mr. D. T. Robbins Job: 640 CHN-970

From: H. L. Meek Re: SOIL EXPLORATION DRILLING EQUIPMENT AND ACCESSORIES

Date: October 2, 1950

Approximately 60 days ago the Purchasing Department was requested to secure a Failing Drilling Machine to be used in the Soil Exploration Program at the Jobsite. We have secured one each Shop Model No. 1500, Shop No. 957 Failing Core Drilling Machine, complete with accessories, from the Naval Electronics Laboratory, San Diego, California. This machine is complete with all necessary accessories and is mounted on a K-7 International Truck. This lot of equipment also included some drilling pipe and some steel casing pipe. This entire lot of equipment and accessories has an approximate value of $25,000 and has been obtained on a loan-and-return basis.

Upon the recommendations of the Failing Company representative in Los Angeles, Mr. Jay C. Failing, we have purchased an additional 2,000 feet of used 6" steel casings and an additional quantity of 2-3/8" diameter steel drill pipe, and ten (10) tons of aqua-jell, (drill mud), for use in the program.

The shipment of the drilling machine and accessories obtained from the Naval Electronics Laboratory, San Diego, was effected on the USS "Sgt. Morris Craine" on September 14, 1950. The supplemental items of drilling materials purchased locally by Holmes & Narver will be scheduled for transhipment from Oakland on the USS Craig, ETD October 15, 1950.

We have obtained the services of a drilling rig operator, Mr. Ray E. Benson, who is very familiar with the Failing type drilling machine and who has had approximately 30 years of field experience in core drilling work. It is our present plan to secure the services of at least two (2) additional operator-mechanics to assist Mr. Ray E. Benson.

We have been advised by Mr. George Failing of Enid, Oklahoma, during the past 30-day period, that they would like to offer the services of their field superintendent, Mr. V. C. Mickle, to assist us in our Jobsite program. It may be noted that Mr. Mickle was in complete charge of similar tests conducted at the Jobsite area in 1947. Your further attention is invited to the fact that the core drilling work was accomplished with the identical drilling machine which we now have in our possession on a loan basis from the Naval Electronics Laboratory, San Diego, California. We have forwarded the necessary Security Clearance Questionnaires to Mr. V. C. Mickle, who advised us, this date, that he would fill out the papers and return them to this office without delay. The approximate charge for Mr. Mickle's services will be $35 per day, plus travel expenses and lodging costs.

At the time of this writing we do not have a definite commitment to utilize the services of Mr. V. C. Mickle. It is the opinion of the writer that we should at least take an option on his services in the event that a Security Clearance cannot be obtained on Mr. Benson for overseas employment.

At 10 a.m., October 2, 1950, Mr. Gordon G. Lill contacted the writer by telephone and offered the following information:

A conference had recently been held in Washington, D.C., which was attended by Col. Daymon of the JTF-3 Washington, D.C. Office, Dr. Burris of the Los Alamos Scientific Laboratory, and Mr. Lill of the Naval Research Laboratory, Washington, D.C. As a result of decisions reached in this conference, it was indicated that the Naval Research Laboratory and the U.S. Geodetic Service would require additional core samples and drill tests in addition to the basic requirements scheduled by the U.S. Atomic Energy Commission. In view of the fact that it was the desire of Mr. Lill to have two or more technical representatives at the Jobsite during drilling operations, it was requested that we notify his office at least two weeks in advance of the scheduled drilling dates in order that he could schedule the transportation of their representatives to conform with field drilling schedule dates. Mr. Lill further requested that we secure the services of Mr. V. C. Mickle to supervise the drilling operations. He further added that Mr. Mickle had attended several recent conferences in Washington, D.C., regarding core drilling programs proposed by various government agencies and was thoroughly familiar with our particular program. He stated that Mr. Mickle was readily recommended by all persons concerned.

The writer advised Mr. Lill that the authority for Holmes & Narver to perform any work for other government agencies must originate with our client, the U.S. Atomic Energy Commission, Los Alamos, New Mexico. The writer further advised Mr. Lill that, under the terms of our contract, all subcontractors for services (technical advisors) must have the prior approval of our client. I also told Mr. Lill that we would suggest that our Engineering Department request approval for the utilization of the services of Mr. Mickle.

At 11 a.m., October 2, 1950, Mr. V. C. Mickle of the George M. Failing Company, Enid, Oklahoma, contacted the writer by telephone and gave me a resume of his recent conferences in Washington, D.C., with the Naval Research Laboratory officials and the U.S. Geodetic Survey Department Heads and stated that he was very willing to cooperate by offering his services for the duration of the Jobsite drilling program. The writer advised Mr. Mickle that we would contact him at a later date regarding our acceptance of his technical services.

I am attaching a copy of the letter from the Director of Procurement to the Resident Manager, dated September 29, 1950, on this same subject. Reference is made to the third paragraph of Mr. Kelly's letter wherein the George M. Failing Company, at Mr. Kelly's request, is forwarding a complete resume and report of the drilling operations as conducted on previous experimental operations at the Jobsite area. Copies of this report will be forwarded to you as soon as we receive them.

The address and telephone number of Mr. Gordon G. Lill of the Naval Research Laboratory, Washington, D.C., is as follows:

Office of Naval Research
Geophysics Branch
Washington 25, D.C.

Attention: Mr. Gordon G. Lill

Telephone No.: RE-7400, Ext. 6-2346

H. L. Meek
Purchasing Agent

HLM:mlm

cc: L. J. Kelly
Operations
Central Files
(Robbins--3 cyps)
Chrono

To: Resident Manager Job: 640 HO #2140

From: Director of Procurement Re: EXPLORATION WORK BY FAILING
DRILL RIG

Date: September 29, 1950

The rig, which we shipped to you on the CRAIN and which will presumably arrive about the 1st of October, was secured from the Navy. The Navy had furnished this same outfit to Eniwetok during the first exercises. Upon return from Eniwetok no charging record was made, and at San Diego no receiving record was made. When we ordered the outfit to be shipped, the Navy repacked everything into 25 boxes and shipped to Oakland just in time to catch the CRAIN. No packing slip was prepared so that we actually know nothing about the equipment you are receiving. We do understand that there are a number of drill bits in addition to the two (2) diamond drill bits which were sent "receipted cargo." There is also adequate equipment for the taking of cores.

The writer got into this problem and has talked to Mr. George Failing and with the Failing Company's engineers, and has been able to get some scant information together. One item is that the rig is designed to be a 1,500 ft. rig, although the Navy succeeded in drilling a hole something over 2,000 ft. in depth during the first exercises. The drill pipe size is 2 3/8" in diameter and all of the drilling equipment, of course, fits this drill pipe. Originally there was some 2,565 ft. of drill pipe furnished. On the supposition that some of this pipe was lost or damaged, we are ordering and will ship on the next boat, ETD October 10, 1950, another 500 ft. of drill pipe. Based on information that casing was not required in the deep holes, we are also sending 10 tons of aqua jell, which is drilling mud and proved satisfactory during the first exercises. We are also sending 2,000 ft. of 6" casing which will enable the operator to take cores.

We are securing from the Failing Company their report of the first operations together with a copy of the official report by a Dr. Ladd who is associated with Navy research and who is still interested in this program.

Mr. Paul Spain has instructed us to have Mr. Dickey of Dames and Moore return to the Jobsite in time to supervise the drilling. We have assumed that this would be about October 15th as the equipment will be there at the time and will have been checked and put in working order.

We have employed a qualified drilling superintendent, named Benson, whom we believe will be available to you prior to October 15th. We will send with Benson a mechanic, a truck driver and a general helper. One or two additional laborers or mechanics may be necessary to round out the crew. Information received by us from the Failing Company will be forwarded to you promptly for your information.

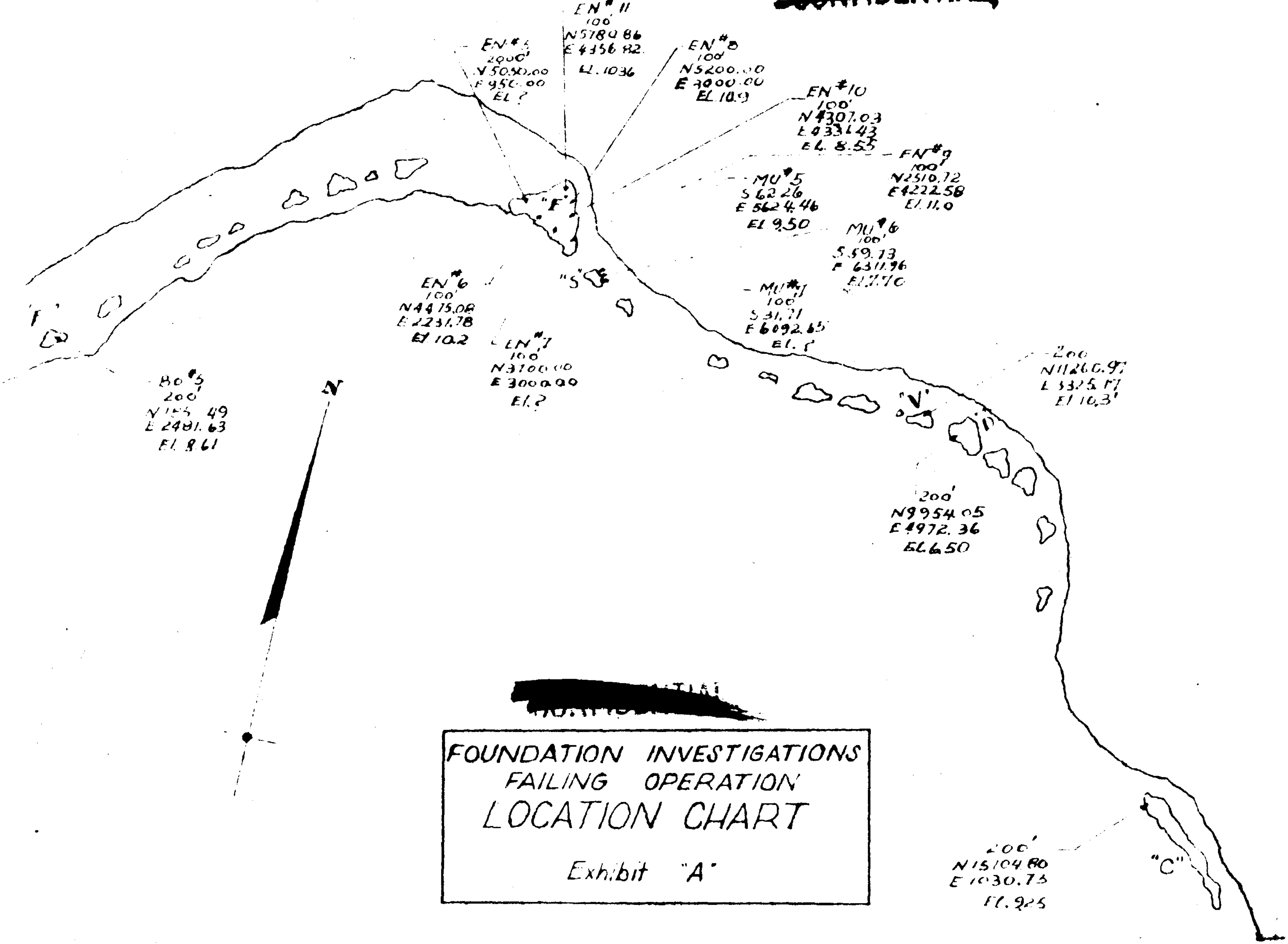
By____________________
Lester J. Kelly
Director of Procurement

LJK:dd
cc: HO Chrono
Central Files
Procurement (2)
OS Chrono
Purchasing (2)

EXHIBIT K

Foundation Investigations

~~CONFIDENTIAL~~



[redacted]

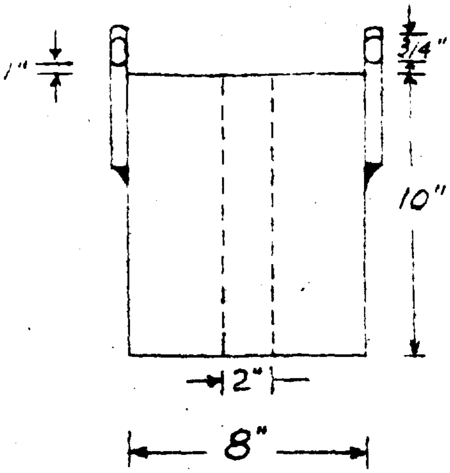
FOUNDATION INVESTIGATIONS
FAILING OPERATION
LOCATION CHART

Exhibit "A"

[redacted]

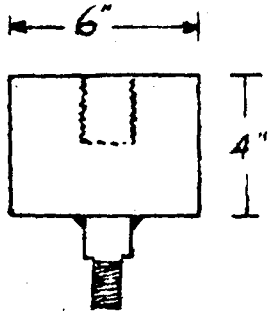
PENETROMETER CONE & HAMMER

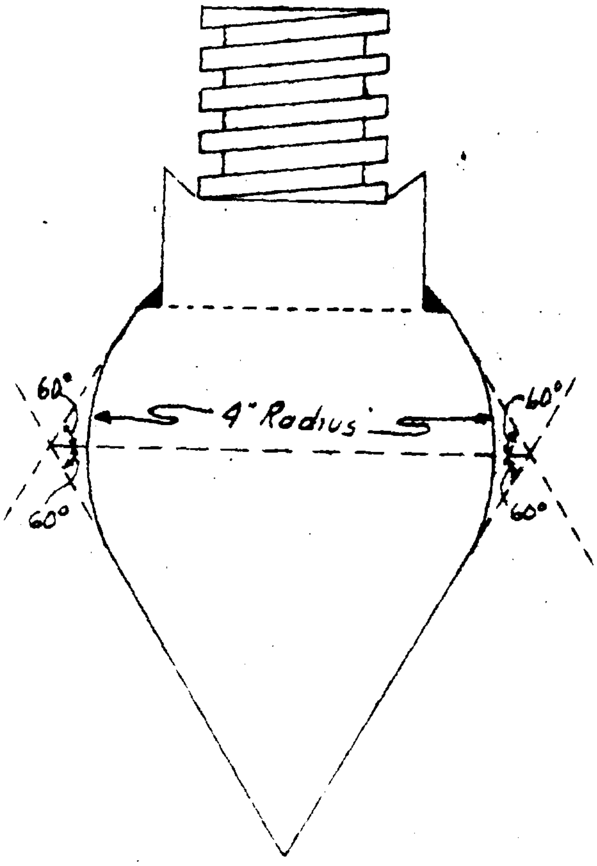
DRIVE HAMMER - Circular 8" in diameter. Bored to 2" and 2 welded 3/4" eye bolts to opposite sides of hammer



DRIVE HAMMER GUIDE - 6 pieces 1½" x 36" black steel pipe threaded and coupled.

DRIVE HEAD - Circular 6" in diameter drilled and tapped center hole for 1½" pipe thread. Welded ½" box thread coupling in denter of base.



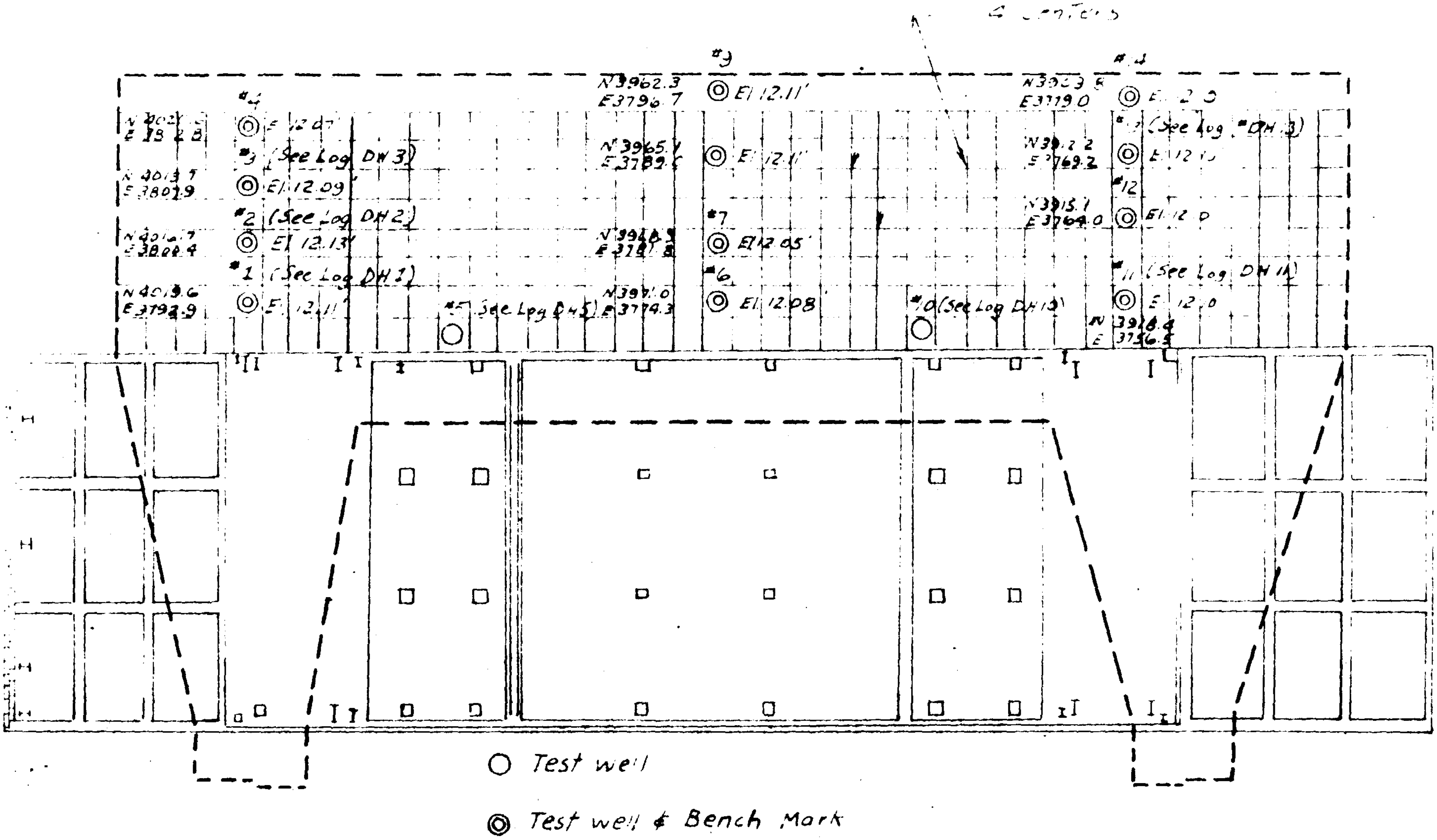


CONE - Circular 6" in diameter round stock. Welded ½" box thread coupling to center of point.

Exhibit "B"

[redacted]

[redacted]



Not to Scale

[redacted]

Foundation Investigation
Building 3.1.1.
Exhibit "C"

[redacted]

HOLMES & NARVER, INC.
Eniwetok Atoll
LOG OF BORINGS

SITE . "C"
HOLE NO. [illegible]
LOCATION [illegible].15104 E.1030

FIELD PARTY Manney
Sheet 1 of [illegible]

GROUND ELEV. [illegible]
RIG Failing "1500"
Date 9/1 to [illegible]

No	Drive	Blows	Pings	DEPTH IN FEET	DESCRIPTION MATERIAL	DESCRIPTION OPERATION
				0	Fill - sand and gravel some asphalt pavement fragments, dense & dry.	Sample #1 from face of mud pit excavation.
1	☒			2	Sand & gravel-dense, moist & non-cohesive well graded up to max 3/4" size.	Hole opened to 7.5' with 7 7/8" rock bit & high gel-strength fluid.
				4	Rock-cemented sand & fine gravel	
				6	Ground water Gravel-fine to medium some coarse sand unstable lacking sufficient binder sizes to make dense.	Hole caving below beach rock layer & taking considerable drilling mud.
2	☒	* 60		8		* 300# hammer falling 18".
3	☒	[illegible]7		10		1 sack of lime used to increase gel-strength & curtail fluid loss.
				12	Sand & gravel-well graded, dense & wet.	
				14		
4	☒	3[illegible]		16	Increase in sand and several embedded blue coral fragments up to 1" in dia.	Set 8" casing to 17.5" in order to stabilize hole below 5.5"
				18		Dames & Moore sampler used for all overburden samples.
5	☒	74		20	Drilling resistance from 5.5' was relatively uniform.	
				22	Hard layer 23.5' to 24.5'	
				24		Bit resistence continued uniform, except as noted to 30.0' thence much greater.
	☒				[illegible] to 1" max [illegible] of coral and limestone in sample.	[redacted]

[illegible]tok [illegible]oll
[illegible]

[redacted]

SITE "[illegible]"
HOLE NO. [illegible]
LOCATION [illegible].1.104 1.1000

[illegible] Feeney

[illegible] ELEV. [illegible]
RIG Failing [illegible]
[illegible] /1 to [illegible]

Sheet [illegible] of [illegible]

No	Drive	Blows	Pirgs	DEPTH IN FEET	DESCRIPTION MATERIAL	 OPERATION
				28		
				30	Very abrupt change in hardness.	New Reed roller core barrel 2-1/4" x 10' inside length run from 31.5' to 42.0', with uniformly hard resistence.
				32	Sand & gravel-fine to coarse, densely cemented in sections up to 8" in thickness.	
				34	Halimeda and Forams.	
7			1.4'	36		Top of rock could reasonably be at 30.0' due to change in bit action which continued to [illegible].
					Top of Rock	
				38	Conglomeratic limestone densely cemented.	
				40	Rock-continued from 37.5'.	After removing reed core barrel at 42.0' the hole was reamed to that depth using the 7-7/8" rock bit.
				42		
					Algal conglomerate cemented.	
				44	No.8 core run with 2[illegible]" x [illegible]" bortz bit and Failing barrel inner tube blocked with fractured rock. Max. core length [illegible]" extremely hard drilling	
8			1.1			The bit ran very rough with considerable chattering which is indicative of the rock formation.
				46		
				48		The [illegible] sampler was put in at 4[illegible].0' and rebounded continually under 27 - [illegible] x 1[illegible]" blows with less than [illegible]' penetration.
9			.			
				50	No. 9 core run with [illegible] [illegible] of [illegible]	

[redacted]

HOLMES & NARVER, INC.
Eniwetok Atoll
LOG OF BORINGS

SITE "C"
HOLE NO. [illegible]
LOCATION N.15104 E.1030

FIELD PARTY [illegible]
Sheet 3 of 3

GROUND ELEV. 9.0'
RIG Failing "1500"
DATE 2/1 to 2/3/50

No	Drive	Blows	Rings	DEPTH IN FEET	DESCRIPTION MATERIALS	DESCRIPTION OPERATION
					Extremely hard	
				54	Well cemented Algal conglomerate.	
				56	Run No. 10 with Reed roller barrel.	
10			1.1"			
				58	Max. core length [illegible]".	
				60		Reed roller barrel in at 61.5' to 70.5'.
				62	Coral conglomerate well cemented.	
				64	Max. core length 1-1/8".	Sample No 11-A is from mud ditch during coring operations from 61.5' to 70.5'.
11			1.0'	66		
				68		
				70		Hole reduced to 5-7/8" at 70.5' & continued at diameter to 84.0'.
				72	No apparent change in rock formation.	Sample No. 12 taken mud ditch during drilling operations with 5-7/8" rock bit from 75.5' to 84.0'.
				74		
12				76		
				78		

HOLMES & NARVER, INC
Eniwetok, Atoll
LOG OF BORINGS

[redacted]

SITE. "C"
HOLE NO. RU-[illegible]
LOCATION N.1[illegible]104 E.1000

FIELD PARTY Kenney
SHEET 4 OF 5

GROUND ELEV. 9.[illegible]'
RIG. Failing "1500"
DATE 3/1 to [illegible]/50

No.	Drive	Blows	Rings	DEPTH IN FEET	DESCRIPTION MATERIAL	 OPERATION
				80		
				82		
				84		
					Well cemented Algal limestone some calcite slightly honey-combed.	Core run No.13 was with Fortz bit.
				86		
13			1.7'	88		Drilling resistence remains uniformaly hard.
				90		
				92		
				94	No apparent change.	
				96		
14				98		Sample No.14 is from mud ditch during drilling operations from 94.0' to 104.5'.
				100		
15			.5'		Algal & coral limestone conglomerate. Well cemented with some	Core run No.15 was with Fortz bit.
16				110	thin weakly cemented joints. Max. section [illegible]". Uniformly firm rock bit resistance at 111'	Sample No.16 is from mud ditch ([illegible]' to 11[illegible]. Remarks: Considerable experimentation was done
17			[illegible].8'	120	No apparent change at 115'. Coral and Algal conglomerate max. sec	with the Reed roller barrel between [illegible]' [illegible]' in an effort to

[redacted]

HOLMES & NARVER, INC.
Eniwetok Atoll
LOG OF BORINGS

SITE "C"
HOLE NO. RU-2
LOCATION N.15104 E.1030

FIELD PARTY Kenney
SHEET 5 OF 5

GROUND ELEV. 9.2
RIG. Failing "1500"
DATE /1 to [illegible]/53

No	Drive	Blow	Rings	DEPTH IN FEET	DESCRIPTION MATERIAL	 OPERATION
19				130	tion 4" at 131'. Total rock drilling & coring operations showed no evidence of any unconsolidated material. Slightly less drilling resistence from 130.0' to 135.0'. Bottom of hole @ 135 NOTE: When operation was resumed 2 Feb. after shutdown the hole was filled up to a depth of 30.0' below the ground surface. The material was from the cohesionless zone between 35' & 65'. The The 17.5' of 8" casing was not sufficient length to protect the hole. Operation was terminated at this depth since it was felt that the initial requirements for the hole had been met.	prove its suitability for further use. Changes were made in rotation rate, viscosity and amount of fluid and bit loading. Because of the excessive core loss it was concluded that any roller cutting medium is too severe for shaping the brittle rock to inner barrel dimensions. Cutting with a Bortz bit in sections proved more effective in shaping the rock which resulted in higher recovery.

HOLMES & NARVER, INC.
Eniwetok Atoll
LOG OF BORINGS

SITE "[illegible]"
HOLE NO. AO-1
LOCATION N.5354.05 E.409.38
FIELD PARTY Kenney
SHEET 1 OF 5
GROUND ELEV. 8.51'
RIG Failing "1500"
DATE 2/7/51

NO	DRIVE	BLOWS	RINGS	DRIVE IN FEET	DESCRIPTION MATERIAL	DESCRIPTION OPERATION
				0	Sand-silty, black containing some fine to medium gravel dense and dry.	Sample No.1 from mud pit excavation. 300# hammer falling 18".
				2		
				4	Sand-fine to medium. Few gravel fragments to ½" max. Dense, moist to wet @ 6.0' partial cementation.	Hole opened to 6' with 3" rock bit & high gel-strength fluid.
				6	Sand & gravel. Dense & well graded to 3/4" wet & pervious some evidence of weak cementation in shallow zones 1" to 3" in thickness occuring between 6' to 8'.	Samples 2 thru 8 were obtained by driving Dames & Moore sampler 2' then reaming and cleaning hole to the shoe depth.
2	☒		38			
				8		
3	☒		31			
				10		
4	☒		32			
				12	Well graded to ¾" with occasional stone fragments to 3".	Bit action [illegible] from 6' to 40'.
5	☒		32			
				14		
6	☒		35		Well graded to 1" with trace of silt showing.	
				16		
7	☒		32			
				18	Well graded to 1" occasional fragment of blue coral.	Set 8" casing to 18.5' to protect hole while working at greater depths.
8	☒		43			
				20		
				22	Sand & gravel stratum continued from 6'.	Continued hole with 3" [illegible] bit & spreading samples interval to 5'. Samples show some disturbance due to gravel fragments.
				24		
	☒					

[illegible]
[illegible]
LOG OF BORINGS [redacted]

SITE [illegible] GROUND ELEV. [illegible]
HOLE NO. [illegible]-2 FIELD PARTY [illegible] RIG Failing [illegible]
LOCATION [illegible].05 E.492.36 SHEET 2 of 2 DATE [illegible]

NO	DRIVE	BLOWS	RINGS	DEPTH IN FEET	DESCRIPTION MATERIAL	DESCRIPTION OPERATION
9	☒	34		26		
				28		
				30	Sand - silty, with embedded blue coral fragments to 1½" few fine to medium gravel sizes. Dense and moist.	
10	☒	38				
				32		
				34		
11	☒	51		36		
					No change	
				38		
				40		
12	☒	53			Sample shows some increase in rock content	Increased bit resistence at 42.0'
				42		
				44		
13	☒	34		46	No change	
				48		Harder drilling at 4[illegible]' continued hard at 51'

[illegible], INC.
Eniwetok Atoll
LOG OF [illegible] ~~CONFIDENTIAL~~

SITE [illegible]
HOLE NO. [illegible]
LOCATION [illegible] E.4[illegible].36
FIELD PARTY Kenney
SHEET [illegible] of [illegible]
GROUND ELEV. [illegible]
BY [illegible]
DATE [illegible]

No.	[illegible]	BLOWS	RINGS	DRIVE IN FEET	DESCRIPTION MATERIAL	DESCRIPTION OPERATION
				5[illegible]		[illegible] Bit 2[illegible]" x [illegible] in at [illegible] and pulled at [illegible] penetration non-uniform. Recovered only [illegible] fragments. Core barrel [illegible] blocked after [illegible] of run
					Increase in stone and [illegible] gravel sizes	
				52		
14			[illegible]'			
				[illegible]		
				[illegible]	[illegible] stone ([illegible]" to [illegible]") and coarse gravel embedded in silty sand matrix	
				58		
15			[illegible]'			
				60		
				[illegible]		
				[illegible]	Apparent increase in rock [illegible]	Drilling slightly [illegible]
				66		
				68		
				70		Core barrel and Bortz [illegible] in at 7[illegible] after drilling continued firm from [illegible]
				72		
[illegible]			[illegible]			
				[illegible]		

Eniwetok Atoll
LOG OF BORINGS

[redacted]

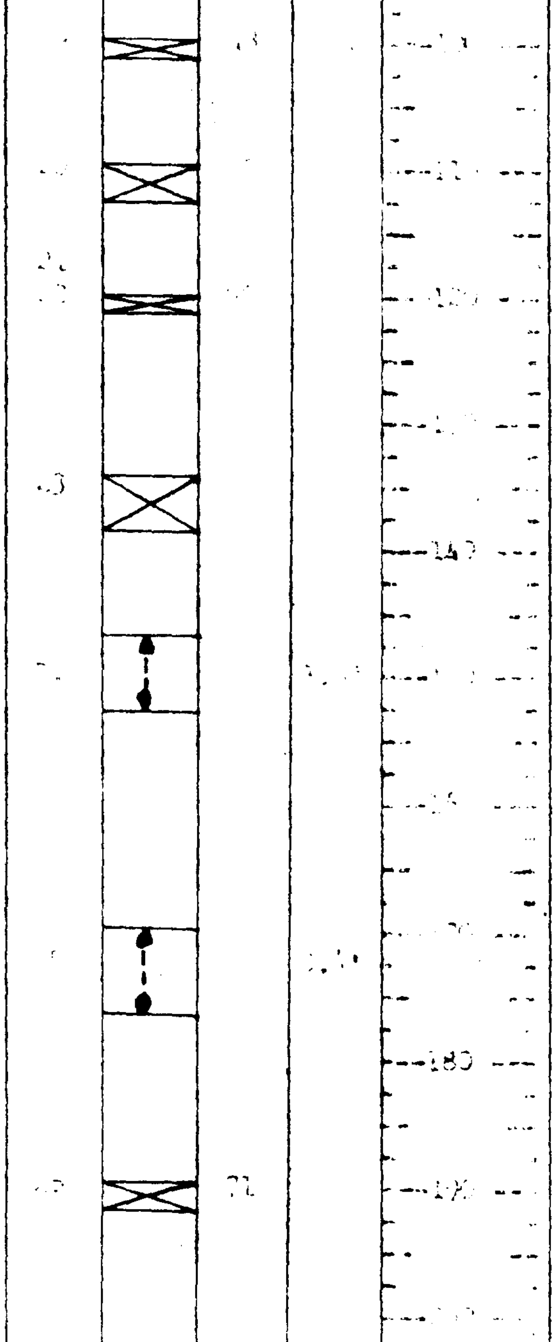
SITE [illegible]
HOLE NO. [illegible]-1
LOCATION N.[illegible]54.05 E.492.36
FIELD ENGR. Tenney
SHEET 4 of 5
GROUND ELEV. [illegible]
RIG Failing [illegible]
AIR [illegible]

NO	DRIVE	BLOWS	RINGS	DRIVE IN FEET	MATERIAL	OPERATION
				76		
				78		
17	☒	61		80	Rock fragments - angular, up to 1" maximum diameter Particle separation is by a thin film of tan silt. Compact and moist	6" casing put to [illegible]
				82		Drilling resistance irregular indicating the presence of coral boulders
				84		
				86		
				88		
18	☒	86		90	Predominately rock fragments max. size 1½" and consisting of hard algal limestone, and halimeda firmly cemented in silty matrix.	
				92		
				94		
				96		
				98		
	☒					

[redacted]

~~CONFIDENTIAL~~

N.	[illegible] E	BLOWS	RINGS	DRIVE IN FEET	DESCRIPTION MATERIAL	COMMENTS



Rock fragments

[illegible] to cream colored [illegible] of core [illegible] seems some [illegible] material

Sample 21 and 22 from same drive and shows [illegible] encountered with core of rock fragments

Samples No. [illegible]
Sample No. [illegible]
Sample No. [illegible]

Samples [illegible]
Samples No. [illegible]

[illegible]

Drilling resistance below 100' is moderate to [illegible] then slightly harder

Coring attempts resulted in blocking inner tube with fractured rock

[illegible] recovery was [illegible] with [illegible] sampler for each drive

[redacted]

HOLMES & NARVER, INC. [redacted]
Eniwetok Atoll
LOG OF BORING

SITE "V"
HOLE NO. EB 3
LOCATION N-1125.27 E.3825.17
DRILL CREW Kenney
SHEET 1 of 2
GROUND ELEV. 10.32
RIG Failing [illegible]
DATE [illegible]

NO	DRIVE	BLOWS	RINGS	DEPTH IN FEET	DESCRIPTION MATERIAL	DESCRIPTION OPERATION
				0	Fill - Sand, gravel some asphalt material fragments dense and dry	300# hammer falling 1[illegible] Sample No. 1 from mud pit excavation
				2	Sand - silty, few scattered gravel occasional boulder to 18" many roots dark brown, dense and moist.	Hole opened thru beach rock with 8" bit and high gel-strength mud
1	☒			4	Sand - some gravel Rock - beach type, fine grained, poorly cemented	
				6		
					Sand - gravel well graded to 1" max. Dense, wet and cohesionless	D-M sampler used continuous thru upper granular zone to 20.0'
2	☒	32		8		
				10		
3	☒	36				
				12		
4	☒	38	6		Some increase in fine sand sizes	
4A				14		
5	☒	35				
5A			6	16	Increase in fines	8" casing put to 17.[illegible]
				18		
6	☒	42	6			
6A				20	Sand and gravel stratum	
				22		
				24		

[redacted]

~~CONFIDENTIAL~~

SITE [illegible]
HOLE NO. [illegible]
LOCATION N-[illegible]
SHEET [illegible] of [illegible]
GROUND ELEV [illegible]
RIG Failing [illegible]
DATE [illegible]

[illegible]	[illegible]	BLOWS	[illegible]	[illegible]	MATERIAL	[illegible]
7	☒	[illegible]			Sand - Fine to med. m., trace of silt. Contains [illegible] coral fragments [illegible] roughly [illegible] sand [illegible]% coral	Extremely easy drilling
				[illegible]	Sand - Silty, soft and wet	
8	☒	23	6			
8A				30		
9	☒	[illegible]		[illegible]	Sand, Silty, with blue coral fragments up to 1"	
10 10A	☒	39	5		Slight decrease in silt content increase in coarse sand and fine gravel occasional piece of blue coral up to 3/4"	
11	☒	[illegible]		40	No apparent change	
					[illegible] at [illegible]	Abrupt change in [illegible]

~~CONFIDENTIAL~~

HOLMES & NARVER, INC.
Eniwetok Atoll [redacted]
LOG OF BORINGS

SITE "V"
HOLE NO. SB 3
LOCATION N-1126.97 E-3225.17
FIELD PARTY Kearney
SHEET 2 of 5
GROUND ELEV 10.32
RIG Failing #1500
DATE 7/10/51

NO	DRIVE	BLOWS	RINGS	DEPTH IN FEET	DESCRIPTION MATERIAL	DESCRIPTION OPERATION
12	☒	73		52	Rock fragments coral and small mollusk shells densely cemented pieces up to 3" some evidence of a silty binder.	Sampler driving action has a tendency to shatter the weakly cemented sections.
				54		
13	☒	99		56	Coarse angular coral fragments some Halimeda and Mollusks some silt and very dense	
				58		
				60		
				62		
				64		
14	☒	66		66	Angular coral fragments many halimeda and mollusk some silt and fine sand sizes compact and moist	
				68		
				70		
				72		
				74		
15	☒	80		76	No apparent change	Harder and more uniform bit resistence at 77'

[redacted]

HOLMES & [illegible], INC.
[illegible]
LOG OF BORING

[redacted]

SITE [illegible]
HOLE NO. EB 3
LOCATION N-2126.97 E-2125.17
FIELD [illegible] Penney
SHEET 4 of [illegible]
GROUND ELEV. [illegible]
RIG Failing 1500'
DATE [illegible]

NO.	DRIVE	BLOWS	REC.	DEPTH IN FEET	DESCRIPTION	
					MATERIAL	OPERATION
				78		
				80		
				82		
				84	No change - larger coral fragments retained in barrel	2¼" I.D. Failing core barrel in at 84' to 86' hard uniform coring resistence
16			0.3'			
				86		
				88		
				90		Drilling resistence remains hard and uniform
				92		
				94		
				96		
				98		Hole cased to [illegible]' with [illegible]" pipe
17		110			Cemented halimeda debris and coral fragments	

[redacted]

HOLMES & NARVER, INC.
Eniwetok Atoll
LOG OF BORINGS

SITE "V"
HOLE NO. EB 3
LOCATION N-1126.97 E-3325.17

FIELD PARTY Renney
SHEET 5 of 5

GROUND ELEV 10.32
RIG Failing "1500"
DATE 2/10/51

NO	DRIVE	BLOWS	RINGS	DEPTH IN FEET	DESCRIPTION	
					MATERIAL	OPERATION
				100	Predominately rock fragments with various degrees of cementation dense and moist	
18	☒	75				
				110		Reed Roller barrel in at 138.5' to 148.5' Exceptionally poor recovery shows only coral pieces approx. 1" in diameter
19	☒	88				
				120		
20	☒	100				
				130	Coral - halimeda with some silt and fine sand sizes	
				140		
21	↕		0.3'			
				150		
22	☒	55			Sample #22 shows an abundance of forams some hard cementation little or no coral or halimeda	
				160		
				170		
				180		
				190		
				200		

CO[redacted]AL

FILE NO. [illegible]
LOCATION [illegible]
DATE [illegible]

NO.	DRIVE	BLOWS	REC.	DEPTH IN FEET	MATERIAL	OPERATION
					[illegible] - Gray [illegible] some fine gravel, compact [illegible] moist	Hole opened with cont[illegible] sampler drives to 7.0' hole [illegible] and sampler out to [illegible] then reamed and sampler put to 12.[illegible] and [illegible]
				2		
					Color change	
				4	Sand - White, clean - some fine gravel dense	
1			6		[illegible] to wet at 5.8' ground water	
2			6	6	Gradual increase in gravel sizes with depth [illegible] fine to medium sand	Sampler resistance No.1 54 300# x 18" blows No.2 64 300# x 18" for total No.3 45 300# x 18" length No.4 5? 300# x 18" No.5 19 300# x 18"
3				8		
4				10		
5						
					[illegible] - [illegible] with [illegible] [illegible] fragments. Numerous shells. Dense, wet and semi-cohesive white in color	Core barrel in [illegible] to 1?' no Rec. [illegible] rock bit thru [illegible] hard and soft [illegible] to 1?.0'. Core barrel taken [illegible] to 21.6'
				14		
				16		Recovered [illegible] of coral fragments and shells. Fines were washed [illegible].
				18		
6			1.3			
				20		Advanced hole to [illegible] put sampler to [illegible] 43 - 300# x 18" blows.
				22		
				24		

[redacted]

HOLMES & NARVER, INC.
Eniwetok Atoll
LOG OF BORINGS

[redacted]

SITE "B"
HOLE NO. MU-5
LOCATION S-62.26 E-5644.46
FIELD PARTY Kenney
SHEET 2 of 3
GROUND ELEV.
RIG Failing "1500"
DATE 12/14/50

NO.	DRIVE	BLOWS	RINGS	DEPTH IN FEET	DESCRIPTION MATERIAL	 OPERATION
				26		
7				28	Silty sand and gravel up to 3" white, wet and compact.	Drilling action between sampler drives indicates a gradual increase in large conglomerate fragments.
				30		
				32		
8				34	Similar with increase in gravel content	
				36		
				38		Advanced hole to 40.0' and put D-M sampler to 41.5' and refusal with 47 - 350# x 18" blows
9				40		
				42	Coral conglomerate fragments embedded in sandy silt compact moist and white in color occasional silty sand lenses up to 1" in thickness	
				44	TOP OF ROCK	Bit action indicated firm rock at 44.5'
10			5.0	46	Conglomerate fine to coarse grained and non-uniformly cemented Max. core length 7" core will [illegible] in core [illegible]	Core barrel put to [illegible] with uniform resistance and full recovery
				48		

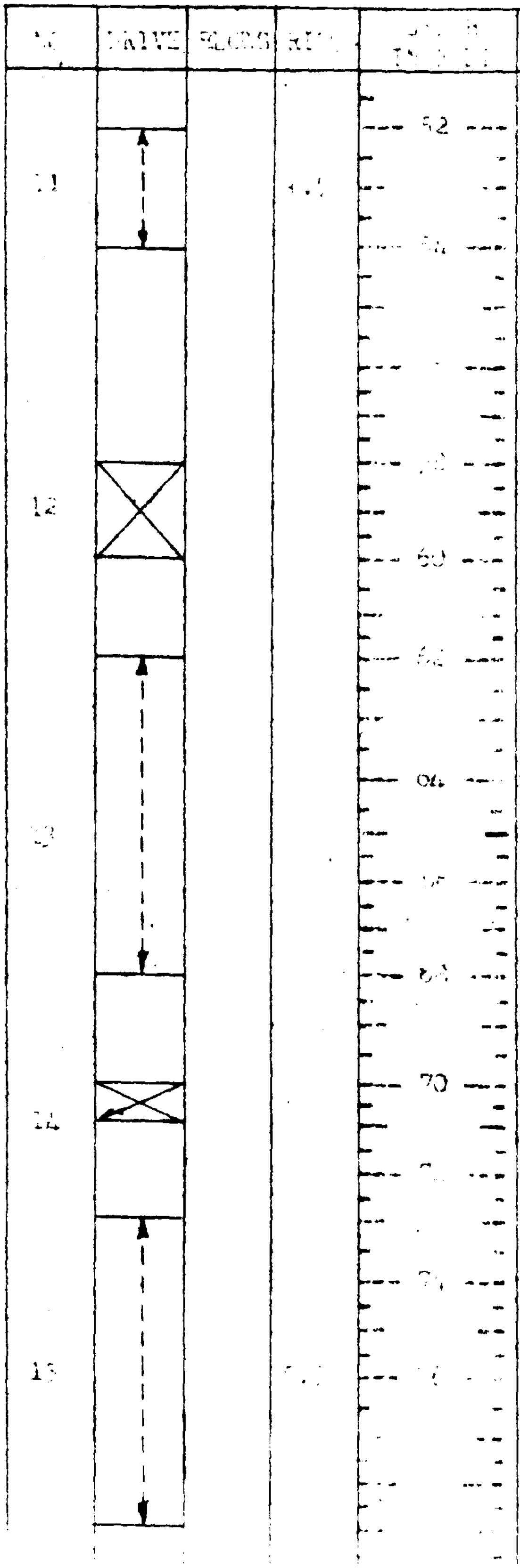
[redacted]

[redacted]

[illegible] ELEV

HOLE NO. [illegible] DATE [illegible]

LOCATION [illegible] F-2124,10



MATERIAL	OPERATION
No change	Core barrel in at [illegible] and removed at 54.[illegible]' [illegible] blocking. Drilling action indicates firm and soft rock [illegible] of 4" average thickness.
	Sample No. 12 is from mud ditch
Conglomerate fine to medium grained. Various degrees of cementation giving honeycomb structure. Max. core length [illegible]"	Hole advanced to 62.[illegible]' under similar conditions. Core barrel in at [illegible] and pulled at [illegible]' for [illegible] of core
	Sample No. 14 is from mud ditch during operations from 68 to 72'
	Core barrel in [illegible] out at 69' for [illegible] recovery.
No change	No fluid loss and no evidence of caving.

[redacted]

[illegible]
Eniwetok Atoll
LOG BORING

SITE [illegible]
HOLE NO. EU-6
LOCATION -592 E-6312
FIELD PARTY Kenney
GROUND ELEV. 3.0'
RIG Failing 1500
DATE 12/7 to [illegible]

Sheet 1 of 4

NO.	DRIVE	BLOWS	RINGS	DEPTH IN FEET	DESCRIPTION MATERIAL	DESCRIPTION OPERATION
				0	Fill - greyish tan, sand, gravel loose and dry to 1.5'	Hole opened to 5.0 with continuous drives with D-M sampler.
				2	SAND - Medium - Coarse, some fine to coarse gravel tan moist and semicompact. Clean and compact at 3.5'	8" pipe set on cemented sand and gravel at 5.0' and 8" rock bit used to penetrate hard formation to 16.0'
1	☒					
				4		
2	☒		6			No. #1,3,4 from mud pit excavation.
3	☒				SAND & GRAVEL - highly cemented in beds of various thickness. Thin layers are from 6 to 8" in depth and separated by thin (2-3") lenses of clean cohesionless sand and gravel up to 1" in diameter.	
4	☒					
				6		
				8		
				10		
					Alternating cemented and non-cohesive zones exist to 16.0'	
				12		
				14		Change noted in drilling action at 16.0' and sampler put to 17.5' with 2 - 300# x 18" blows per inch.
				16	SAND - Medium to coarse and containing some fine gravel. Compact and wet. Non-cohesive - clean	
5	☒					
				18		There seems to be a gradual reduction in thickness of cemented layers and a corresponding increase in the uncemented sections as the depth of hole is increased.
				20		
					SAND - [illegible]	Material caves in badly and hole was stabilized by increasing gel-strength of fluid thru the addition of 1 sack of lime.
				22		
6	☒					
				24	(X) Indicates samples suitable for shipment. Increase in fine to medium gravel sizes. [illegible]	Due to cohesionless nature this material (coarse [illegible] and fine gravel) [illegible] be retained in sampler.

[illegible] Soil CO[redacted]DENTIAL

[illegible]

HOLE 3 [illegible]
Sheet 2 of 4

GROUND ELEV. 3[illegible]
RIG
DATE [illegible]

[illegible]	[illegible]	[illegible]	[illegible]	DEPTH [illegible]	DESCRIPTION [illegible]	[illegible]
				26		2-300# x 18" blows per inch at 21 to 22.5' (6) Mud ditch sample
7	☒			28	SAND - Coarse, dense and gravelly. Pervious	(7) Mud ditch sample
				30		Noticable decrease in drilling resistence.
8A	☒					
			6	32	Increase in finer sand sizes and traces of silt- dense and wet numerous thin shell fragments. Some fine gravel up to 1/3"	12" barrel extension used on sampler in order to recover more material. Inside length increased from 1.5' to 2.5' Sample No. 8A is excess material after removing the lower 6 rings for preserving and shipping.
8						
				34		
				36		
				38		
				40		In advancing hole from 43' to 47', an abrupt change was noted. In with 2.[illegible] sampler to 47.6' and refusal in fractured conglomerate. Resistence for this 0.[illegible] drive was 10 - 300# x 16" blows per inch.
9A	☒					
9			6	42	Fine to medium sand - trace of silt, dense and wet.	
				44	Few small, well preserved shells up to 1/2" in diameter.	
				46		
					TOP OF ROCK	
10	☒					
				48	Conglomerate - weakly cemented, badly fractured, and containing numerous thin silt filled seams between solid pieces 6" or less in length.	
				50		
					[redacted]	
				52		Reamed and advanced [illegible] 52 [illegible] under more [illegible]

HOLMES & NARVER
Eniwetok Atoll
LOG BORING [redacted]

SITE "C"
HOLE NO. MI-6
LOCATION S-592 E-6312

FIELD PARTY Kenney

GROUND ELEV. 6.0'
RIG FAILING [illegible]
DATE 12/7 to 12/[illegible]/56

Sheet 3 of 4

NO.	DRIVE	BLOWS	RINGS	DEPTH IN FEET	DESCRIPTION MATERIAL	 OPERATION
						resistence.
				54	Some uniform fine to medium grained lime. Stone interbedded with the softer conglomerate.	A 50 p.s.i. reading was maintained on hydraulic feed gage (total bit load of 1250 lbs) to counteract lift due to circulation thru bottom discharge ports bit.
R 1				56	Contact is weak at these joints which exist in a vertical plane as well as in other directions.	
				58		This step resulted in better recovery of the poor rock thru fragment blocking of the bit.
R 1				60	Few porous and honeycomb sections.	Mud loss approx. 100 gal. per 10'.
				62	CONGLOMERATE	Core Barrel put to 62.3' for 3.0' recovery
					Coarse grained, hard and soft streaks few shell sections and some pieces of fine grained limestone.	
				64		Slightly irregular bit action showing alternating hard and soft rock layers of from 4 to 6 inches in thickness.
				66		
D 2					D-2 is mud ditch sample indicating no change in formation	During coring, reaming, and drilling operations mud loss was approx. 100 gal. per 10' of hole.
				68		
				70		Mud kept at a relatively high gel-strength.
R 3			0.8			
				72		Core barrel in at 70' and out at 71.0' due to blocking. Recovery indicated no change in formation.
				74		
D 4						
				76	D-4 is muck ditch sample indicating slight increase in fine grained limestone content.	
				78		
					[redacted]	
				80		

HOLMES & NARVER
Eniwetok Atoll
LOG BORING

C[redacted]DENTIAL

SITE [illegible]
HOLE NO. MU-6
LOCATION [illegible]

FIELD ENGR. Kenney

GROUND ELEV. 5.0'
RIG [illegible]
DATE 1/7 to [illegible]

Sheet 4 of 4

NO.	DRIVE	BLOWS	RINGS	DEPTH IN FEET	DESCRIPTION	
					MATERIAL	OPERATION
D 5				82	D-5 is mud ditch sample showing no change.	Rock bit showing firmer and more uniform resistence at 83 to 83.5' Core barrel in at 83.5' to 90.0' under more uniform coring action.
				84		
R 6			2.8'	86	CONGLOMERATE Less limestone and more coarse grained honeycombed sections up to 5" for any one piece.	
				88		
				90	Pore diameters vary from 1/16" to ½" max.	
				92		Hole reamed and taken to 95.0' with uniform rock cutting resistence
				94		
				96		
R 7			2.5		Recovery from final core barrel run showed no change in formation	Remarks: No evidence of cavitation other than the porous and honeycomb sections previously described average mud loss roughly 100 gal. per 10' of rock penetrated.
				98		
					HOLE COMPLETED	
				100		
				102		
				104		
				106		

[redacted]

[illegible], Inc.
Eniwetok Atoll
Log of Borings

CO[redacted]AL

SITE #5?
HOLE NO. [illegible]
LOCATION [illegible]
FIELD [illegible] Of Kennon
SHEET 1 of 1
GROUND ELEV 8.?
RIG Failing [illegible]
DATE [illegible]/50

NO	TYPE	BLOWS	RINGS	DEPTH IN FEET	DESCRIPTION MATERIAL	DESCRIPTION OPERATION
				0		Hole opened to ?.0' with D-M sampler No. 1 [illegible] 4?-300# x 18" [illegible] of penetration sample No. [illegible] ?? - 300# x 18" blows to refusal at 7.?' on cemented sand and gravel.
				2	[illegible] - [illegible], contains some fine gravel - grey-ish moist and dense.	
1	☒		6	4	White clean and pervious at ?.0'	
2	☒			6	Ground water SAND - GRAVEL alternating layers of highly cemented coarse sand and fine gravel separated by thin zones of cohesionless sand and gravel of slightly coarser gradation (up to 3/4")	
				8		
				10		
				12		Hole cased to 12.0' with 8" pipe Core barrel put in at 1?.0' thru alternating hard and soft sections not greater than 6" in depth.
					GREY - FINE SAND and GRAVEL.	
R3			2.5'	14–18	Core recovery showed fine to coarse grained conglomerate with few thin limestone pieces. this rock is evidently embedded in medium to fine sand which is washed out during coring and sampling operation.	
				20		Hole reamed to 24.0' and D-M put to refusal at [illegible] indicating more conglomera
				22	Sand and gravel greyish, wet and dense-contains large coarse grained conglomerate sections and few pieces of green coral fragments.	In with core barrel to 26.
R4			0.?	24		
5	☒			26	[redacted]	Put D-M sampler to ?.?' and refusal with 24 - [illegible] x 18" blows

[illegible], INC.

[illegible]

[redacted]

[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	W.O.	[illegible]
[illegible]	[illegible]	DATE	[illegible]

No.	Type	Sl. [illegible]	Blows	Depth in Feet	Description: Material	Description: Operation
	☒				No change	Hole advanced to 29.5' and D-M put to [illegible] and refusal with 26 - 300 x 18" blows
				30	Unable to hold in sampler any sizable portion of the fine grained matrix which contains the embedded rock fragments.	
				34		
[illegible]					Green and gray [illegible] pieces up to [illegible] in dia.	
					[illegible] fine grained limestone [illegible].	
	☒				Rock fragments up to 1½' with some evidence of [illegible] fine sand matrix	Hole advanced to [illegible] and D-M sampler put to [illegible] with a total of [illegible] 300 x [illegible] blows.
				42		
				44		Continued hole with [illegible] rock bit to 48.0' with a noticeable increase in [illegible] content by change in drilling action
				48	TOP OF ROCK	
[illegible]			.7'	50	Medium grained limestone interbedded with coarse grained conglomerate.	In with core barrel and Bortz bit to [illegible] and blockage
					Showing both horizontal and vertical [illegible] to [illegible] in thickness, seams are filled with fine silty sand	

[redacted]

[illegible]
[illegible]ROCK [illegible] CO[redacted]

HOLE [illegible]
GROUND ELEV [illegible]

No.	DEPTH	BLOWS	RUN	DEPTH FT.	DESCRIPTION MATERIAL	REMARKS
					[illegible]	
R10			1.5'			
				60	[illegible]	
11				62	[illegible] and inter-bedded [illegible] grained limestone beds of shallow thickness.	
				64		Hole reamed and advanced to 64.5' on what seemed to be firmer rock
12				66	[illegible] is slightly honeycombed and weakly cemented in numerous places	
				68		
				70	Coring was not undertaken where drilling action indicated soft of fractured rock.	
				72	Ditch samples were obtained in place of a core barrel run which would result in blocking after a short distance	
				74		
13				76		Sample No. 13 is from mud ditch and shows no apparent change
				78		
				80		[illegible] section of core removed from box for [illegible] (81.5 - 8[illegible])

[redacted]

[illegible] INC.
Eniwetok [illegible]
LOG OF BORING

SITE [illegible]
HOLE NO. MU-[illegible]
LOCATION [illegible] [illegible]1.71 [illegible]

[illegible] Hopper
SHEET 4 of 4

GROUND ELEV 8.5
RIG [illegible]
DATE [illegible]

RUN	DRIVE	BLOWS	RING	DEPTH IN FEET	DESCRIPTION MATERIAL	OPERATION
14			[illegible]	82	[illegible] - coarse [illegible] porous and honey comb structure.	
				84		
					[illegible] of medium grained [illegible] stone encountered [illegible] 85-87'	
				86	Max. [illegible] some thin laminations at 84 - 85' [illegible] fracture at 87.[illegible]'	
				88		Hole reamed and advanced to 90.0' thru what appeared to be similar rock conditions.
				90		
				92		In with core barrel to 97.5
					Recovery shows less limestone and more porous	
15				94	weakly cemented conglomerate	
				96		
					No fluid loss and tool action indicated no cavitation.	
				98		
				100		
				102		
				104		
				106		

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Eniwetok Atoll
LOG BORING

SITE "E"
HOLE NO. EN-6
LOCATION N-4475.08 E-2231.78

FIELD PARTY Ke[illegible]

GROUND ELEV. 10.2
RIG Failing 1500
DATE 22 Nov 19

PAGE 1 of 4

NO	DRIVE	BLOWS	RINGS	DEPTH IN FEET	DESCRIPTION MATERIAL	OPERATION
				0	SAND-Silty, some fine gravel. Tan, moist, and non-cohesive and loose.	Hole opened to 11.0 feet with 8 inch roller bit and heavy mud. Cased hole to 13.5 feet to shut off cavin stratum at 9 to 11 feet
1	☒			2	(Samples #1 & 2 from mud pit excavation)	
				4		
2	☒			6	SAND & GRAVEL - Slightly cemented, dense, fine, tan, moist and clean. Contains numerous moids. Max. size ½"	
				8	GROUNDWATER AT 8.5 FEET.	
					GRAVEL - highly cemented fine to medium.	
				10		
				12	GRAVEL - some coarse sand greyish green and white loose and caving.	
				14		
3	☒			16	SILTY SAND: Contains some embedded dowel-shaped coral fragments, thin shells, and some medium gravel. The upper portion of this stratum is extremely soft and wet. Max diameter of coral fragments is 1½"	Casing was cleaned out and hole advanced to 14.5 feet in very soft material. (DM) sampler was put to 16.0 feet rapidly under 2,000 lb. hydraulic pressure. (Max) penetration was slightly irregular due to coral fragments.
				18		
4	☒			20	SILTY SAND: Stratum continues from 14.5'	Hole advanced to 20.0' under very easy drilling conditions. (D-M) sampler in at 20.0' to 22.0' under 2 000 lb hydraulic pressure. (Max) recovery indicated numerous [illegible] green coral fragments and only 3" of [illegible] [illegible] ted in shoe section.
				24		
5	☒					

[redacted]

[illegible]
Eniwetok Atoll
LOG BORING
FIELD PARTY Kenney

SHEET [illegible]
HOLE NO. EN-6
LOCATION N-2275.08 E-[illegible]

GROUND ELEV. 10.2
RIG Failing 1500
DATE 22 Nov. 1950

[illegible] OF [illegible]

[redacted]

NO.	DRIVE	BLOWS	RINGS	DEPTH IN FEET	DESCRIPTION: MATERIAL	DESCRIPTION: OPERATION
				28		Evidently the coral section found in the upper portion of the sampler were being chased down the hole by the action of the bit in this soft material.
				30		Hole advanced to 24.5' and (D-M) sampler put to 27.0' with maximum hydraulic pressure of 3,000 lbs. Penetration rate slightly uneven due to embedded coral fragments. Sampler over-driven in an effort to obtain more material.
6				32	Noticeable increase in firmness and little or no dowel-shaped coral showing.	
				34		
				36		Hole taken to 31.5' and (D-M) sampler put to 34.0'. No recovery. In with thin wall sampler to 34.0' and recovered full sample of sandy silt with embedded gravel up to 1" in Dia.
				38		(D-M) sampler altered by removing one ball valve and inserting heavy rubber ring in shoe before drive.
7				40		Hole advanced to 39.0' with no apparent change in drilling action. (D-M) sampler in at 39.0' and pressed to 41.5'. Rate uniform. Max. Hydraulic pressure 12,500 lbs. Full recovery and shoe containing large piece of gravel.
				42	Increase in density and rock content. Decrease in moisture content.	
8				44		
				46		
				48	Increase in rock content.	
C.B. 1				50	TOP OF ROCK 50.2' Conglomeratic limestone coral head fragments	Drilling to 50.0' indicated more rock. In with (D-M) sampler at 50.0' and refusal at 50.2' with 15,000 lbs. H.P.
			7"	52		

[redacted]

TE "E"
LE NO. EN-6
CATION N-4475.08 E-2231.78

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Eniwetok Atoll
[illegible] BORING

FIELD PARTY Kenney

PAGE 3 OF 4

GROUND ELEV. 10.0
RIG Failing [illegible]
DATE Nov. 1950

NO.	DRIVE	BLOWS	RINGS	DEPTH IN FEET	DESCRIPTION: MATERIAL	DESCRIPTION: OPERATION
						Core barrel put in at [illegible] and run to 55.0'. Recovery 7" of 2¼" conglomerate core.
				56		
C.B. 2			4"			Reamed hole to 8" to 55.0' and advanced to 58.0'
				58	Because loose gravel between 10.0' and 33.0' was falling into the hole under the 8" casing, a string of 6" casing was put in to a depth of 58.0' Core barrel in at 58' and out at 59' due to blocking.	
				60		
C.B. 3			3"			Hole advanced to 60.0' and(D-M) sampler put to refusal at 60.2' with 15,000 lbs. H.P. In with core barrel to 62.0' recovery 3" conglomerate core.
				62		
				64		Hole taken to 65.0' and drilling action indicated rock of different hardness.
				66	No apparent change	In with (D-M) sampler at 65.0' and refusal under 15,000 lbs. H.P. (no movement). Core barrel run from 65.0' to 74.0', recovered 1.0' of conglomerate core.
				68		
C.B. 4			1.0'			
				70		In with (D-M) sampler to 74.0' and recovered what looked like ground-up rock. Reamed and cleaned out hole to 75.0'. Put (D-M) sampler to 75.3' and refusal under 15,000 lbs. H.P. sampler drive continued to 76.5' with an average penetration resistance of 1,000 lb. [illegible] 18" blows per inch.
				72		
				74		
		38			Rock is soft, fine-grained limestone, badly fractured yet is seemingly in a dense state.	
				76		
				78		

[redacted]

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SITE 1
[illegible]
[illegible] N-4475,08 E-2[illegible]

[illegible]
Eniwetok Atoll
LOG BORING

FIELD PARTY [illegible]
PAGE 4 OF 4

GROUND ELEV. 10.2
RIG [illegible]
DATE [illegible] Nov. 1950

NO.	[illegible]	BLOWS	[illegible]	DEPTH	DESCRIPTION [illegible]	OF [illegible]
				84		Advanced hole to 81.0' and put (S-M) sampler to 81.5' and refusal with [illegible] 18" hammer blows per inch. Recovered 4 inches of conglomerate core.
				86	Conglomerate and thin (1") layers of white limestone.	Drilled to 86.0' through alternating hard and soft section.
C.B. 5			8"	88	Jointing between limestone and cellular conglomerate is weak and results in short core sections.	
				90		In with core barrel to 91.0' recovered 8" of hard conglomerate and thick shell sections Max. length, 4".
				92	Conglomerate and limestone appearing in thicker beds.	Back into open hole with core barrel to 96.0'. Recovered 3.0' of core. Max. length. 4 inches.
C.B. 6			3.0'	94		
				96	Last 1.0' of core is a dense, brittle, fine-grained limestone, tan in color. Core breakage believed due to wide bit kerf and resulting core barrel wobble	
C.B. 7			3.0'	98	No fluid loss and no evidence of cavitation during operations.	Final run from 96.0' to 101.0' for 3.0' recovery.
				100		

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GROUND ELEV. 7.7
RIG FAILING 1500
DATE 27 Dec. 1950

FIELD PARTY Penney

SHEET 1 of 4

NO.	DRIVE	BLOWS	RINGS	DEPTH IN FEET	DESCRIPTION MATERIAL	 OPERATION
				0	SAND - Dark grey, dense and dry, some fine to medium gravel.	Sampler resistance: 300 lb. hammer falling 18"
				2		Hole opened to 9.0' thru cemented sections. 8" rock bit showed abrupt change at 9.0'
					SAND & GRAVEL - Firmly cemented in zones of 6" in thickness.	
				4		
				6	Cemented zones separated by cohesion lenses or layers of coarse and medium gravel.	
						D & M Sampler 2" x 30" with ring liners used for all overburden samples.
				8		
					SAND - Tan, medium to coarse, some fine gravel. Compact and wet.	Sample #1A excess material
1	☒	42	6	10		
				12	Same as above - few gravel sizes up to 1/2"	
2	☒	35	6			Sample #2A excess
				14		
				16		
					Same as above	Sample #3A
3	☒	35	6	18		
				20	(6) Indicates undisturbed sample of 6 rings. SAND STRATUM FROM 9.0'	
						Sample #4A excess material
				22		
4	☒	37	6		Greenish, with slight increase in sizes showing up at 27.0'	
				24		Gradual decrease in drilling and driving resistance starting at 24.0'

CO[redacted]

NO.	DRIVE	BLOWS	RINGS	DEPTH IN FEET	DESCRIPTION	
					MATERIAL	OPERATION
5	☒	21	6	28	Same as above (softer)	Sample #5A
				30		
6	☒	24	6	32	Gravel sizes to 3/4"	Sample #6A
				34	Soft	
				36		37' of 6" casing placed after having some cave-in trouble at 30.0'
7	☒	30		38	Few embedded gravel sizes to 1 1/2"	
				40	Soft Same Stratum	Increased drilling and driving resistance starting at 44.0'
				42	Grey sand with some gravel sizes up to 1 1/2"	
3	☒	71		44	Increase in gravel fragments of small stone size.	
				46		
9	☒	62		8	Same as above	Sampler Refusal at 40.5'
				0		

[redacted]

C[redacted]

NO.	DRIVE	BLOWS	RINGS	DEPTH IN FEET	DESCRIPTION MATERIAL	DESCRIPTION OPERATION
	☒	100		54	Predominately rock fragments.	
10						
				56		
				58		
11	☒	62		60		
				62	Rock fragments. Both weak and firm cemented sections	
				64	Embedded in silty sand matrix.	
				66		D & M Sampler used for all samples to 71.0'
				68		
12	☒	85		70	Same as above.	
					Rock fragments 3/4" to 1" in diameter.	
				72		
				74		
				76		

[redacted]

[redacted]

NO.	DRIVE	BLOWS	RINGS	DEPTH IN FEET	DESCRIPTION MATERIAL	OPERATION
				80		
13	☒				Predominately rock fragments some fine sand - gravel TOP OF ROCK Conglomerate-alternating sections of hard and weakly cemented material 3" to 5" thick	Sampler refusal at 81.0' Rock bit encountering more uniform resistance at 82.5'
				82		
			6"			
14	☒			84		Core barrel 2 3/4" x 4 3/4 x 10' long used for all rock coring.
				86	Barrel blocked at 84.0'	
				88	No change	
15	☒			90	Barrel blocked at 91.0' in weakly cemented rock.	Between core barrel runs the hole was reamed and advanced with a 6" rock bit.
				92		
				94		Coring locations were selected on the basis of bit action in order to start run on firm rock and avoid blocking.
				96		
				98		No mud loss and no evidence of cavitation.
				100		
	☒			102		
[illegible]			2"	104	No apparent change in rock condition at 106.0' Bottom of hole at 106.0'	
				106		

[redacted]

Eniwetok Atoll

LOG OF [illegible]

CO[redacted]ENTIAL

HOLE NO. [illegible]-3
LOCATION [illegible]-5200 [illegible]
FIELD PARTY Kenney
RIG [illegible]
DATE [illegible] Jan. 195[illegible]

Sheet 1 of 4

No.		BLOWS	RINGS	DEPTH IN FT.	DESCRIPTION MATERIAL	DESCRIPTION OPERATION
				0	[illegible] Black, dense, moist with few roots.	Hole opened to [illegible].0' with 8" rock bit and high gel-strength fluid.
				2		Penetration [illegible] and uniform except for cemented layers encountered from 5 to 11.5'.
1	☒				SAND AND GRAVEL Tan, dense, clean and moist to wet at 9.5' Gravel sizes up to 1½" in diameter.	
	☒			4		
				6	Some weakly cemented zones up to 6" in thickness exist from 5.0' to 11.5'	
7				8		
					Gr. [illegible]	Samples 3A & 4A are excess material from sampler after removal of 6" rings.
				10	SAND AND GRAVEL Coarse sand sizes and fine to medium gravel	D-M Sampler in from 12' to 14' easy driving.
3 3 A	☒	41	6	12		
				14		
4 4 A	☒	52	6	16		Hole Reamed and taken to 15.0' before putting sampler to 17.0' with increased resistence.
				18	Increase in finer sizes	
5	☒	52		20		Hole clean to 20.0' and sampler put to 21 with some irregular resistence due to stone content.
				22	Evidence of few small stone sizes 4" to 6" embedded in sandy matrix.	
				24		
6	☒	38			Increase in finer sizes	

CO[redacted]

Eniwetok Atoll [redacted]

SITE "Y"
HOLE NO. BN-5
LOCATION N-5200 E-3000

FIELD PARTY Gannaway

GROUND ELEV. 10.4
RIG. Failing 1500
DATE 23 Dec. 1950

Sheet 2 of 4

NO.	DRIVE	BLOWS	RINGS	DEPTH IN FEET	DESCRIPTION MATERIAL	OPERATION
	△				and color changes to gray-ish [illegible] sizes to 4"	
				28		
				30		
7	☒	26			Grayish silty sand and gravel	
				32	Gravel to 3/4"	
				34		Easy bit penetration
8	☒	9	6		No change except much softer	
8A				36		8A-Excess material
				38		
		16	6	40		
9	☒				No apparent change	
9A				42		
				44		
					Increase in stone sizes and small boulders	Abrupt increase in bit resistance at 45.0'
				46		
						Core barrel [illegible] Bit in from 47.6' to 49.' [illegible] 6" of coral boulder sections
10	☒		6"	48		
				50		Resistance firm to 51.5' then soft for remainder of run
				52	[redacted]	

[illegible]
Eniwetok Atoll
LOG OF [illegible]

SIZE [illegible]
HOLE NO. I-2
LOCATION N-5200 E-3000

FIELD [illegible] [illegible]

GROUND ELEV. 10.26
RIG, Failing 1500
DATE 23 [illegible] 1950

Sheet [illegible] of [illegible]

NO.	DRIVE	BLOWS	[illegible]	DEPTH IN FEET	DESCRIPTION MATERIAL	OPERATION
				54	SAND & GRAVEL, some silt, dense, contains few stone fragments up to 2"	
11	☒	46		56		
				58		
12	☒	75		60	SAND GRAVEL. Silty dense, and moist. Few stone and boulder fragments	
				62		
				64		
13	☒	62		66		
				68		Sampler refusal at 66.0' Harder drilling between 60. ' to 70.0'
				70	TOP OF ROCK	
14	☒		6"	72	Conglomerate - fine to medium grained and slightly porous and soft	Core barrel run indicated both weak and well cemented sections of shallow thickness barrel removed from hole due to blocking of bit at 72.0'
				74		
15	☒	72		76	Rock Fragments	Rock bit encountering alternating hard and soft layers during drilling operations
				78		
				[illegible]		During [illegible] operations [illegible]

HOLE NO. N-[illegible]

LOCATION N-6000 E-30[illegible]

LOG OF DRILL [redacted] TOTAL [illegible] 12.36

[illegible] Kenney

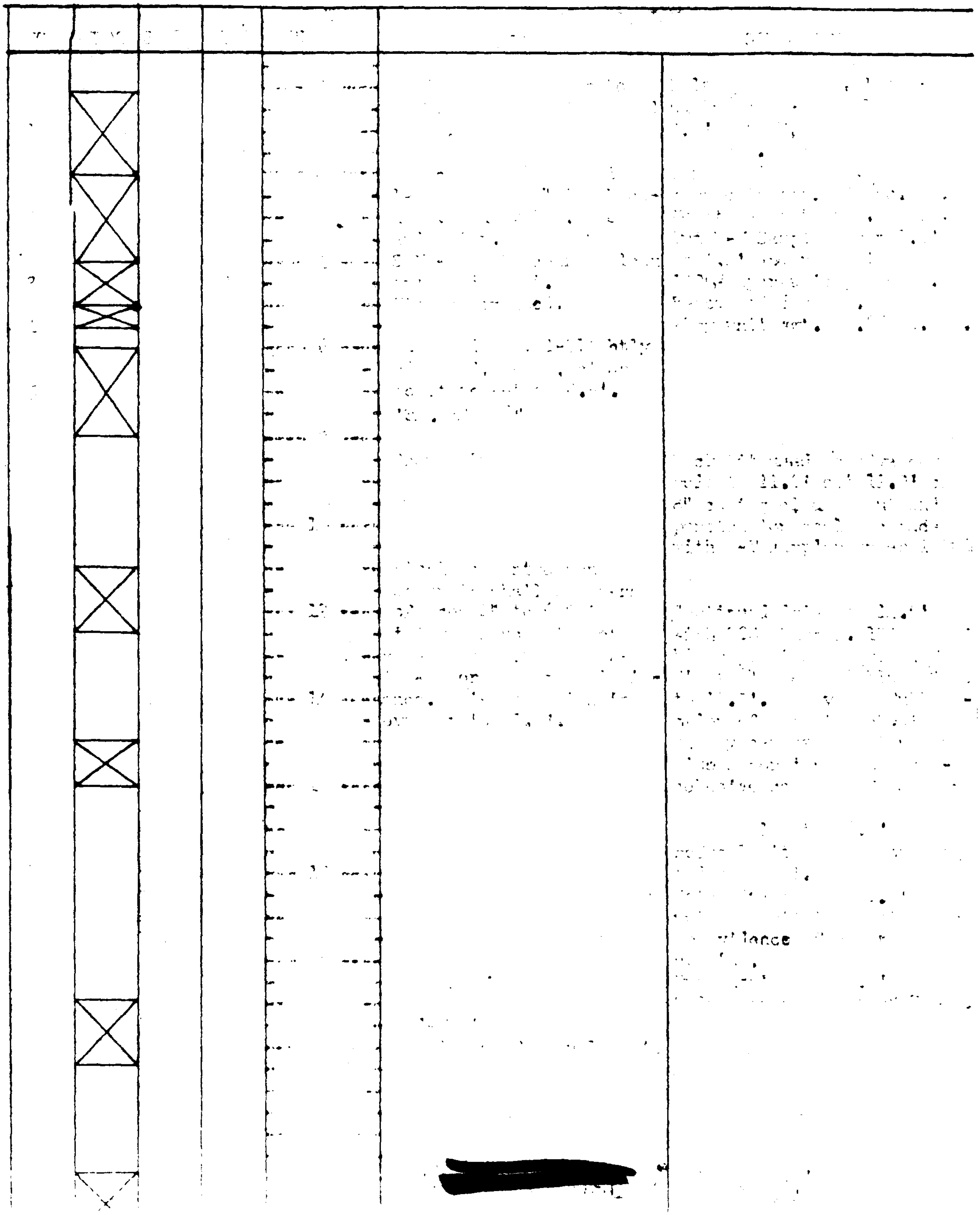
RIG. Falling [illegible]

DATE [illegible] Dec. 19[illegible]

Sheet 4 of 4

NO.	DRIVE	BLOWS	RUN	DEPTH IN FEET	MATERIAL	CONDITION
				82		pebbles, penetration rate was very irregular due to [illegible] 1/2" to 5" [illegible] and soft zones.
					Conglomerate	
				84	Hard-Soft Sections	
						Barrel Blockage in soft rock very frequent.
16			1.5	86		
				88		
				90	No apparent change in rock structure.	
						6" core section preserved for shipment (90.5'-91.0')
				92		
17			4.0			
				94		
				96		
18			1.3			
				98		
				100		
19			1.5	102		All circulation lost at 103.0' and regained at 105.0' thru the use of 1 sack of lime put into hole. No casing used------
				104		
20			2.0	10[illegible]	[redacted]	

C[redacted]



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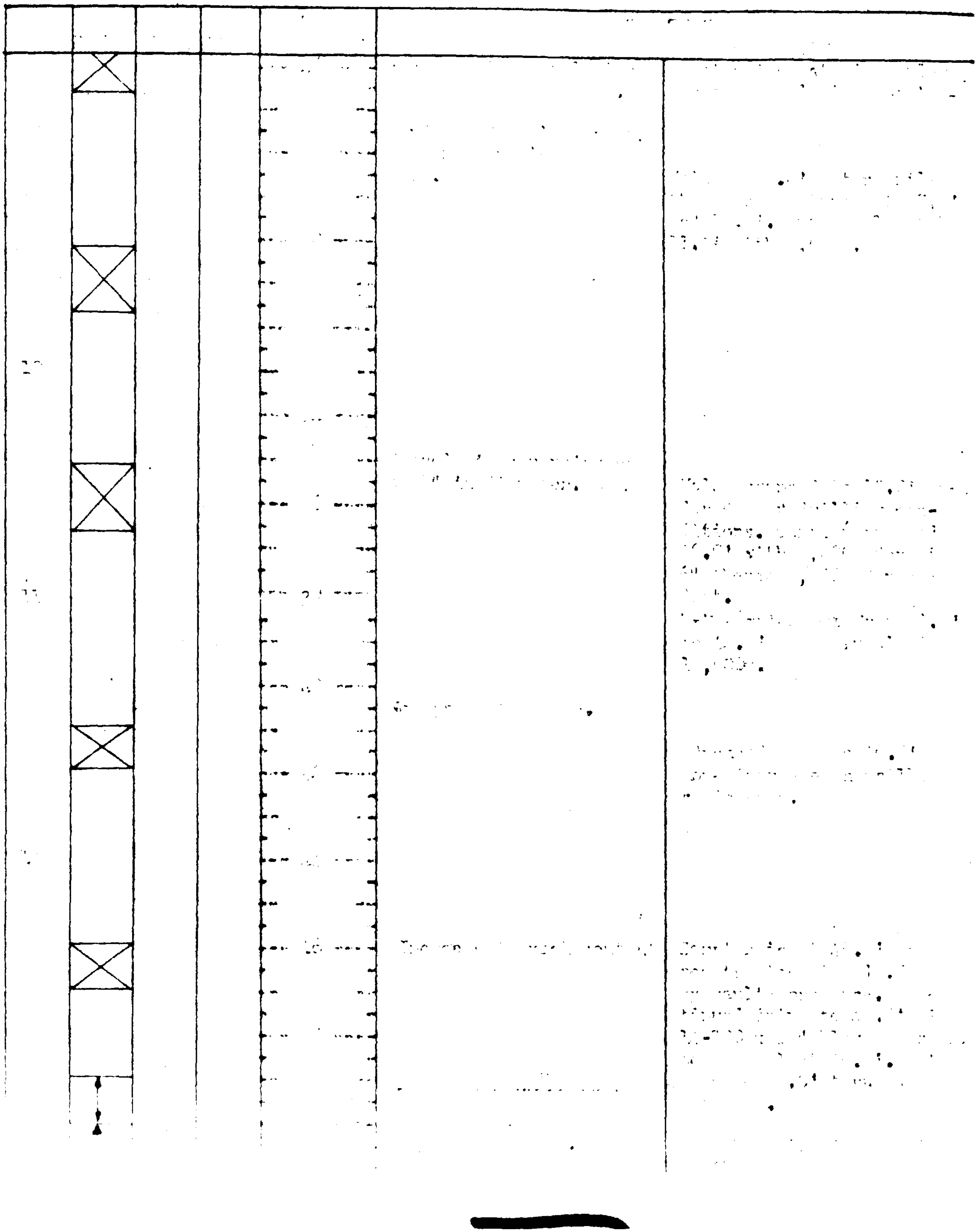

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~~CONFIDENTIAL~~

[illegible]

[redacted]

HOLMES & NARVER, INC. [redacted]
[illegible] Atoll
LOG OF BORINGS

SITE [illegible]
HOLE NO. EN-10
LOCATION N-4357.0[illegible]/E-[illegible]331.42

FIELD PARTY [illegible]
SHEET 1 OF 2

GROUND ELEV. [illegible]
RIG [illegible]
DATE [illegible]

NO.	DRIVE	BLOWS	RINGS	DEPTH IN FEET	DESCRIPTION SOIL	DESCRIPTION OPERATION
				0	SILT & GRAVEL dirty grey to white to 3.0' Gravel sizes up to 1½" [illegible] - Dense	Hole opened with [illegible] bit and drilling [illegible] Sampler 's. 1, 2, & [illegible] [illegible] bit saturation.
1	☒			2		
2	☒			4	[illegible] to 6.0' Dense and set at 5.5' Gravel is coarse and few stones up to 4" in Dia.	Hole continued with bit to 9.5' when bit broke into softer material. Rock could not [illegible] such shallow depth due to barrel being 12.0' in length
3	☒			6	Rock Conglomerate Dense and highly cemented, similar to rock found near surface in EN-11.	
				8		
4	☒	62		10	SILT SAND & GRAVEL Embedded rock fragments up to 3" in Dia.	D & M SAMPLER in at 10.0' and driven to 11.5' and refusal with [illegible] blows.
				12		
				14	Hard layer from 14' to [illegible]	In with core barrel from 15.5' to 17.0' through alternating hard and soft formations. No recovery.
	↕		No Rec.	16	Larger embedded coral stones and small boulders	Put D-M Sampler to 19.[illegible] with 68 300# x 18" blows required for the 1.[illegible]
5	☒	68		18		
				20		Hole advanced by jetting and drilling to [illegible].5'
				22	Increase in rock content	Bit action indicated rock. Core barrel 2 3/8" I.D. and Sortz bit put to [illegible] Rec. 1.2'
6	↕		1.2'	24		Lack of [illegible] required the use of casing.
				26		

[redacted]

~~CONFIDENTIAL~~

					[illegible] total [illegible]	[illegible] ,the [illegible] [illegible] pulled [illegible] 26.5'
				30		[illegible] elevation [illegible] Total [illegible] Sampler to [illegible] 15,000 x 12" blows [illegible]
7	☒	1?			[illegible]	
					Bedrock	
8	☒	[illegible]		35	[illegible]	Casing put to [illegible] pulled [illegible]
				40		
					[illegible] little [illegible] sand, [illegible]	[illegible] cleaned out [illegible] sampler [illegible]
9	☒	[illegible]		45		
				50		[illegible] condition.
					[illegible] fines.	
	☒	[illegible]		55		[illegible] was [illegible] at 57.0' [illegible]
					[illegible]	[illegible]
	☒					[illegible]

[redacted]

1

[illegible] INC.
~~CONFIDENTIAL~~ [illegible] Soil
[illegible]

[illegible] Henney [illegible]
[illegible] [illegible] DATE [illegible]

NO.	DRIVE	BLOWS	RINGS	DEPTH IN FT.	DESCRIPTION	
				52		Cleaned out [illegible] and extended hole to 5[illegible]. Put [illegible] sampler to [illegible] refusal with [illegible] blows.
1[illegible]	☒	60				
				58		
						Drilled to [illegible] alternating hard and soft sections [illegible]. Put [illegible] sampler to [illegible] and refusal.
				60		
13	☒	72				
				62	[illegible] increase in fine [illegible].	Advanced [illegible] alternating hard and soft sections of shallow thickness to 66.0'.
				64		Put sampler to [illegible].0'
				66		
14	☒	68			No change	
				68		Cleaned and advanced hole to 72.0' [illegible] drilling conditions.
				70		
15	☒	68		72		
				74		Bit action indicated [illegible] rock at 7[illegible]' continued drilling to [illegible] 2¾" core barrel to [illegible]
				76		
				78		
					[illegible]	

[redacted]

[redacted]

[illegible]	[illegible]	BLOWS	[illegible]	[illegible]	DESCRIPTION	REMARKS
[illegible]			1. [illegible]		[illegible]	[illegible]
[illegible]			1. [illegible]		[illegible] fine [illegible]	[illegible] firm [illegible] material.
					[illegible]	[illegible]
					[illegible]	
						[illegible] at least [illegible] tion.
[illegible]					[illegible]	[illegible]
			1. [illegible]		[illegible]	[illegible]
					[illegible]	

[redacted]

[illegible]
Eniwetok Atoll
[illegible]

[redacted]

SITE [illegible]
HOLE NO. [illegible]
LOC [illegible] _-5780.86 _-4356.32

FIELD PARTY Kenney

GROUND ELEV. [illegible]
RIG [illegible]
DATE

Sheet 1 of 4

NO.	DRIVE	BLOWS	RINGS	DEPTH IN FEET	DESCRIPTION MATERIAL	 OPERATION
				0	FILL–[illegible] aggregate of [illegible] and [illegible], rubble	Hole opened to [illegible] thru fill and underlying heavy sand and gravel formation. Sample No. (1) from [illegible] pit excavation.
1	☒			2	Sand & Gravel–[illegible] coral stones up to 6" in diameter well rounded, clean, dense and moist.	
				4	Rock–Conglomerate, dense highly cemented and extremely hard drilling. Max. length [illegible]	Sharp transition to rock at 4.5' Hole continued to [illegible] to permit entry of 11' cor barrel
				6		
2	▨		2.0'	8	Rock is less firm below 9.5' and is separated by layers of white silty sand and fine gravel up to 6" in thickness.	Section of core from [illegible] to 9.0' preserved for shipment.
	↓			10		Drilling from 9.5' to 12.0 with Bortz Bit show alternating hard and soft sections.
3	↕		1.2'	12	Sand and Gravel – medium to coarse sand – gravel sizes up to 2½" dense clean and wet.	Hole taken to 14.0' and D-M sampler put to 16.0' with 42 blows.
4	☒	42		14		Hole advanced to 21.0' thru hard and soft sections at slightly less frequent intervals.
				16	Some decrease in rock content	
				18		
				20		(D-M) sampler put to 22.5' with 60 300 x 18" blows for 1.5'
5	☒	60		22	Decrease in fine sand sizes, some silt showing and rock fragments up to 3" plus.	Advanced hole to [illegible] thru hard and soft sections.
				24	[redacted]	(S-M) sampler put to [illegible]

[illegible]
Eniwetok Atoll
LOG OF BORING

[redacted]

ITEM " "
HOLE NO. EN-11
COORDINATES N-57[illegible].26 E-125[illegible].82

FIELD ENGR. Penney

GROUND ELEV. ______
RIG. [illegible] 1500
DATE ______

Sheet 2 of 4

NO.	DRIVE	BLOWS	RECOV.	DEPTH IN FEET	DESCRIPTION SAMPLE	DESCRIPTION OPERATION
					No change	with 40 for 1.5' drive.
				28		
				30		Hole taken to 33' under similar drilling conditions
				32		Put (D&M) sampler to 33.5' and refusal with 16 blows for ½" penetration.
	☒	16			No change	
6				34	Increase in rock content	Drilling resistance increasing due to presence of more rock.
				36	This material appears to be drilled as coral boulders (4" to 6") embedded in a silty sand mixture.	
				38		
			3.0'			
7				40		Core sections recovered from 38' to 43' are not cut to full 2 1/2" diameter and show no evidence of fresh fracturing. Hence the belief that the rock is in boulder form embedded in silty sand and gravel.
				42	No change in formation	
				44		
				46		
8				48		
			1.5'		No change in formation.	
				50		
				52	[redacted]	Hole being advanced with [illegible]

HOLMES & NARVER
Eniwetok Atoll [redacted]
LOG BORING

SITE ______
HOLE NO. ______
LOCATION [illegible] FIELD PARTY Kenney

[redacted]UND ELEV. ______
RIG. DRILLING [illegible]
DATE ______

Sheet 3 of 4

NO.	DRIVE	BLOWS	RINGS	DEPTH IN FEET	DESCRIPTION MATERIAL	 OPERATION
				54		penetration very irregular in sections from 3" to [illegible] in thickness. Bit action indicating more resistence to penetration. Sample No. 8a from ditch sample.
8a						
				56		
					Increase in rock content.	
				58		
					TOP OF ROCK	
				60	Conglomerate - dense, white and weakly cemented. Coarse grained with few thin (1/16" to 1/8") silty sand seams.	Core barrel put to 62.5' after encountering more uniform and harder drilling conditions between 58 to 60'. Barrel removed due to blocking at 62.5'
9						
			1.0'	62		
				64		
					Max. core length 3" shows some alternating hard and soft rock.	
				66		
10						Sample No. 10 taken from ditch sample. Hole reamed and taken to 70.0' thru firmer rock.
				68		
				70		Core barrel put to 73.0' and pulled due to blocking.
					Slightly better cementation. Max. core length 4".	
11			2.3'	72		
				74		Harder drilling as depth approaches 80.0'
				76		
						Sample No. [illegible]

[redacted]

Eniwetok Atoll
LOG OF [illegible]

[illegible] [illegible]
[illegible] [illegible]

[redacted]

[illegible] Tenner

Sheet [illegible] of [illegible]

NO.	[illegible]	[illegible]	R[illegible]S	DEPTH IN FEET	DESCRIPTION [illegible]	[illegible]
13	↓		2.[illegible]'		[illegible] per [illegible] [illegible], [illegible] [illegible] [illegible] evidence of porous or [illegible] structure. [illegible] fluid loss at [illegible], [illegible] and at [illegible]. Circulation recovered at [illegible] and [illegible] thru increased gel-strength. At [illegible] hole took approximately [illegible] gal. of thick mud and circulation could not be regained. Hole abandoned at 82.5' to conserve mud.	
				82		
				84		
				86		
				88		
				90		
				92		
				94		
				96		
				98		
				100		
				102		
				104		
				106	[redacted]	

CO[redacted]NTIAL

HOLMES & NARVER
Eniwetok Atoll
LOG OF BORING

ITE "F"
OLE NO. B05
OCATION

FIELD PARTY Kenney
SHEET 1 of 5

GROUND ELEV 8.5
FAILING "1500"
2/15/51

NO	DRIVE	BLOWS	RINGS	DEPTH IN FEET	DESCRIPTION MATERIAL	DESCRIPTION OPERATION
				0	Sand - Fine to coarse well graded to 1/2" some fine to medium gravel to 3/4" max. Loose and dry to 2.0' compact and moist to 5.5' Sample No. 1 from mud pit excavation (representative)	300# hammer falling 15" Hole opened with 8" rock bit and high Gel strength mud easy drilling to 5.5' Much harder to 7.0'
				2		
1	☒			4		
				6	Rock - Beach type fine grained and weakly cemented	
2	☒	40		8	Sand and gravel with some conglomeratic limestone boulders (small) trace of silt	Drilling resistence from 7.0' to 20.0' very irregular due to large coral conglomeratic boulders
3	☒	90		10		
4	☒	43		12		
				14	Increase in finer sizes	attempt to recover sample at 13' to 15' failed when ball valve became clogged and allowed fluid to drain thru sampler
5	☒	23		16	Matrix of silty sand is very soft	
				18		Set 18.5' of 8" casing
6	☒	69		20		Drilling resistence varies from soft to hard with every 2.0' of hole made
				22	Silty sand and gravel containing small boulders (8" to 12") generally soft except where sampler encounters rock in boulder form	
7	☒	33		24		

[redacted]

C[redacted]

NO	DRIVE	BLOWS	RINGS	DEPTH IN FEET	DESCRIPTION MATERIAL	OPERATION
				28		
8	☒	72		30	Mostly rock fragments	
				32		
				34		More uniformly easy drilling conditions
9	☒	30			Increase in fines - gravel to 1 1/2"	
				36	Soft and wet	
				38		
				40		
10	☒	20			Silty sand and gravel soft and wet	
				42		
				44	Finer	
11	☒	30			Soft and wet	
				46		
				48		
12	☒	24				

[redacted]

C[redacted]

NO	TYPE	BLOWS	[illegible]	DEPTH IN FEET	DESCRIPTION MATERIAL	OPERATION
13	☒	34/R		54	More rock fragments decrease in silt and sand sizes	Harder drilling at 56.5'
				56		
				58	Increase in rock fragments	
14	☒	64		60	Predominately rock consisting of weakly cemented coral and algal fragments up to 1 1/2" to 2"	
				62		
15	☒	50		64	Well cemented sections make up the larger pieces. Weakly cemented material break up into gravel sizes during sampling and boring operations.	
				66		
16	☒	60		68	No change	Alternating hard and med. hard drilling.
				70		
				72		
				74		
17	☒	65/R			No change	
				76		

[redacted]

C[redacted]TIAL

NO	DRIVE	BLOWS	RINGS	DEPTH IN FEET	DESCRIPTION MATERIAL	DESCRIPTION OPERATION
					Sand	
				80		
					Weak and well cemented conglomerate	
				82		
						Fairly uniform bit resistance
				84		
18	☒	90/R				
				86		
				88		
						Set 85.0' of 6" casing
				90		
				92		
				94		
19	↕		0.5'		Core recovered shows only well cemented sections	attempted to core with Bortz bit and tailing core barrel - [illegible] after 1.0' run
				96		
				98		
				100		
20	☒	53.8			Predominantly rock fragments consisting of weakly cemented coral and algal [illegible]	
				102	[illegible] to 100.0'	
					[illegible] 101.5'	Done [illegible]

[redacted]

[redacted]

NO	DRIVE	BLOWS	RINGS	DEPTH IN FEET	DESCRIPTION MATERIAL	DESCRIPTION OPERATION
22	☒	66			Hole 22 127' to 128.5'	
				130		
23	☒	63/R			Hole 23 137.5' to 139.0'	
				140		
24	☒	75			Hole 24 148' to 149.5'	
				150		
25	☒	71			Hole 25 158.5' to 159.5'	
				160		
				170		
				180		
				190		
				200		

[redacted]

LOG OF BORING CO[redacted]

JOB No. [illegible] NAME [illegible] BORING NO. [illegible]-5 PAGE 1 of 1

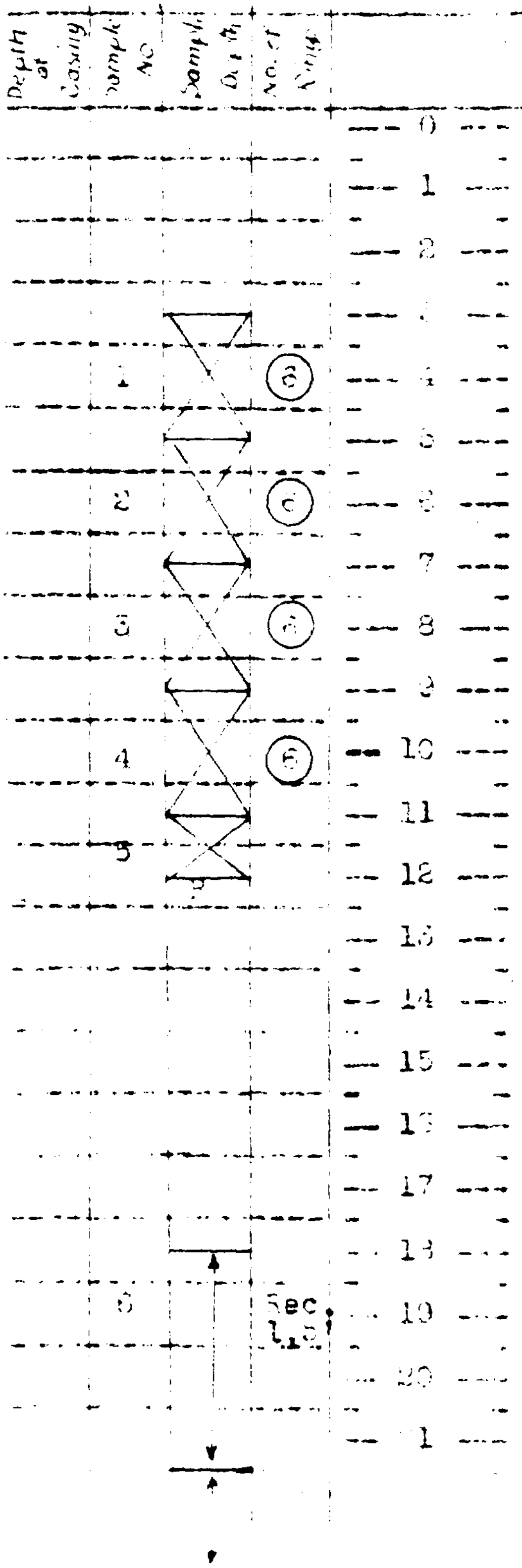
LOCATION SITE "C" TYPE OF BORING [illegible]

Location of Borings: RIG FAILING "1500"

DATE 1?/14/50 Diam. ______

ELEVATION ______

DESCRIPTION - SOIL TYPE, SAMPLER [illegible], ETC.
MATERIAL OPERATIONS



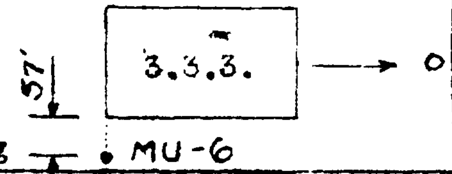
Sand - Greyish Black some fine gravel, compact and moist	Hole opened with continuous sampler drives to 7.0'. Hole reamed and sampler put to 9.0' then reamed and sampler put to 1 .0' and refusal
Color change	
Sand - White, clean. Some fine gravel, dense, moist to wet at 5.3'. Gr. Water.	Sampler Resistance: No. 1 - 54 @ 300# x 18"* 2 - 64 " " 3 - [illegible] " " 4 - 3[illegible] " " 5 - 1[illegible] " " * Blows for Total Length
Gradual increase in gravel sizes with depth. Less fine to medium sand.	
Silty-Sand with embedded round and angular coral fragments (Numerous shells) Dense, wet and semicohesive. White in color.	Core barrel in from 1[illegible] 13'. No recovery. Continued with rock bit thru alternating hard and soft sections to 1[illegible]. 0'. Core barrel taken from 1[illegible] to [illegible].
	Recovery 1.5' of coral fragments and shells. Fines were washed out.
[redacted]	Advanced hole to [illegible] and put sampler to [illegible] with 40 [illegible] 300# x 1[illegible] blows.

LOG OF BORING

JOB NO. 640 NAME ENIWETOK ATOLL BORING NO. MU-3 PAGE 1 OF 1

LOCATION SITE "S" TYPE OF BORING EXPLORATORY

S - 582
E - 6312



Location of Boring

RIG FAILING "1500"

DATE 12/7/50 DIAM. 3" to 95
4½" 100

ELEV. 8.0

Depth of Casing	Sample Hole	Sample Drive	No. of Rings		DESCRIPTION - soil type Material	Sampler records, etc. Operations
				0	Fill- Greyish tan sand & gravel. Loose and dry to 1.5'	Hole opened to -5.0' with continuous drives using D-M sampler. 8" pipe set on cemented sand and gravel @ 5.0' and 8" rock bit used to penetrate hard formation to 16.0'.
				1		
				2	Sand-medium coarse. Some fine to coarse gravel. Tan moist & semi-compact at 3.5'. Some fine gravel.	
	1			3		
	2		⑥	4		Change noted in Drilling action at 16.0' and sampler put to 17.5' with 2 @ 300# x 18" blow/inch.
5.0'	3			5	Sand & Gravel - Highly cemented in beds of various thickness. Thin layers are from 6 to 8" in depth and seperated by thin (2 to 3") lenses of clean cohesionless sand and gravel up to 1" in diameter. Alternating cemented & non-cohesive zones exist to 16.0'.	
8"	4			6		
				7		
				8		
				9		There seems to be a gradual reduction in thickness of cemented layers and a corresponding increase in the uncemented section as the depth of hole is increased
				10		
				11		
				12		
				13		
				14		
				15		
				16	Sand - Medium to coarse and containing some fine gravel. Compact and wet. Non-cohesive and clean	Materials gives in badly and hole was stabilized by increasing Gel-strength of fluid thru the addition of 1 sack of lime.
	5		⑥	17		
				18		
				19		
				20		Due to the cohesionless nature of this material(course sand & fine gravel) it could not be retained in [illegible]
				21		
				22	▽ = 8.5'	

[redacted]

LOG OF BORING

JOB NO. 640 NAME ENIWETOK ATOLL BORING NO. 1-3.3.3 PAGE 1 OF 3

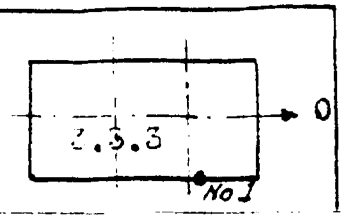
LOCATION SITE "3"

RIG FAILING "1500"

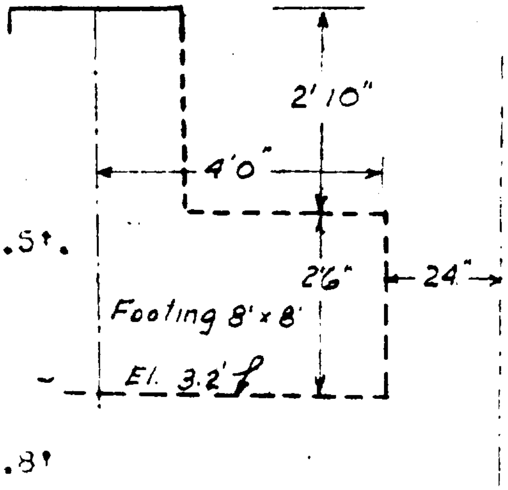
Date 12/5/50 Diam. 3½"

Elevation 8.0'

Location of Boring:



Sample No	Sample Depth	No of Rings	Depth in Feet	DESCRIPTION, SOIL TYPE, SAMPLER RECORDS, ETC.
			0	Exist. Grade
			1	Fill- Compacted sand & fine to medium gravel.
		8	2	
1			3	Greyish, dense & moist to wet @ 6.5'.
2		⑥	4	
			5	Evidence of fill to 6.8'.
3		7	6	
			7	Gr. Water @ 6.8'
			8	Highly cemented sand and fine to medium gravel. Sampler refusal at 6.8' with 300# hammer falling 18".
			9	
			10	



SAMPLER RESISTENCE
D-M (2 1/2" I.D.

No. 1. 1 300# x 18" blow / inch.
2. 1 " " " "
3. [illegible] " " " "

*FIELD TEST DATA

Unit Wt. (Dry) = 98.20 lbs/cu. ft.
% Moisture = 12.36 %

⑥ Indicates cores suitable for shipment.

[redacted]

LOG OF BORING

[redacted]

JOB NO. 040 NAME ENIWETOK ATOLL BORING NO. 3-3.3.3 PAGE 2 OF 2

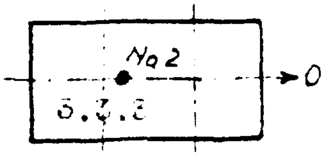
LOCATION SITE "G" TYPE OF BORING EXPLORATORY

RIG. FAILING "1500"

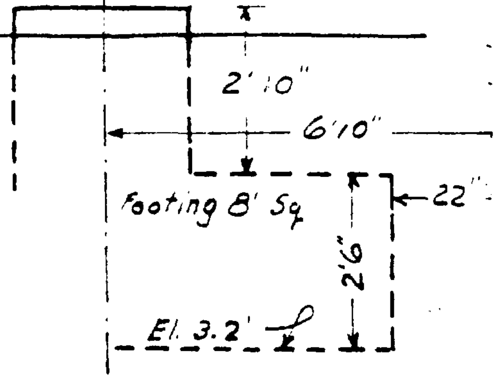
DATE 12/5/50 DIAM. 5½"

ELEVATION 8.0'

Location of Boring:



Depth of Casing	Sample No	Sample Depth	No. of Rings	Depth in Feet	DESCRIPTION - SOIL TYPE, SAMPLER RECORDS, ETC.
				0	Exist. Grade
				1	Compacted sand and fine medium gravel fill.
			8	2	
	1			3	Greyish, dense and moist to wet at 3.5'.
				4	
	2		⑥	5	
				6	
	3		⑥	7	▽ Gr. Water. Base of fill
8.0'				8	Natural sand and fine to medium gravel, dense and wet.
	4			9	Highly cemented sand and fine to medium gravel occurs in thin beds 2" to 6" in depth and separated by shallow layers of non-cohesive material of a like nature.
				10	



SAMPLER RESISTANCE
D-M (2". I. D.)

No. 1. 1 3700# Hydraulic Pressure
2. 6 300# x 18" blow/inch
3. 1 " " " "
4. Cemented core section from 1 3/4" core barrel (3" recovery)

*FIELD TEST DATA

Unit Weight (dry) = 90.6#/cu. ft.
Moisture Content = 10.65%

⑥ Indicates undisturbed samples suitable for shipment

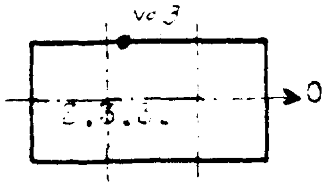
[redacted]

LOG OF BORING [redacted]

JOB NO. 840 NAME ENIWETOK ATOLL BORING NO 3-3.3.3 PAGE 3 OF 3

LOCATION SITE "E" TYPE OF BORING EXPLORATORY

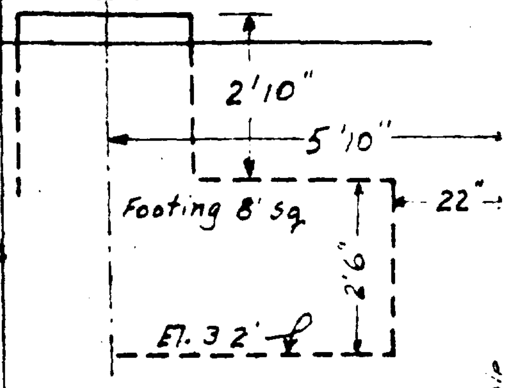
Location of Boring



DATE 1[illegible]/5/50 DIAM. 3½"

ELEVATION 7.2'

Sample No	Sample Depth	No. of Rings	Depth in feet	DESCRIPTION - SOIL TYPE, SAMPLER RECORDS, ETC.
			0	Exist. Grade
			1	Fill - Compacted sand and fine to medium gravel.
			2	
1		8	3	Greyish, dense and moist to wet at 6.8'
			4	
2		⑥	5	
3		⑥	6	Evidence of fill to 6.5' V Gr. Water 6.8'
		N.R.	7	Sand and fine to medium gravel. Highly cemented. Sampler put from 6.5' to 7.0' and refusal with 300# hammer.
			8	
			9	
			10	



SAMPLER RESISTENCE
D-M (2 1/2" I.D.)

No. 1. 1 @ 300# x 18" blow/inch
2. 2 " " " "
3. 2 " " " "

* FIELD TEST DATA

Unit Weight (dry) = 80.87 lbs/ cu. ft.
Moisture content = 8.73%

⑥ Denotes samples suitable for shipment.

[redacted]

CO[redacted]

LOG OF PENETROMETER TEST

JOB NO. 340 NAME ENIWETOK ATOLL PAGE NO. 1 of 1

LOCATION SITE "S" BLDG. [illegible].3 TYPE OF TEST PENETROMETER

DATE 12/13/50 DIAM. 2 inch

LOCATION NO.	1	2	3	4	5	6	7	8	9	10	11	12
ELEVATION	7.5	7.0	7.0	7.5	7.0	7.5	7.0	--	7.0	6.0	7.0	
0												
-	6	8	3	4	3	5	3		4	3	4	
1	6	5	3	5	5	6	4		4	3	5	
-	4	5	4	4	6	6	3		5	3	8	
2	4	3	3	4	4	6	3		4	2	8	
-	6	2	3	3	4	5	1		8	2	3	
3	5	2	3	3	2	4	4		5	1	8	
-	8	4	4	12	3	4	6		5	4	10	
4	7-R	18R	10R	20	6	5	9		6	8	11	
-				18	5	3-R	9		10	10	13	
5	----	----	----	9	29	---	23-R		12	16	11	
-				8	26		----		13	10	4	
6				20-R	18				11	10	6	
-				----	14				9	10	3-R	
7					10				11	9	----	
-					11				12	13		
8					12				15	14		
-					22-R				16	20		
9					----				18	21		
-									19	16		
10									20	12		
-									18	12		
11									12	14		
-									13	18		
12									18	12		
-									14	13		
13									13	13		
-									18	12		
14									15	[illegible]		
-									15	17		
15									17	17		

NOTE: Hammer Wgt. = 140 lbs.
Ht. of Drop = 18 ins.
R = Refusal

Elevations are at start of drive which consisted of one blow to penetrate top 6" to 12" loose dry surface material.

POINTS LOCATED 60" to [illegible]" FROM CENTER LINE OF COLUMN.

[redacted]

LOG OF BORING [redacted]

JOB NO. 640 NAME ENIWETOK ATOLL

BORING NO. MU-7 PAGE 1 OF 1

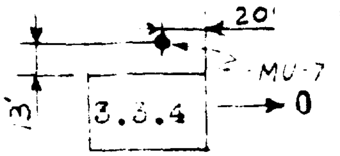
LOCATION SITE "[illegible]"

TYPE OF BORING EXPLORATORY

RIG FAILING "1500"

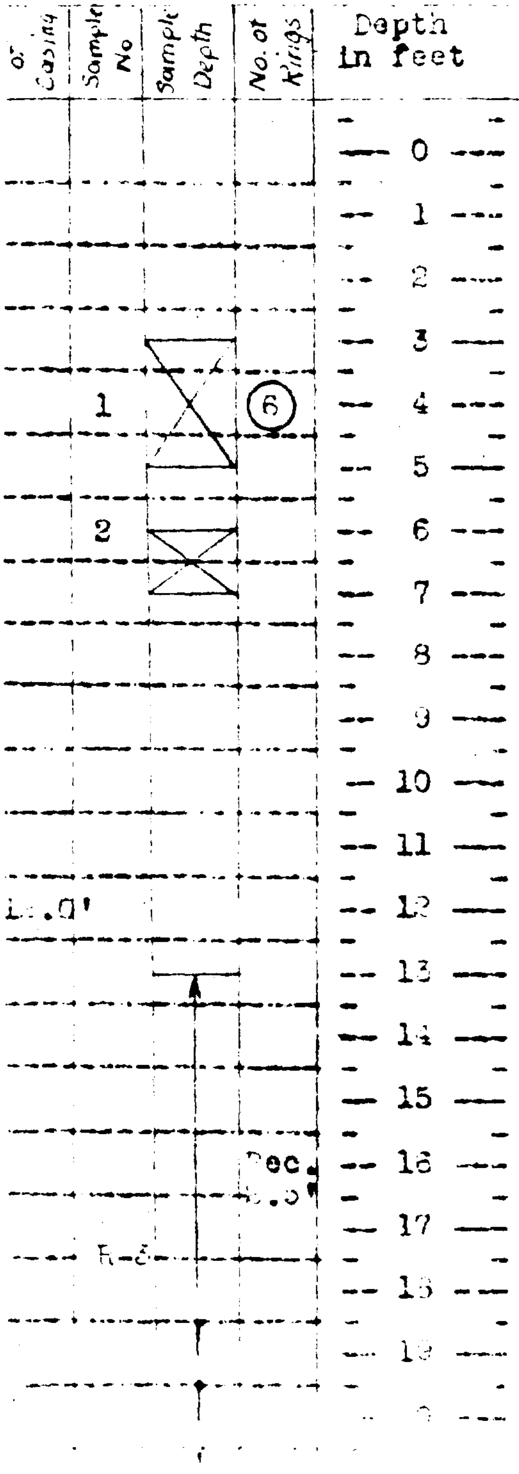
Location of Boring

N - [illegible]
E - [illegible]



Date 12/12/50 Diam 8" - 12'
6" - 22.5'
4½" - 37.5'

Elevation 8.5



DESCRIPTION - Soil type, Sampler Record, Etc.

MATERIALS	OPERATIONS
Sand - Coarse, contains some fine gravel - Greyish, moist and dense.	Hole opened to 7.0' with D-M sampler. Sample No. 1 required 42 - 300# x 18" blows for 1.5' penetration Sample 2, 20 - 300# x 18" blows to refusal @ 7.0' on cemented sand and gravel.
▽ Gr. Water	
Sand - Gravel, alternating layers of highly cemented coarse sand and fine gravel seperated by thin zones of cohesionless sand and gravel of slightly coarser gradation (Up to 3/4")	Hole cased to 12.0' with 8" pipe Core barrel put in at 13' thru alternating hard and soft sections not greater than 6" in depth.
Grey - Fine Sand and Gravel. Core recovery showed fine to coarse grained conglomerate with few thin limestone pieces	
This rock is evidently embedded in medium to fine sand which is washed out during coring and sampling operations.	Hole reamed to 24.0' and D-M put to refusal at 24.0' indicating more conglomerate.

○ Indicates samples suitable for shipment.

[redacted]

[redacted]

LOG OF BORINGS

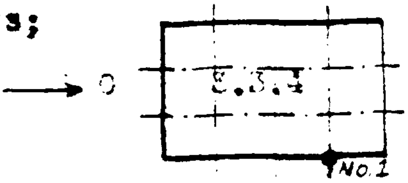
JOB NO. 640 NAME ENIWETOK ATOLL BORING NO. 1-3,3.4 PAGE 1 OF 2

LOCATION SITE "S" TYPE OF BORING EXPLORATORY

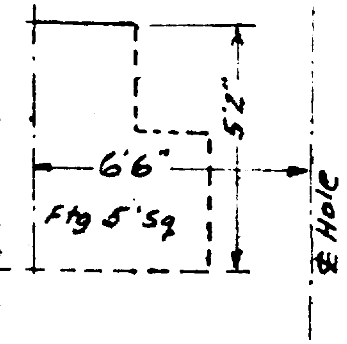
DATE 12/6/50 DIAM. 3½"

ELEVATION 8.5'

Location of Borings;



Depth of Casing	Sample No.	Sample Depth	No. of Rings	Depth in Feet	DESCRIPTION - Soil Type, Sampler Record, Etc.
				0	Existing Grade
				1	Fill - Compacted sand and fine to medium gravel Grey, loose & Moist to 2.5'
	1		6	2	
				3	
	2		6	4	El. 3.2'
	3		6	5	Base of fill.
				6	Gr. Water at 6.0'
None	4	*	5	7	Sand and fine gravel. White, clean and dense Highly cemented sand and fine gravel. Sampler refusal at 7.2'
				8	
				9	
				10	



Sampler Resistence (D-M 2½" I.D.)

No. 1 - 10 @ 300# x 18" blows for 1.5' drive
2 - 9 " " " " " "
3 - 22 " " " " " "
4 - 20 " " " " " "

* Field Test Data:
Unit Wt. (Dry) = 94.74#/ cu. ft.
Moisture Content = 9.27%

⑥ Suitable for shipment.

[redacted]

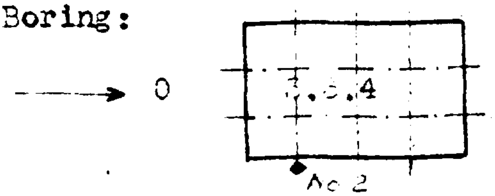
[redacted]

LOG OF BORING

JOB NO. 640 NAME ENIWETOK ATOLL BORING NO 2-3,3,4 PAGE 2 OF 2

LOCATION SITE "S" TYPE OF BORING EXPLORATORY

Location of Boring:

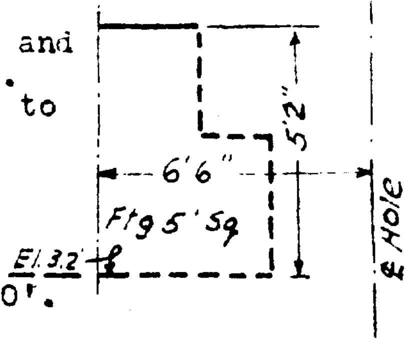


RIG FAILING "1500"

DATE ______ DIAM. 5½"

ELEVATION 8.5'

	Sample No	Sample Depth	No. of Rings	Depth in feet	DESCRIPTION - SOIL TYPE, SAMPLER RECORDS, ETC.
				0	Existing Grade ℄
				1	Fill - Compacted sand and fine to medium gravel. Grey, loose and moist to 3.0'
	1		⑥	2	
				3	
	2		⑥	4	
	3		⑥	5	Dense from 4.5' to 6.0'.
				6	Base of Fill
None	4		⑥	7	▽ Gr. Water @ 6.5'. Sand and medium gravel, white, clean and dense. Highly cemented sand and fine to medium gravel. Sampler refusal at 7.0'.
				8	
				9	
				10	



SAMPLER RESISTENCE
D-M (2 1/2" I.D.)

No. 1.	9 @ 300# x 18"	blows	for	1.5'	drive		
2.	14	"	"	"	"	"	"
3.	32	"	"	"	"	"	"
4.	65	"	"	"	"	"	"

⑥ Suitable for shipment.

[redacted]

[redacted]

LOG OF PENETROMETER TESTS

JOB NO. 640 NAME ENIWETOK ATOLL PAGE 1 OF 1

LOCATION SITE "S" BLDG. 3.[illegible].4 TYPE OF TEST PENETROMETER

DATE 12/13/50 DIAM. 2"

LOCATION NO. ELEVATIONS	1	2	3	4	5	6	7	8	9	10	11	12
--- 0 ---	7.5	7.5	7.5	7.5	7.5	obstructed	7.0	7.0	7.5	7.5	7.0	7.5
- -	4	5	6	4	2		3	4	3	8	2	2
--- 1 ---	5	6	5	3	3		5	5	4	3	1	1
- -	6	4	5	4	5		5	5	4	3	2	4
--- 2 ---	4	4	5	4	3		5	5	3	4	1	3
- -	3	4	4	5	3		4	4	2	6	2	5
--- 3 ---	2	2	6	6	2		2	3	3	4	3	4
- -	1	3	5	3	3		4	2	7	5	14-R	10-R
--- 4 ---	2	2	9	3	4		12	7	9	5	----	----
- -	5	3	12R	6	17R		17-R	8-R	10	6		
--- 5 ---	21	17	---	4	---		----	---	9	9		
- -	14-R	20-R		25-R					22	12-P		
--- 6 ---	----	----		----					21	----		
- -									18			
--- 7 ---									17			
- -									18-R			
--- 8 ---									----			
- -												
--- 9 ---												
- -												
-- 10 ---												

NOTE: Hammer Wgt. = 140 lbs.
Ht. of Drop = 18 ins.
R = Refusal

Elevations are at start of drive which consisted of one blow to penetrate top 6" to 12" loose dry surface material.

Points located 48" to 60" outside center line of column, except 2, 5, 8 and 11 which were along center line of building.

[redacted]

[redacted]

LOG OF PENETROMETER TESTS

JOB NO. 640 NAME [illegible] ATOLL PAGE 1 OF 1

LOCATION SITE "E" TYPE OF TEST PENETROMETER

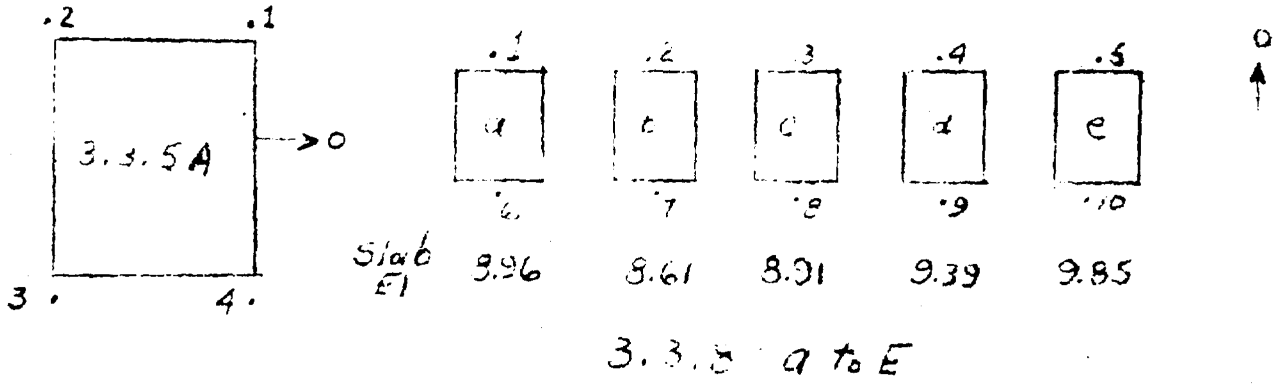
DATE 12/[illegible]1/50 DIAMETER 2"

	BLDG. 3.3.5A				BLDG. 3.3.5 A to E									
LOCATION NO	1	2	3	4	1	2	3	4	5	6	7	8	9	10
ELEVATION														
0	10.4	10.5	10.5	10.8	6.0	7.6	7.7	8.4	9.1	8.0	7.6	[illegible]	10.[illegible]	[illegible]
	15	6	5	3		[illegible]	10	7	7	[illegible]	4	7	[illegible]	
1	5	10	7	3	[illegible]	[illegible]	6	10	11	[illegible]	8	10	5	[illegible]
		7	10	6	[illegible]		[illegible]	7	9	[illegible]	[illegible]	8	[illegible]	11
2	[illegible]	4	10	[illegible]	[illegible]	7	5	14	11	10	[illegible]	15	10	[illegible]
	4	6	7	7	[illegible]	[illegible]	[illegible]	20	[illegible]	10	[illegible]	21	15	[illegible]
3	3	8	7	8	[illegible]	[illegible]	[illegible]	22	13	[illegible]	[illegible]	20	[illegible]	[illegible]
	4	5	7	7	[illegible]	[illegible]	[illegible]	15	12	[illegible]	7	16	21	20
4	8	8	6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	14	[illegible]	10	[illegible]	[illegible]	[illegible]
	11	21	10	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	10	23R	6	[illegible]	[illegible]	[illegible]
5	10R	[illegible]	10R	[illegible]	13	[illegible]	[illegible]	[illegible]	16	---	[illegible]	16	[illegible]	---
	---	---	---	---	[illegible]	[illegible]	[illegible]	10	14		[illegible]	[illegible]	[illegible]	
6					[illegible]	18	[illegible]	10	18R		[illegible]	[illegible]	[illegible]	
					---	[illegible]	[illegible]	15R	---		---	[illegible]	[illegible]	
7						---	[illegible]	---				[illegible]	18	
							[illegible]					---	[illegible]	
8							[illegible]						---	
9														
10														

NOTE: All points are located approx 4' from foundation wall.

NOTE: Zero elevation is Elevation of point after one blow with 140# hammer

Hammer Wgt. = 140 lbs.
Ht. of Drop. = 15 ins.
R = Refusal



[redacted]

CC[redacted]

LOG OF PENETROMETER TESTS

JOB NO. 840 NAME ENIWETOK ATOLL PAGE 1 OF 1

LOCATION SITE "S" TYPE OF TEST PENETROMETER

DATE 12/19/50 DIAM. 2"

Location No.	1	2	3	4	1	2
Elevations	Bldg. 3.3.5 B				Bldg. 3.3.8 G	
--- 0 ---	8.0	8.0	8.0	8.0	7.5	7.5
- -	---	8	5	5	3	5
--- 1 ---		12	5	7	6	8
- -		5	4	7	10	10
--- 2 ---		2	3	7	13	10
- -		4	3	4	14	10
--- 3 ---		4	4	3	14	12
- -		3	3	6	12	13-R
--- 4 ---		8-R	3	6	13	---
- -		---	7-R	4	6	
--- 5 ---			---	6-R	6	
- -				---	12	
--- 6 ---					10-R	
- -					---	
--- 7 ---						
- -						
--- 8 ---						
- -						
--- 9 ---						
- -						
--- 10 ---						

NOTE: Hammer Wgt. = 140 lbs.
Ht of Drop = 18 ins.
R = Refusal

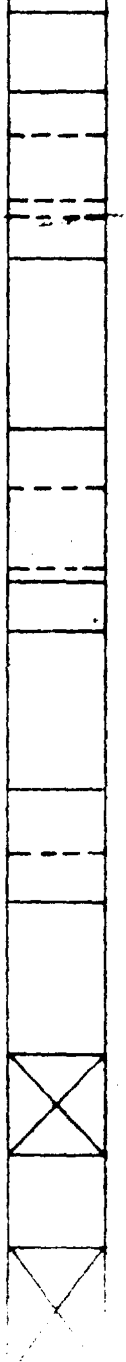
Elevations are at start of drive which consisted of one blow to penetrate top 6" to 12" loose dry surface material.

FOR BUILDING 3.3.5 B
Points located 3.0' outside foundation wall.

FOR BUILDING 3.3.6 G
Points located 4.0' outside foundation slab.

[redacted]

[redacted]



[illegible]

[redacted]

[redacted]

[illegible] poorly [illegible]

[illegible] sand to [illegible] com- tation.

[illegible] to nd depth.

[illegible]

[redacted]

[redacted]

Sheet 1

					Depth	Description	Remarks
					2	[illegible]	This [illegible]
					4		[illegible]
					6	ROCK	Hole reamed to [illegible] 7 7/8" [illegible] Set 10" casing [illegible] advanced [illegible] to 11.0'. Resistance was uniformly hard to 10.0' thence, slightly softer to 11.0'
					8	[illegible] granular [illegible] above [illegible]	
					10		
1			[illegible]	[illegible]	12	[illegible] granular	In with 5" [illegible] to 11.0'. [illegible] to 11.5' [illegible] 13.0' [illegible] soft.
			[illegible]	[illegible]	14	[illegible]	[illegible] 14.0' [illegible] then soft to 14.0' [illegible] 14.0' then soft.
		60			16	[illegible] gravel to [illegible]	Sampler in at 14.0' [illegible] Hole reamed [illegible] 16.0' Sampler in at [illegible] 17.0' [illegible]
					18	[illegible]	[illegible] to 22.0' [illegible]
					20	[illegible]	[illegible]

[redacted]

~~CONFIDENTIAL~~

[redacted]

[redacted]

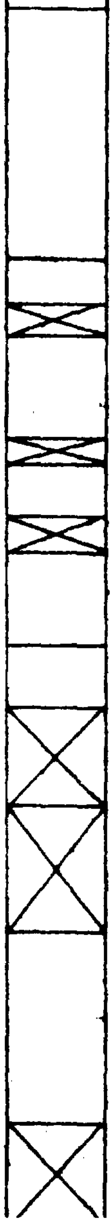


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EXHIBIT L

Foundation Grouting

HNC 1526

November 11, 1950

To: Mr. R. E. Cole
Director
Division of Engineering and Construction
Santa Fe Operations Office
Los Alamos, New Mexico

Thru: Mr. C. T. Cooper
AEC Resident Engineer
Eniwetok, M.I.

From: Raymond E. Davis

Subject: PLAN OF FOUNDATION GROUTING, STRUCTURE 3.1.1

1. Reference is made to the following documents concerned with the grouting of structure 3.1.1:

   a. Memorandum to C. T. Cooper from Raymond E. Davis, dated August 2, 1950, Subject: "Foundation Grouting, building 3.1.1"

   b. Memorandum to R. E. Cole from Raymond E. Davis dated October 11, 1950, Subject: "Foundation Grouting, Building 3.1.1"

   c. Memorandum to C. T. Cooper from John Ranttila dated November 11, 1950 Subject: "Cores from Grouting Test Area"

2. As a result of a re-analysis of the problem of providing adequate foundation stability and rigidity for Building 3.1.1 based upon additional experimental data and observations made at the jobsite during the period October 31, to November 11, it is recommended that the plan of grouting the foundation materials be as shown on the accompanying drawing.

3. An examination of the 4 in. cores recovered from the test area reveals that the voids in the gravel and coarse sand to an average depth of somewhat less than 1 ft below the coral conglomerate are completely filled with hardened grout, as are also large connected voids in the conglomerate. At the age of about 2 1/2 months, the compressive strength of this upper layer of grouted gravel and coarse sand was in excess of 2000 psi and its modulus of elasticity was at about 2,500,000 much higher than expected, or in fact desired.

4. Below this dense and strong material was a thinner layer of grouted sand becoming increasingly more porous and weaker with depth. No cores were recovered at depths in excess of about 15 in. and air jetting disclosed no grout at deeper levels. From this evidence, it appears that the path of flow of the grout after leaving each grout pipe was up along the pipe, laterally through the coarse material just below the conglomerate, then downward into the finer sand.

The depth of grout penetration was substantially uniform over this area, and no grout was found at distances in excess of 3 ft from the area.

5. The operation of drilling grout holes on approximately 3 ft centers is now in progress. Beneath buildings, 1, 2, 4, 6, and 7 where drilling has been completed, it appears that there are two layers of strongly cemented conglomerate separated by a layer of slightly cemented or uncemented gravel which in places is as much as 18 in thick. This material causes sticking of the bits and seriously retards the drilling operation. It seems not unlikely that this gravel layer may exist over substantial portions of the area to be grouted.

6. As determined by grout holes drilling and other explorations it appears that the thickness of conglomerate varies greatly within short distances.

7. The conditions described in preceding paragraphs and other considerations lead to the following suggested procedures for drilling and grouting, to be modified as job experience dictates.

a. Vertical holes should be drilled on approximately 3 ft centers in each direction over the entire area to be grouted, as shown on the accompanying drawing. Where reinforcing steel makes vertical holes impracticable, as beneath the rear footing, inclined holes should be drilled so as to obtain complete grouting coverage. Along the rear footing the tops of these inclined holes can be located outside the building.

b. Where two layers of strongly cemented conglomerate are encountered, with gravel between, drill through top layer. Air jet hole to determine thickness of uncemented or weakly cemented material and presence of lower layer. Air and water jet grout pipes to lower layer and grout one hole at a time with lower end of grout pipe just above lower layer. Later, when grout has hardened sufficiently, complete drilling through lower layer.

c. Air and water jet groups of holes for a distance of two or three feet below the conglomerate, to insure penetration of gravel and coarse sand. Grout one hole at a time, in general progressing from an area which has been previously grouted. Start each hole, with grout pipe at required depth, by water jetting to be immediately followed by grouting. Continue pumping as long as hole will take grout. If early plugging is indicated, clear by shutting off grout and turning on water. Grout layer immediately beneath conglomerate even though it may be below the limit of the grouted section as shown on the drawing.

d. After grout has hardened sufficiently, drill through cemented material. Air and water jet groups of holes washing fines up the hole and also up adjacent holes. Air jet each hole to the full grouting depth as shown on the drawing; continue air jetting as pipe is withdrawn and reinserted. Follow final air jetting by immediate water jetting with pipe in position at the bottom of hile. With all pipes in a given group thus positioned, start grouting by gradually decreasing the jet water supply and increasing the grout supply until undiluted grout is being pumped. Raise the pipe as pumping is continued. If a tendency toward plugging develops shut off grout and clear hole with water. Then resume grouting as at the beginning. If plugging occurs, raise grout pipe and clear by water and/or air jetting. Reinsert to desired depth with water jet in gentle operation, and resume grouting as before. Keep water flowing through adjacent grout pipes of ungrouted holes to prevent plugging.

e. For deep holes it may be found that better results can be obtained if grouting as described in (d) is performed in two or more stages, working from the top down, and drilling each stage after the grouted material has hardened sufficiently, to prevent cave in. To determine whether this will be necessary, grouted areas may be explored by jack hammer holes and air jetting these holes. If the material is cemented, the hole will not cave in. It is not likely that the presence of weakly cemented material can be detected by drilling alone. If the drill is withdrawn from any desired depth and the hole is blown with the air jet, even weakly cemented material will not be dislodged below this depth.

8. The grout mix proportions to be employed will depend upon conditions encountered but should generally be within the range of (1 sack of cement to 1 sack of fly ash to 22 gallons of water to 2½ lbs of intrusion aid), to (2 sacks of cement to 1 sack of fly ash to 18 gals of water to 2½ lbs of intrusion aid). It is particularly desired that the rich mix of lowest practicable water content be employed to a depth of not less than 10 ft beneath the lean concrete of the back footing of 3.1.1 and to the rear of the structure for a distance of about 15 ft. For locations below this level, and further to the rear, the water content of the grout may be increased and the cement decreased if it will facilitate the grouting operation. It is hoped that it will not generally be found necessary to use more than 18 gals of water with the lean mix shown above. The amount of Intrusion Aid may be increased by as much as 50 percent in zones of difficult groutings; this will retard setting of the grout and decrease early strength, but will have no significant effect upon later age strengths.

9. Areas outside the structure over which there is no cover of conglomerate will need to be covered with a thin slab of contrete prior to grouting. This will prevent grout from channeling to the surface.

10. Lean concrete below the back footing of 3.1.1 is to be extended to the rearfor a distance of 18 in at the bottom of the footing and thence downward and outward at an angle of 45° to the conglomerate. This should be done after the material covering the conglomerate over the area to be grouted at the rear of the structure has been excavated, and grouting along the back footing has been completed.

There seems to be no need of this lean concrete extension beyond the length of the grouted area as shown on the drawing, since at the time of the blast the ends of the rear footing for a length of 15 ft (under buildings 1 and 7) will be subjected to substantially no load. Prior to concrete placement, contact surfaces of old lean concrete and conglomerate should be thoroughly sand-blasted and vigorously brushed with a coating of neat cement grout.

11. It is not believed that grouting beneath 3.1.1 is likely to cause building displacements since regardless of the pumping pressures employed they will be dissipated within a short distance at the end of the grout pipe. Also adjacent open grout holes will make impossible the development of significant pressures beneath the conglomerate except over small areas. Nevertheless as a matter of record and to guard against the remote possibility of measurable displacements due to grout pressure, it seems desirable that a level crew observe lower floor and footing levels at or near holes that are being grouted beneath the structures.

12. The grouting inspector should obtain the following information for each hold grouted; Date, location of hole, elevation top of conglomerate (when not overlaid with lean concrete), elevation of bottom of conglomerate, grout mix and volume taken by gravel between layers of conglomerate (where present), grout mix and volume in first stage below conglomerate, grout mixes and volume in other stages at lower levels, at selected holes, sufficiency of grouting as determined by later explorations with jack hammer and air jet.

13. It is planned to obtain 5 in diameter core samples from the grouted mass. It is recommended that 12 core holes be drilled at the rear of 3.1.1 six to be selected locations along a line close to the rear of the structure, and three each along parallel lines at distances of 15 and 30 ft from the rear wall of the building. Selected samples of grouted material will be shipped in saturated condition to a laboratory not yet designated. The remainder of the cores, including coral conglomerate, will be stored at the jobsite for future examination. Core drilling should not be undertaken until the age of the hardened grout is at least 60 days. The recovery of cores from weakly cemented material may be impossible, in which case washings should be carefully examined for the presence of particles of hardened cement paste, and if present in what estimated amount. The presence of any considerable thickness of uncemented sand may be detected by probing. Laboratory tests to be made on selected samples returned to the United States should, as far as practicable, include determinations of compressive strength, dynamic and static modulus of elasticity, Poisson's ratio, wave velocity and unit weight.

14. It was originally proposed that cement for grouting be shipped in steel drums because of the absolute necessity of using a material free from lumps or agglomerations of cement particles. This was not done, but it appears that cement for grouting was shipped in special Navy "E" type bags, with the understanding that it would

be so stored in a weatherproof building as to prevent warehouse set, and would be delivered to the job in a fresh condition. Judging from deliveries so far made, these conditions were not complied with, since from an inspection of the unopened bags alone, it has been found necessary to reject about seventy percent of the cement and more will certainly be rejected as the bags are opened at the mixer. This is a very serious matter. Unless fresh, uncaked cement can be positively supplied at all times, it is believed that the only solution is to screen all cement to be used for grouting purposes in such a manner that not more than 10 percent will be retained on the 200 mesh sieve, as determined by grab samples taken hourly during the screening operation. Screened cement represented by any sample not meeting the requirement should be rejected. This matter requires immediate attention. Unless the screened cement can be delivered in 94 lb sacks, the labor of batching will be increased.

15. As originally scheduled, the grouting was to have been started by October 15. Now nearly a month later, it is not under way because of lack of sufficient labor as well as suitable cement. The grouting must be completed not later than the end of January 1951. The instrumentation program for 3.1.1 requires that by December 15 grouting be completed to the rear of the structure at and near the center line of building 4, to permit the placing of cable conduit to building 301J. To complete the work in time, suitable cement and a minimum of 30 more men must be furnished at once for the two crews scheduled to carry out the grouting operation; and as the work gets underway, more may be required. The labor situation is appreciated but there seems to be little point in the early completion of other work at the expense of progress on this work which under favorable labor conditions can scarce be finished before the deadline date.

/s/ RAYMOND E DAVIS

RED:lfm

Distribution; (With encl. Foundation Grouting Plan and Sections - bldg. 3.1.1)

R. E. Davis
C. T. Cooper
John Ranttila
R. Sorensen
Lt. Comdr Rowen
H&N Jobsite (3)
1-Inspection Dept w/2 cy Encl.
1-A.H.Hawkins, w/3 cy encl
1-Files

P. W. Spain
H&N, LA
Boyd Anderson
J-6
Sherwood Smith
M.D. Kirkpatrick

HNC-2051
24 March 1951

To: R. E. Cole, Director
Office of Engineering and Construction
Santa Fe Operations Office
Los Alamos, New Mexico

THRU: P. W. Spain
AEC Resident Engineer
Eniwetok Proving Grounds

FROM: Raymond E. Davis and Vernon C. Kenney

SUBJ: EXPLORATION OF GROUTED FOUNDATION, STRUCTURE 3.1.1

1. Reference is made to the following documents concerned with the foundation grouting of Structure 3.1.1.

a. Memorandum to C. T. Cooper from Raymond E. Davis dated 2 August 1950, Subject: "Foundation Grouting, Building 3.1.1"

b. Memorandum to R. E. Cole from Raymond E. Davis dated 11 November 1950, Subject: "Foundation Grouting, Building 3.1.1"

c. Memorandum to C. T. Cooper from John Ranttila dated 11 November 1950, Subject "Cores from Grouting Test Area"

d. Memorandum to P. W. Spain from John Ranttila dated 1 February 1951, Subject "Completion Report of Foundation Grouting, Structure 3.1.1"

2. Based upon quantities of materials given in Document (d), it has been calculated that the total volume of grout pumped into the foundation beneath and to the rear of Structure 3.1.1 was approximately 30,000 cubic feet, or 1,100 cu.yds. Beneath the structure the work of jetting and grouting was done through jackhammer holes on 3 foot centers; for the grouted area to the rear of the structure, the jackhammer holes were on 4 foot centers. Thus each hole in the rear of the building served an area of 16 sq.ft., and each hole beneath the building served an area of 9 sq.ft.

3. The grouting was done in stages proceeding downward. After vigorous air and water jetting for the removal of fines and for the creation of a shallow cavity beneath the coral conglomerate or the previously grouted area, the grouting for each new stage was started with the end of the grout several feet below the bottom of the cavity.

4. From the jackhammer operations which preceded grouting, it was found that the depth of the coral conglomerate was in general much greater than had been assumed from a study of the logs of earlier wagon drill holes at selected locations along the front and rear of the building. As interpreted, the wagon drill data indicated the total absence of conglomerate or naturally cemented coral sand and gravel under substantial portions of the

grout stages was quite generally adequate to prevent rupture of the core at these weakened planes during the drilling operations.

10. Nearly pure grout of fair to good quality (with or without inclusions of gravel) as a continuous layer extended to depths of 17 to 19 feet below the floor level. Material recovered below this depth with soil sampler was a well graded sand without grout at points between old grout holes, and usually a poorly grouted coarse sand of no strength to depths of 20 feet near old drill holes. At points most distant from adjoining old grout holes, the lower surface of the well grouted layer averaged about a foot higher than at or near old drill holes.

11. In order to secure some immediate information concerning strength, representative samples were subjected to compression tests in the Material Laboratory at Parry. The results follow:

a. Conglomerate core, coarse sand to gravel sizes, weight 128 pounds per cu.ft. fairly well cemented, but with 25% voids - compressive strength 1940 psi.

b. Five grout cubes (1 1/2 and 2 inches) from short pieces of core which in drilling broke off every 2 or 3 inches, very low density and high gas bubble content (indicating double dose of intrusion aid), judged to be the poorest grout recovered, compressing strengths 790 to 830 psi, with average of 810 psi.

c. Grouted core, 80% grout of fair quality, 20% coral inclusions, cold joint just below coral inclusions, noticeably softer grout immediately below cold joint, weight 97 pounds per cu.ft., compressive strength 1690 psi, fractured just below cold joint.

d. Grouted coarse sand and gravel core, some voids, good quality grout, weight 127 lbs. per cu.ft., compressive strength 1870 psi.

e. Pure grout cube (2 1/4") cracked on one side, good quality grout, compressive strength 3800 psi.

f. Pure grout core, good quality, high density, no imperfections, weight 128 lbs. per cu. ft., compressive strength 5040 psi.

12. From the results of an examination of cores, observations of core drilling operations, and strengths obtained from test specimens, it appears that those portions of the foundation which will be subjected to heavy loads consist of essentially a continuous slab 11 to 12 feet thick, comprised of a top layer of conglomerate exhibiting widely varying degrees of cementation bonded to a lower layer of grout and grouted gravel. In the light of data presently available, it is roughly estimated that the average compressive strength of the conglomerate is 1000 psi and that of the underlying pure grout and grouted gravel 1800 psi.

13. From the results of the earlier grouting experiment (see document (c)) where air jetting for removal of fines was carried out much less

structure, and the presence of a layer of conglomerate only two or three feet thick over a large part of the building site. Actually, the entire building area and the foundation area to its rear was found to be covered with a conglomerate layer several feet in thickness. In areas of heavy foundation loading, at and to the rear of the structure, the thickness of conglomerate as estimated during the grouting operation was five to ten feet and averaged about six feet. The top of the conglomerate layer was found to be 6 to 9 feet below floor level.

5. To determine the effective depth of grouting, and the nature and quality of the conglomerate and the grouted mass beneath, and to secure representative samples for shear and other tests to be performed in the laboratory of the USBR in Denver, nineteen 5 inch diameter holes were drilled with diamond coring equipment (Failing Rig) during the period February 20 to March 23. Also using the Dames and Moore sampler, materials below the limits of the coring operation were recovered and inspected. The log of these holes describing the character and extent of the materials encountered is given in the appendix. The size of the Failing Rig made drilling inside the building impossible.

6. The location of the core holes is shown on the sketch of Fig. 1.

Seventeen holes were within the grouted area, and two holes were 11 and 15 feet outside the grouted area near the rear corners of the building. Nine of the 17 core holes were at or near old grout holes and 8 were at or near the maximum distance from old grout holes. As will be seen from Fig.1 most of the holes were located in a zone 5 to 15 feet from the rear building line. This was considered to be the critical zone insofar as foundation stability is concerned. The depth of grout penetration within this zone called for by the sections of Document (c) varied from 27 to 22 feet below floor level.

7. As will be discovered by a study of the logs (See Appendix), the cores showed the top of the conglomerate at depths of 5 to 7 feet. The conglomerate was quite variable both as to grain size and degree of cementation. Weakly cemented coral particles in the gravel sizes was generally partially impregnated with grout of good quality, particularly near old drill holes and along the underside of the conglomerate layer. Weakly cemented sand showed no grout penetration.

8. The conglomerate layer was found to vary in thickness from about 5 to 10 feet and the conglomerate was of poorest quality near the bottom. Where this bottom layer was weakly cemented sand not impregnated with grout, it was too weak to secure cores.

9. Below the conglomerate was found a continuous layer of grout usually of fair to good quality, and frequently containing zones of well grouted coarse sand, gravel or large fragments of coral. Generally at the bottom of these zones was a cold joint between two stages of grouting, indicating that the coral particles had laid in the bottom of a cavity created by the jetting operation. Just below these cold joints, whether topped by grouted gravel or pure grout, the grout appeared to be of somewhat poorer quality than for the stage as a whole, though the bond between

vigorously and for which the quantity of fines removed was relatively much smaller, it appeared possible or even likely that much of the material comprising the grouted mass would be of very low strength, perhaps averaging as little as 500 psi. The sections to be grouted shown in Document (b) were based upon this assumption of very low strength of the grouted mass and upon a much lesser thickness of coral conglomerate than actually exists. Generally speaking, the shearing strength is proportional and compressibility inversely proportional to compressive strength of such materials as comprise the grouted mass. This being the case, from a study of the data of this report it must be concluded that the quality of the foundation in the rear of Structure 3.1.1 is at least the equal of and perhaps much better than that which was anticipated when Document (b) was prepared.

14. While no cores were taken beneath building 3.1.1 the fact that the grout holes were on 3 foot centers would make it appear that the quality of grouting in this area would be at least the equal of that at the rear of the structure.

15. The greatly improved quality and homogenity of the grout in the grouted area, as compared with that of the earlier test area may perhaps be accounted for by the much more vigorous and prolonged air jetting employed in the former.

16. Jackhammer holes made outside the grouted area during the grouting operation disclosed no grout cuttings. Cores taken near the rear corners of the structure 11 to 15 feet outside the boundary of the area, likewise show no trace of grout. The thickness of grout and grouted gravel observed in cores taken from the area in the rear of the building seems to be sufficient to account for most of the grout used, and while it seems likely that some grout did escape through channels beneath the conglomerate, the amount so lost is believed to be small.

17. The cores taken near the rear corners of the structure, outside the grouted area are of interest. The one near the southeast corner showed very good conglomerate at depths from 5 to 15 feet. The one near the southwest corner showed poor quality conglomerate from 7 to 15 feet. At each of these locations the conglomerate was underlaid with approximately 4 feet of fine silly sand mixed with gravel and large coral fragments. Below this material to a depth of at least 22 feet was a well graded sand.

18. Figure 1 also shows a longitudinal section through the grouted area 10 to 15 feet to the rear of the building and also a transverse section about 40 feet from the east end.

19. Twelve bench marks have been placed at the locations shown in Figure 1. These consist of either 6 or 8 inch casings grouted 3 1/2 feet into core holes in the conglomerate. These casings were filled with grout, and in their upper ends a round headed brass bolt was placed. The survey crew at Engebi has determined the elevations of these bench marks.

20. Sixteen cores varying in length from 8 to 24 inches, including conglomerate, grouted gravel and nearly pure grout of varying quality have

been selected for shipment to the Denver laboratory of USBR. A description of these cores with their core hole locations is given in the appendix. The results of tests to be made by USBR should provide information useful in foundation analyses both with respect to stability and rigidity.

/s/ VERNON C. KENNEY /s/ RAYMOND E. DAVIS

RED:lfm
cc: w/Engl. (Table 1)
P. W. Spain, R. E. Davis, V. C. Kenney
H&N jobsite, H&N, Losa, C. T. Cooper
lcdr Rowen, Sherwood Smith, M. D. Kirkpatrick
Boyd Anderson, CJTF-3, CRG 3.1, John Ranttila,
R. C. Sorensen

TABLE I
List of Cores to be Shipped to USBR Laboratory

HOLE NO	SPEC NO.	DEPTH IN FEET		DESCRIPTION
		FROM	TO	
1	DH1-1	9-2	11.2	Coarse grained conglomerate
	DH1-2	17.2	18.0	Grout, with sand in suspension, cold joint near midheight.
2	DH2-1	5.9	7.1	Dense fine grained conglomerate
	DH2-2	8.5	10.1	Weakly cemented coarse grained conglomerate grouted from 8.5 to 9.5
	DH2-3	14.1	14.7	Pure grout, poor quality, cold joint near midheight.
	DH2-4	15.8	16.5	Hard grout, some sand in suspension
5A	DH5A-1	16.1	18.3	Grout with grouted layers coarse gravel and layer coral fragments.
5E	DH5E-1	16.1	17.3	Grouted gravel and layer coral fragments.
10	DH10-1	8.2	9.1	Fine grained conglomerate
	DH10-2	12.5	13.5	Pure grout with cold joint at 13.0 with some suspended sand from 13.0 to 13.5
	DH10-3	16.6	17.2	Good grout with sand in suspension
10A	DH10A-2	11.6	13.0	Pure grout, cold joint at 12.8
10B	DH10B-1	9.1	11.1	Well cemented conglomerate, except at 10.1 streaks of grout along old drill hole
	DH10B-2	12.1	12.9	Well grouted gravel and porous conglomerate
11B	DH11B-3	16.0	17.3	Pure grout with layer grouted gravel at 16.8
15	DH15 - 1	10.1	11.4	Dense medium to coarse grained conglomerate

DESCRIPTION OF FIVE INCH DIAMETER CORES TAKEN FROM GROUTED AREA IN THE REAR OF STRUCTURE 3.1.1 (Distances are referred to floor level)

HOLE #1 (Between old grout holes)

Top of conglomerate at 5.1 ft to 6.8 ft
5.1' to 6.8' - well cemented conglomerate in sand and gravel
6.8' to 7.8' - uncemented sand and gravel, no grout
7.8' to 15.0'- alternating layers of well cemented and weakly cemented conglomerate
15.0' to 17.0'- very weakly cemented sand and gravel with fragments up to five inch size
17.0' to 19.8'- grout with inclusions in the sand and gravel
Below 19.8' - well graded sand, no grout

HOLE #2 (Between old grouting holes)

Top of conglomerate at 5.6 ft.
5.6' to 8.6' - well cemented conglomerate
8.6' to 9.4' - weakly cemented conglomerate impregnated with grout
9.4' to 13.4'- well cemented conglomerate
13.4' to 14.0'- weakly cemented conglomerate in gravel sizes impregnated with grout
14.0' to 16.5' - nearly pure grout with cold joint at 15.0', and grouted coral layer from 15.3 to 15.8'
16.5' to 18.7'- very weakly grouted sand and gravel recovered with sampler
18.7' to 19.0'- pure grout of good quality
19.0' to 20.0'-sand and fine gravel, no grout
Below 20.0', well graded sand, no grout

HOLE #3 (Between old grout holes)

Top conglomerate at 6.8'
6.8' to 11.5' - well cemented conglomerate ranging to poorly cemented conglomerate below 11.0'
11.5' to 12.6' - sand and gravel, or very weakly cemented conglomerate
12.6' to 14.8' - alternate layers of well cemented and purely cemented conglomerate
14.8' to 15.7' - pure grout and grout impregnated porous conglomerate
15.7' to 18.8' - weakly grouted sand and gravel
18.8' to 20.4' - well grouted gravel
20.4' to 21.5' - sand and gravel containing fragments of grout recovered with sampler
Below 21.5', well graded sand and gravel, no grout

HOLE #5 (Between old grout holes)

Top of conglomerate 6.7'
6.7' to 8.3' - Alternate layers of well cemented and weakly cemented conglomerate

8.3' to 8.4' - partially grouted, weakly cemented conglomerate
8.8' to 14.3' - well cemented to poorly cemented conglomerate, no grout
14.3' to 14.8' - well grouted sand and gravel
14.8' to 16.8' - pure grout, but very poor quality and low density, with a high gas bubble content
16.8' to 17.0' - pure grout of good quality
Below 17.0', well graded sand with no trace of grout

HOLE #5A (At old grout hole)

Top of conglomerate at 6.9'
6.9' to 12.6' - alternating layers of well cemented and poorly cemented conglomerate with grout of good quality penetrating weakly cemented conglomerate between 11.6' and 12.6'
12.6' to 13.6' - well grouted gravel
13.6' to 16.5' - nearly pure grout of good quality except for patches of well grouted gravel at 15.6'
16.5' to 18.3' - pure grout of good quality with layers of well grouted gravel mostly in larger sizes of 25% gravel and 75% grout
18.3' to 20.3' - sand and fine gravel and gravel and grout, no strength, recovered with sampler
Below 20.3', well graded sand

HOLE #5B (Near old grout hole)

Top of conglomerate at 7.0'
7.0' to 9.0' - ranging from well cemented to poorly cemented conglomerate
10.0' to 12.5' - weakly cemented conglomerate, mostly in the gravel sizes showing good grout penetration
12.5' to 14.5' - lost core; recovered material indicates weakly grouted gravel and sand, and weakly cemented conglomerate
14.5' to 16.5' - pure grout, general quality, with some fine sand in suspension, and some large fragments of coral
16.5' to 19.0' - mostly large pieces of coral, weakly grouted
Below 19.0', well graded sand, no grout

HOLE #5C (Near old drilling hole)

Top of conglomerate at 7.0'
7.0' to 8.0' - hard fine grained conglomerate
8.0' to 9.5' - soft, weakly cemented fine conglomerate
9.5' to 10.0' - well cemented fine conglomerate
10.0' to 11.5' - coarse weak conglomerate, well impregnated with grout
11.5' to 16.0' - coarse coral fragments and weakly cemented conglomerate weakly grouted, running into weakly grouted sand and gravel
15.0' to 16.0' - nearly pure grout of good quality in which several large fragments of coral were embedded

16.0' to 16.5' - two large pieces of coral well bonded together with good grout
16.5' to 18.5' - grouted gravel
Below 18.5', well graded sand

HOLE #5D (Near old drilling hole)

Top of conglomerate at 7.0'
7.0' to 7.8' - well cemented conglomerate ranging to weakly cemented sand, no grout
7.8' to 9.5' - reamed hole apparently weak, very poorly cemented conglomerate
9.5' to 10.5' - strong fine grained conglomerate ranging to weakly cemented sand, no grout
10.5' to 11.5' - weakly cemented conglomerate becoming coarser with depth, no grout
11.5' to 12.3' - well grouted coarse grained conglomerate and gravel
12.3' to 13.3' - pure grout of good quality
13.3' to 14.4' - nearly pure grout of good quality with inclusions of gravel
14.4' to 15.4' - nearly pure grout containing some large coral fragments
15.4' to 16.9' - large coral fragments weakly grouted
Below 16.9', well graded sand, no grout

HOLE #5E (Near old drilling hole)

Top of conglomerate at 7.0'
7.0' to 11.3' - conglomerate with a fine grain zone at 8.8' no grout
11.3' to 12.0' - weakly cemented coarse conglomerate impregnated with grout
12.0' to 13.5' - nearly pure grout of fair quality
13.5' to 16.0' - grouted gravel and large coral fragments
16.0' to 16.9' - nearly pure grout of good quality
16.9' to 17.5' - grouted coral fragments
17.5' to 18.1' - nearly pure grout of good quality with patches of well grouted sand and gravel
18.1' to 18.7' - grouted sand and gravel and coarse coral fragments
18.7' to 20.4' - poorly grouted sand and gravel, no strength, recovered with sampler
Below 20.4', well graded sand no grout

HOLE #5F (The maximum distance from four adjacent old grout holes)

Top of conglomerate at 7.0'
7.0' to 9.5' - conglomerate with some grout and weakly cemented coarse material between 9.0' and 9.5'
9.5' to 12.5' - fine grained conglomerate changing to coarse grained weakly cemented conglomerate partially impregnated with grout
12.5' to 14.0' - weakly cemented conglomerate of medium grained size, containing considerable grout, mostly broken up in drilling

14.0' to 14.5' - very porous conglomerate and gravel well grouted
14.5' to 15.5' - pure grout of good quality
15.5' to 17.5' - well grouted gravel and large coral fragments
17.5' to 18.0' - poorly grouted sand, no strength, recovered with sampler
Below 18.0', well graded sand, no grout

HOLE #10 (Between old grout holes)

Top of conglomerate at 7.2'
7.2' to 11.2' - conglomerate in alternating zones of well cemented and poorly cemented grout between 10.7' and 11.2'
11.2' to 12.5' - well grouted gravel and weakly cemented conglomerate
12.5' to 14.0' - nearly pure grout except at 13.0' where there is a well grouted gravel layer at a cold joint, and at 14.0' a well grouted sand layer
14.0' to 15.3' - pure grout of good quality containing some fine sand in suspension
15.3' to 15.8' - weakly grouted sand recovered with sampler
15.8' to 16.0' - well grouted sand and gravel, but grout of poor quality
16.0' to 16.5' - pure grout of poor quality and low density, high gas bubble content
16.5' to 17.3' - good quality grout with a substantial percentage of fine sand which was carried in suspension; cold joint at 17.3'
17.3' to 17.6' - grouted gravel
Below 17.6', well graded sand, no grout

HOLE #10A (At old grout hole)

Top of conglomerate at 6.2
6.2' to 8.6' - well cemented conglomerate, no grout
8.6' to 9.6' - grouted sand and gravel and weakly cemented conglomerate
9.6' to 14.0' - good grout with patches of well grouted sand and gravel, and in places, considerable fine sand in suspension
14.0' to 15.5' - nearly pure grout of good quality
15.5' to 16.0' - good grout with patches of well grouted sand and gravel
16.0' to 17.0' - weakly grouted sand and gravel
17.0' to 18.0' - well grouted sand and gravel
18.0' to 19.0' - poorly grouted sand, no strength, recovered with sampler
Below 19.0', well graded sand, no grout

HOLE #10B (Over old grout hole)

Top of conglomerate at 6.2'
6.2' to 11.1' - conglomerate in alternating well cemented layers. Weakly cemented conglomerate outside of old hole. Well grouted old hole filled with grout of good quality.

11.1' to 12.1' - imperfectly grouted weak conglomerate
12.1' to 13.3' - well grouted porous conglomerate with pure grout of good quality below 13.3'
13.3' to 15.4' - hard well grouted gravel and sand
15.4' to 17.6' - good quality grout and well grouted gravel
17.6' to 18.6' - well grouted large sized gravel
Below 18.6', sand with a few pieces of hard grout ranging into well graded sand without trace of grout

HOLE #11 (Between old grout holes)

Top of conglomerate at 6.8'
6.8' to 10.3' - conglomerate for the most part well cemented but with some thin porous layers
10.3' to 10.5' - well grouted gravel
10.5' to 11.2' - grouted gravel and weakly cemented conglomerate
11.2' to 11.7' - partially grouted sand and gravel
11.7' to 13.5' - weakly grouted sand and gravel; lost core
13.5' to 14.8' - pure grout from fair to poor quality
14.8' to 16.8' - good quality pure grout
16.8' to 17.2' - well grouted gravel
Below 17.2', well graded sand, no grout

HOLE #11A (Near old grout hole)

Top of conglomerate at 7.0'
7.5' to 11.5' - weakly cemented conglomerate
11.5' to 13.6' - weakly cemented conglomerate and weakly grouted sand and gravel, recovered with sampler
13.6' to 19.0' - fair to poor quality grout with patches of intruded sand and gravel, grout of low density, high gas bubble content.
Below 19.0', well graded sand, no grout.

HOLE #11B (Near old hole)

Top of conglomerate at 7.0'
7.0' to 9.5' - well cemented conglomerate
9.5' to 12.8'- very weakly cemented conglomerate in sand and gravel sizes, with partial grout intrusion
12.8' to 17.3'- nearly pure grout of good quality with patches of well intruded gravel
17.3' to 17.5'- weakly grouted sand
Below 17.5', well graded sand, no grout

HOLE #13 (Between old grout holes)

Top of conglomerate at 7.0'
7.0' to 11.0' - conglomerate in alternating zones of well cemented and poorly cemented material in sand and gravel sizes
Below 11.0', sand and gravel with trace of grout at 15.0' and well graded sand below 15.0'

HOLE #15 (Outside of grouted area near southeast corner of 3.1.1)

Top of conglomerate at 5.0'
7.5' to 11.4' - well cemented conglomerate
11.4' to 15.2' - for the most part weakly cemented to very weakly cemented sand and gravel
15.2' to 17.2' - gravel and large coral fragments mixed with silty sand
17.2' to 19.2' - sand and gravel up to 3/4 inch size
19.2' to 21.2' - well graded sand

HOLE #16 (outside of grouted area near southwest corner of 3.1.1)

Top of conglomerate at 7.4'
7.4' to 15.2' - conglomerate of alternating zones of well cemented and poorly cemented material
15.2' to 17.5' - gravel and large coral fragments mixed with silty fine sand
17.5' to 19.5' - well graded sand and gravel
Below 19.5', well graded sand

FOUNDATION GROUTING - STRUCTURE 3.1.1

Specifications for the Foundation Grouting under Structure 3.1.1 were set up in a letter dated 11 November 1950, to R. E. Cole, Director, Division of Engineering and Construction, U. S. Atomic Energy Commission, Santa Fe Operations Office, Los Alamos, New Mexico, from Raymond E. Davis.

Grouting under the 3.1.1 building was placed, intending to solidify loose sub-surface material in the regions of the severest pressures imposed by the blast. Grouting was designed to render a strength of 500 p.s.i.

Drilling inside the building was accomplished by the use of 8 Gardner-Denver Model #S-73 air hammers using 1" drill rod with 1 7/8" drill bits. Holes were drilled vertically on three foot centers inside the structure and on four foot centers in the rear of the structure. (See Exhibit "C"). The intersection of lines shown on Exhibit "C" represents the approximate location of the grout holes. A four foot grid system was devised to be used in reporting grouting progress, and is shown on Exhibit A. Some difficulty was encountered by the drill bits sticking in the holes due to loose material caving in from above. This condition accounts in part for the slow progress made at the outset of operations.

Inside drilling was accomplished by the use of sectional drill steel and was considerably slower than the outside drilling, because of restricted quarters and lack of head room.

The first drilling varied from 1' to 5' in depth inside the building and revealed a seam of loose material in the coral conglomerate. The first grouting was for the purpose of solidifying this seam. All subsequent drilling, generally in 3' stages was either through the coral conglomerate or through a previously grouted area or stratum. In the rear of the structure the overburden was removed from an area 40' x 200' to a depth of approximately 8'. (See Exhibit "A" and "B".)

Exhibits "E" through "I" represent data obtained during the drilling and grouting operation. The thickness of coral conglomerate as shown does not necessarily indicate a solid material but in some cases was found to contain loose sand and gravel. At various levels the drilled holes were air and water jetted, followed by the introduction of grout. This sub-surface exploration indicated a wide latitude in material ranging from hard lime coral to a soft, slightly cemented coral conglomerate, having no particular pattern. The seam was composed of loose material between two layers of coral conglomerate. The method used to solidify the seam was to drill into the loose stratum and pump grout to refusal. On several occasions when grout was being pumped into a selected hole, the adjoining holes showed no evidence of penetration. However, evidence of grout would appear several holes distant. This would tend to indicate great irregularity in the seam. Grout consumption was slow and was applied with pressures up to 300 psi.

After grouting of the seam was accomplished, the regular drilling pattern was continued. (See Exhibit "C"). In all holes loose material was encountered and removed by air jetting at a pressure of 100 p.s.i. The jetting was dual in purpose, first to blow out fines leaving coarser material and lower the level of the remaining coarse material, secondly, to create a void between the remaining material and the solid coral or grouted layer above, thus creating space for freedom of movement upward during the grouting process. Representative samples of jetted materials were taken from random holes at various depths. The results of the sieve analyses of these samples are shown in Exhibit "D". From an interpretation of available data it is apparent that after jetting, the loose material below the conglomerate consisted of medium to coarse sand with varying percentages of gravel.

After air jetting was completed, grout pipes were water jetted to the same level. The grouting operation was accomplished using one double drum mixer, 1 duplex 3" x 1½" grout pump and two 4 stage 3" x 1½" centrifugal water pumps. 3/4" steel pipes equipped with a tee head and two plug cocks were inserted into the jet holes below the bottom of the material to be grouted. One cock was connected to the grout pump, the other cock to the water jet pump developing a pressure of approximately 150 p.s.i. Each hole was water jetted preceding the introduction of the grout. Water under pressure was presumed to have a tendency to promote agitation and flotation, thus holding loose particles in suspension in the mass to be grouted. While the water jet was creating a boiling action in the loose mass, the water valve was closed and the grout valve opened. The grout pipe was raised as necessary to permit the grout to flow with as little pressure as possible. (0 to 50 p.s.i.) The above procedure was followed inside the structure, using a mix of 1:1. Outside grouting mix was 2:1.

TABLE OF MIXES

Mix	Cement Sacks	Alfesil Sacks	Intrusion Aide Pounds
1:1	1	1	2
2:1	2	1	2

As each stratum was grouted, the holes were redrilled to below the grouted area and the method outlined above was repeated until the desired depth had been attained. Each grouting was intended to produce a solidified layer approximately two feet thick. The above grouting procedure was used to attain a maximum grouted depth of minus 27 under the rear foundation wall. This 27 foot maximum solidified area was 15 feet wide extending from the rear face of the foundation 10 feet toward the front and 5 feet to the rear. From the maximum depth and 10 feet toward the front the grouted mass tapered upward to an elevation of minus 12 feet plus or minus at the inside front foundation wall. In the rear from the maximum depth and 5 feet back of outside foundation wall the solidified mass extended upward reaching a depth of minus 12 feet, 33 feet to the rear of the structure. (See Exhibit B - Section B-B).

QUANTITIES OF MATERIALS USED IN GROUTING

Mix	Batches	Bags of Cement	Bags of Alfesil	Intrusion Aide
1:1	1948	1948	1948	4870
2:1	5755	11,510	5755	14,387
TOTAL	7703	13,458	7703	19,257

All cement used passed a 16 mesh sieve, was given soundess test, fineness test, time of set and compression test to insure its quality, and was found to meet conditions as specified by A.S.T.M.

Net volume to be solidified within grouting limits equaled 5470 cu.yds. During the entire grouting operation a constant check was maintained by instrument to detect any movement in the structure. This was done by setting a series of bench marks at various points on the back face and floor of the structure. These benches were accomplished by setting spikes in the concrete by means of an explosive operated (Driv'it) gun. The checking was done by the use of an Engineers level. A nearby bench having an established datum was used as a reference point in these comparisons. No movement occurred.

The following major equipment was used to accomplish the grouting operation:

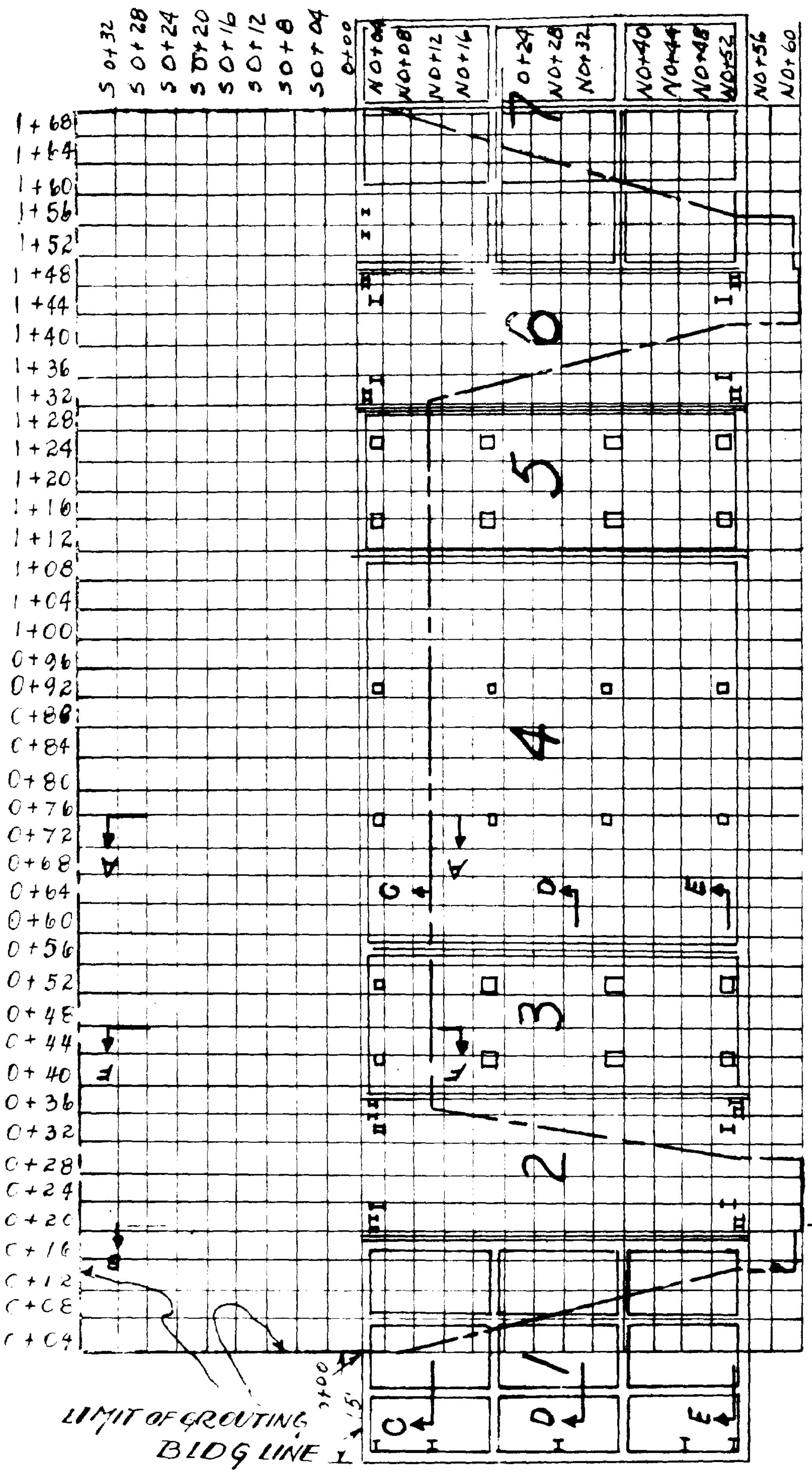
Quantity	Description
1	1½" x 1" Simplex Recip.Pump for Sump
1	3" x 1½" Single Stage Gorman Rupp Centrifugal Pump for Sump
2	3" x 1½" Four Stage Goulds Centrifugal Pump for Water
1	3" x 1½" Duplex Gardner Denver Grout Pump
2	315 C.F.M. Gardner Denver Compressors
2	315 C.F.M. Ingersoll Rand Compressors
1	365 C.F.M. Gardner Denver Compressor
2	Double-drum grout mixers (only 1 of these used at a time; One of these broke down and had to be replaced.)
8	S-73 Gardner Denver Air Drills
1 lot	1" drill rod
1 lot	3/4" grout and jet pipe
1 lot	Air hose
1 lot	Grout hose
1 lot	Pipe and fittings
1 lot	1 7/8" drill bits, 2½" bits, 2" bits

Grouting dates herein given are for the purpose of showing progress, and dates are to be considered somewhat flexible.

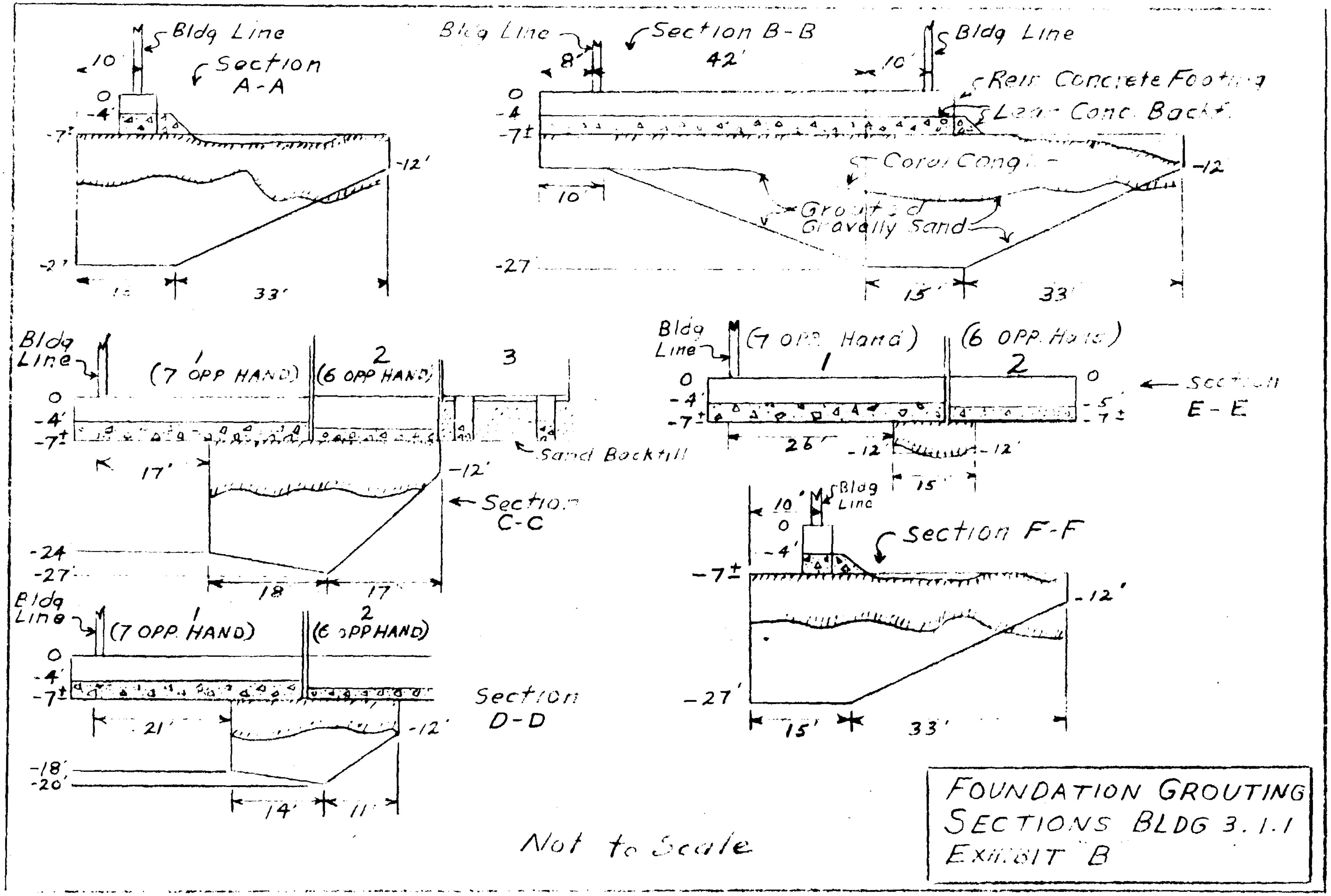
	Grouting Dates
15' - 18'	13 - 15 Dec. 1950
18' - 20'	21 - 30 Dec. 1950
20' - 22'	4 - 7 Jan. 1951
22' - 24'	14 - 18 Jan. 1951
24' - 26'	21 - 25 Jan. 1951

FOUNDATION GROUTING PLAN BLDG. 3.1.1.

EXHIBIT "A"

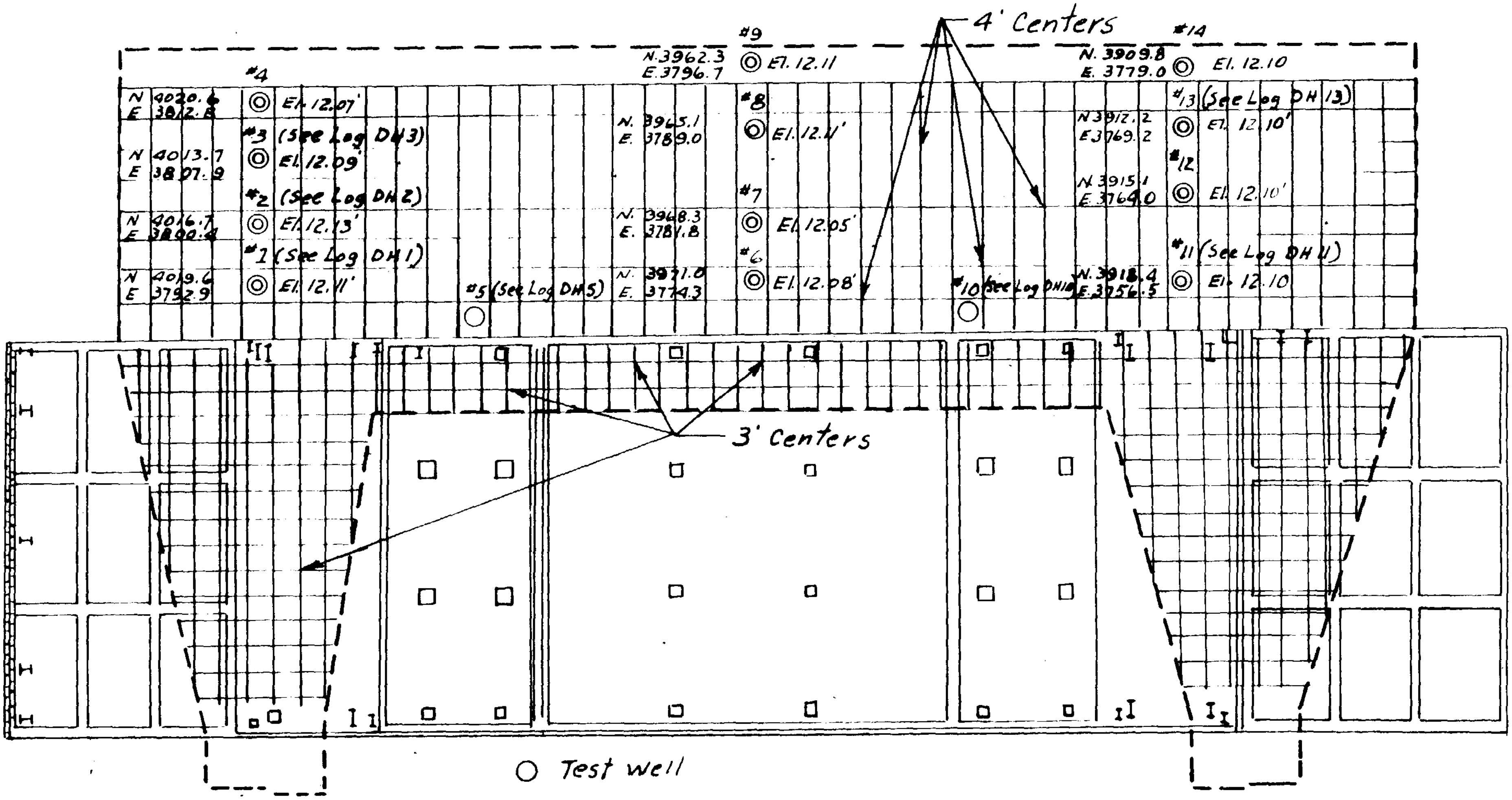


Not to Scale



Not to Scale

FOUNDATION GROUTING
SECTIONS BLDG 3.1.1
EXHIBIT B



○ Test well

◎ Test well ¢ Bench Mark

Not to Scale

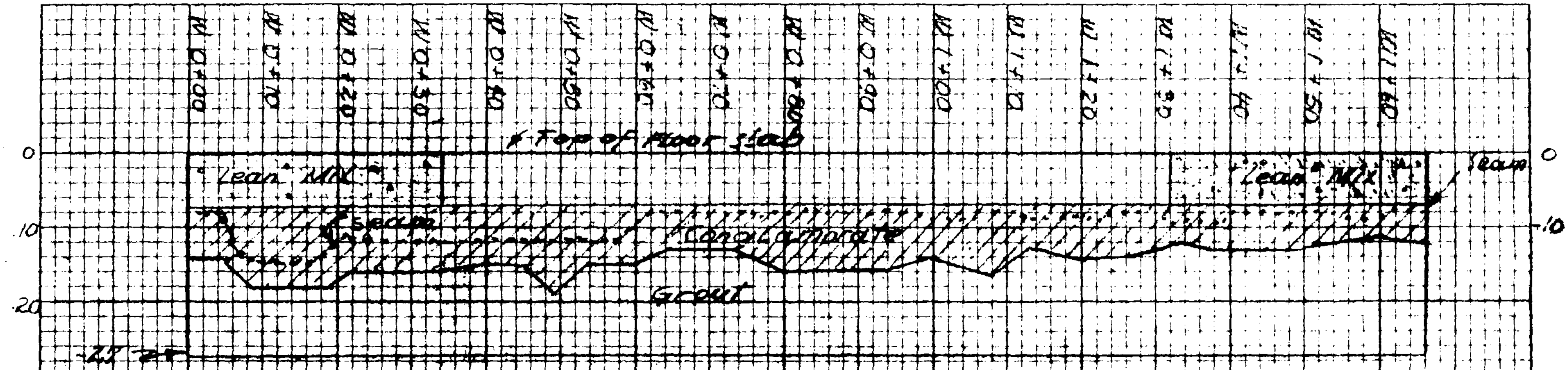
FOUNDATION GROUTING
Building 3.1.1
Exhibit "C"

PARTICLE SIZE DISTRIBUTION OF MATERIALS AIR JETTED FROM DRILL

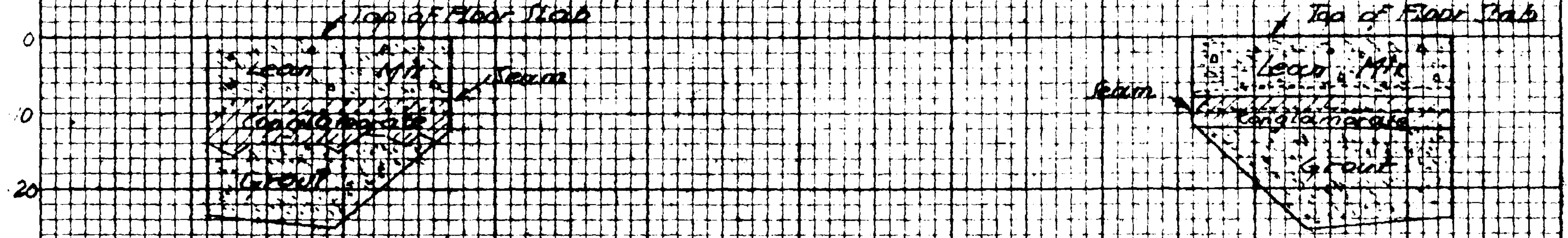
HOLES PRIOR TO GROUTING

LOCATION	DEPTH IN FEET BELOW FLOOR SLAB	SCREEN SIZE AND PERCENT PASSING										
		1"	3/4"	1/2"	3/8"	4	8	16	30	50	100	200
0 04 N 0 64 [illegible]	18-22		100	95	90	72	52	27	15	9	5	3.5
[illegible] N [illegible] 20 [illegible]	20-24			100	99	97	92	78	63	[illegible]	15	6
0 08 N 0 [illegible]	12-15		100	99	96	82	61	27	14	6	5	3.6
0 08 N 0 30	12-15		100	95	91	75	54	25	12	6	2.7	1.4
0 24 N 0 24	16-22		100	99	96	90	75	47	29	15	6.3	3.1
0 04 N [illegible] 08	15-17		100	90	86	75	63	31	11	5	2	1.2
0 04 N 0 [illegible]	14-16		100	95	88	72	52	21	9	4	2.6	1.8
0 28 N [illegible] 46 [illegible]	17-20		100	91	82	61	41	16	7	3	1.4	0.7
0 28 N 0 08	17-20		100	92	85	70	57	38	27	18	11	6.2
0 28 N 1 36 [illegible]	12-18		100	96	91	73	54	23	15	6	3	1.6
0 14 N 1 56	23-25		100	97	92	64	73	40	21	8	3	1.2
0 14 N 1 04	23-25		100	96	87	64	40	15	7	3	2	1.3
0 10 N [illegible] 16	23-25	100	98	92	83	59	42	21	9	4	1.6	0.9
0 10 N 1 52	18-20			100	97	88	73	47	31	19	11	6.8
0 1[illegible] N 0 20	21-24	100	96	89	79	61	47	31	22	13	6.6	3.9
0 06 S 0 43 [illegible]	18-20	100	98	97	93	84	76	57	39	24	12	4.8
0 10 N 0 12	23-25		100	97	95	92	87	69	52	30	12	7.2
0 20 S 0 60	15-18	100	98	97	93	86	75	52	34	19	9	4.9
0 10 N [illegible] 50	18-21	100	99	91	82	68	51	27	14	6	2.5	1.3
[illegible] 04 S 1 66	20-22	100	94	86	80	64	35	12	7	2	0.8	0.6
[illegible] 20 S 1 [illegible]	15-18	100	97	91	81	63	46	9	0.[illegible]	[illegible]	0.3	0.2
[illegible] 12 [illegible]	[illegible]6-18	100	98	95	87	67	45	19	9	5	3.5	2.3
0 12 N 0 32	17-20	100	98	91	78	57	42	22	11	5	2.8	1.7
0 08 N 1 29	13-16	100	97	96	92	80	66	43	28	14	7	4
0 16 S 0 76	15-17	100	99	97	92	78	57	21	6	2	0.8	0.4
0 12 S 1 00	1[illegible]-15		100	97	93	78	54	20	5	1	0.3	0.2

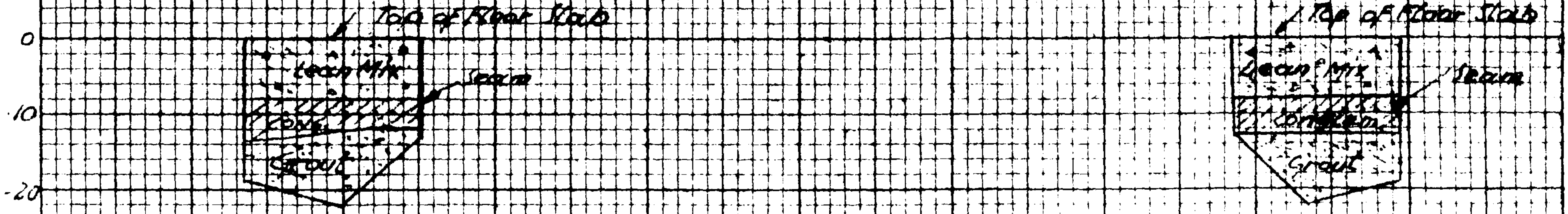
Exhibit "I"



Cross Section at N 0+04

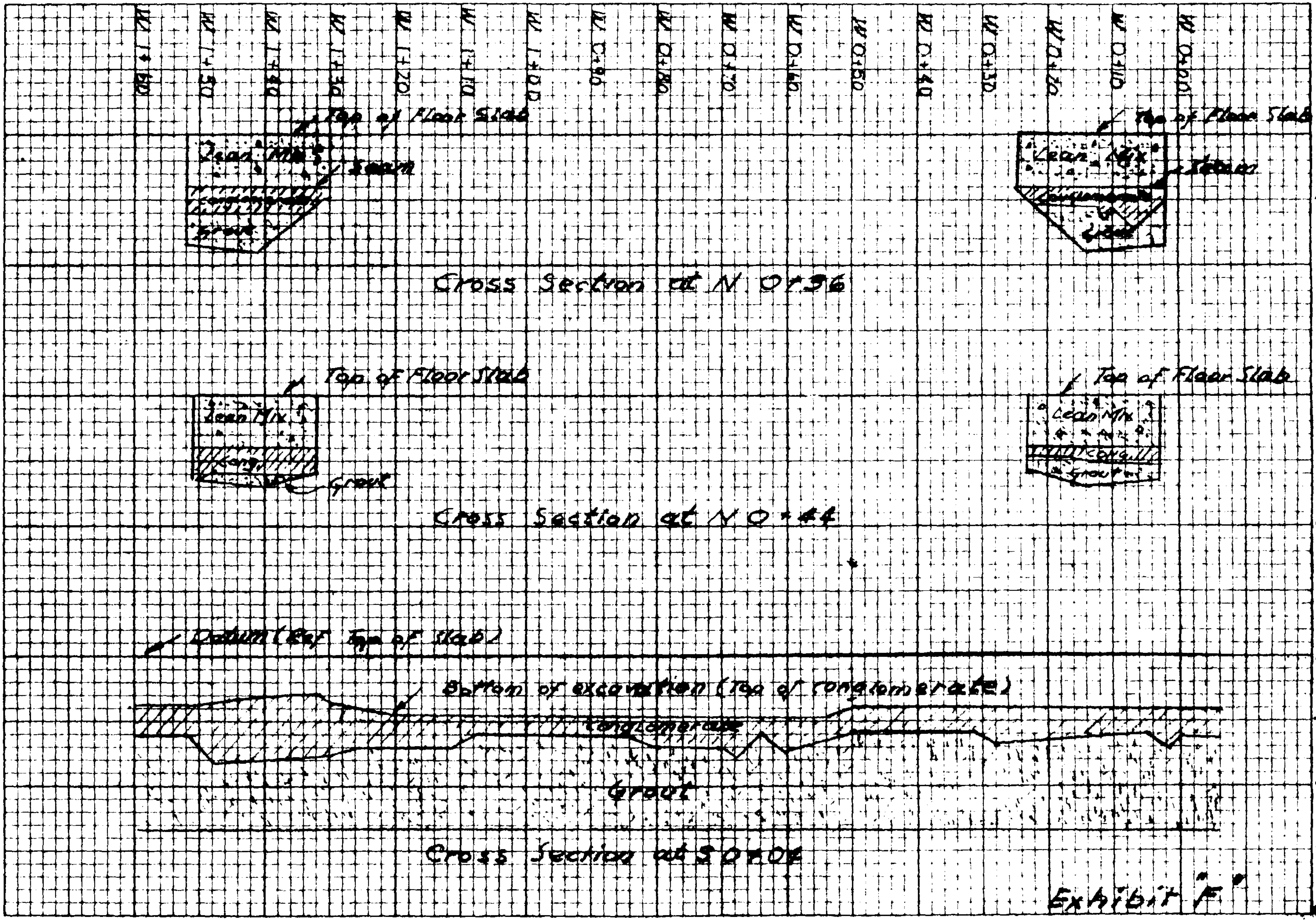


Cross Section at N 0+16



Cross Section at N 0+24

Exhibit "E"



Cross Section at N 0+36

Cross Section at N 0+44

Cross Section at S 0+06

Exhibit "F"

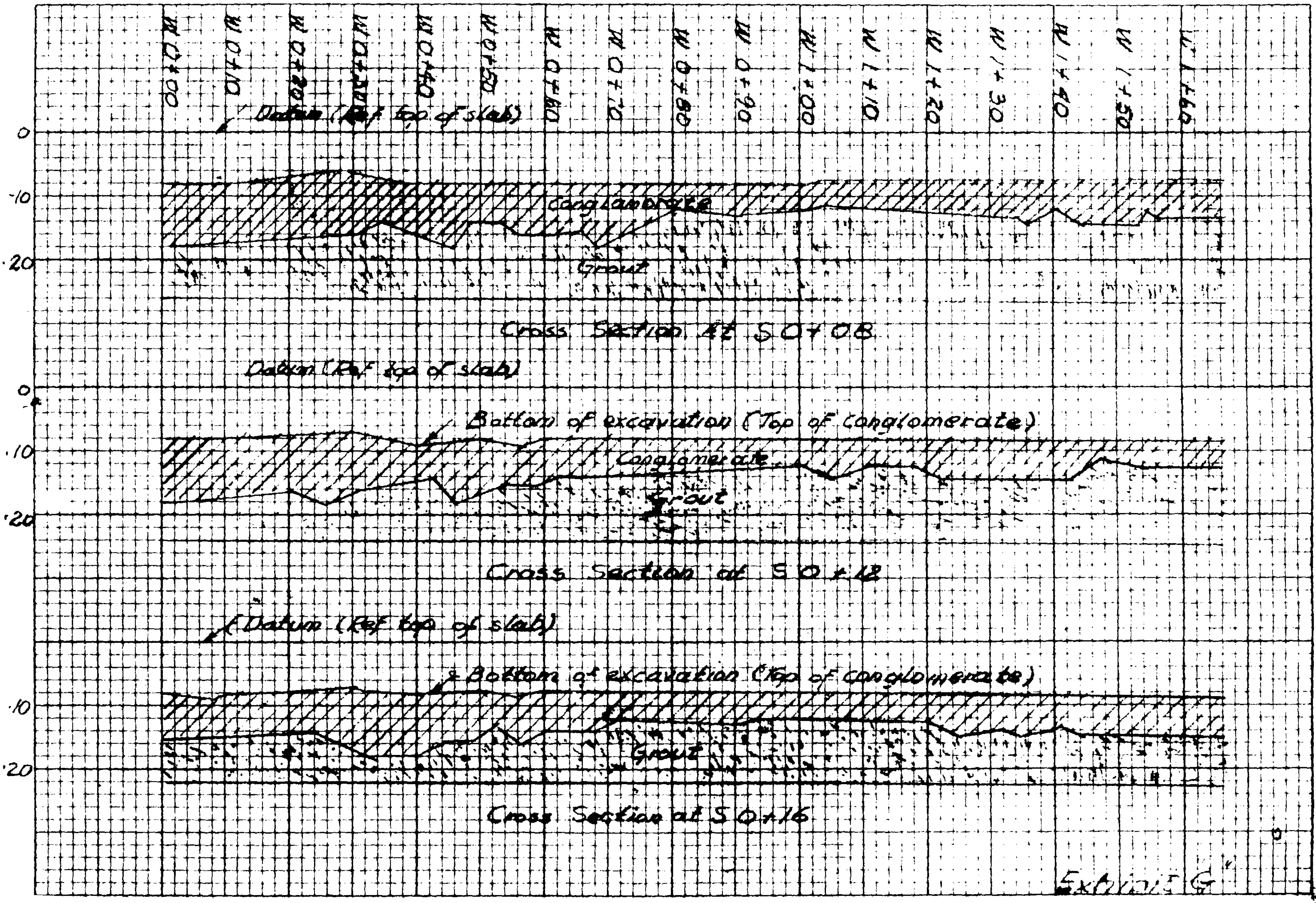

W 0+00
W 0+10
W 0+20
W 0+30
W 0+40
W 0+50
W 0+60
W 0+70
W 0+80
W 0+90
W 1+00
W 1+10
W 1+20
W 1+30
W 1+40
W 1+50
W 1+60
0
-10
·20
Datum (Ref top of slab)
Conglomerate
Grout
Cross Section At S 0+08
Datum (Ref top of slab)
0
·10
·20
Bottom of excavation (Top of conglomerate)
Conglomerate
Grout
Cross Section at S 0+12
Datum (Ref top of slab)
0
·10
·20
Bottom of excavation (Top of conglomerate)
Grout
Cross Section at S 0+16

Exhibit "G"

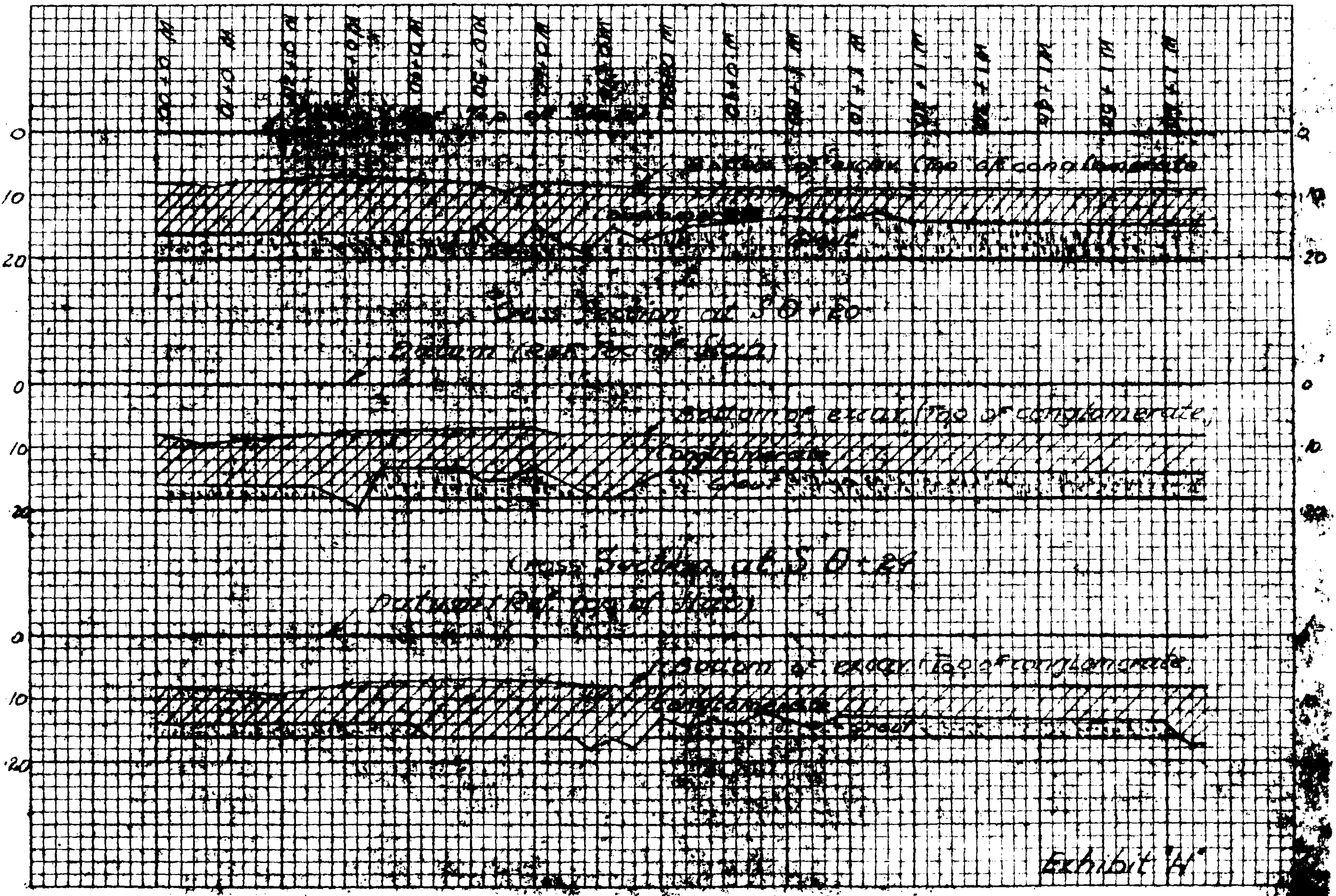
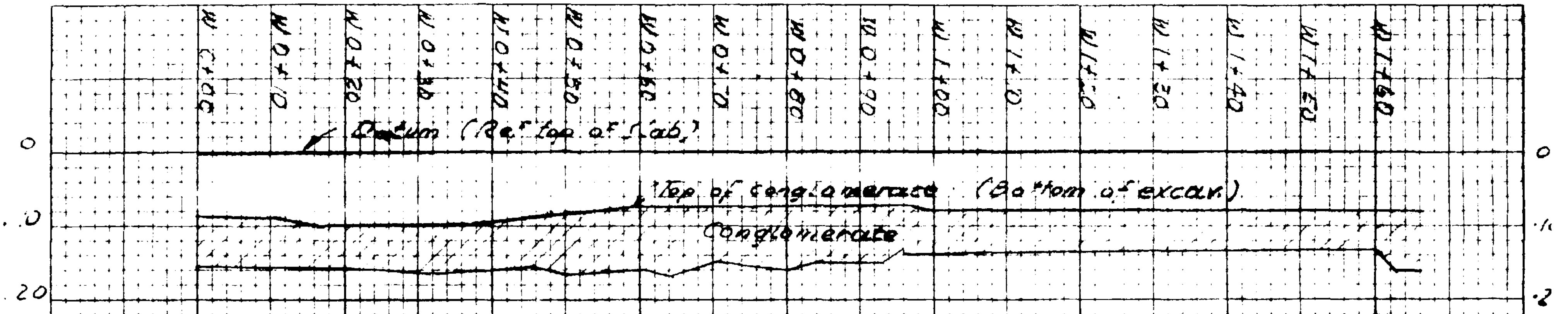

W 0+00
W 0+10
W 0+20
W 0+30
W 0+40
W 0+50
W 0+60
W 0+70
W 0+80
W 0+90
W 1+00
W 1+10
W 1+20
W 1+30
W 1+40
W 1+50
W 1+60
0
10
20
Bottom of excav. (Top of conglomerate
Cross Section at S 0+20
Datum (Ref. top of [illegible])
Bottom of excav. (Top of conglomerate)
Conglomerate
Gravel
Cross Section at S 0+24
Datum (Ref. top of [illegible])
Bottom of excav. (Top of conglomerate)
Conglomerate
Gravel

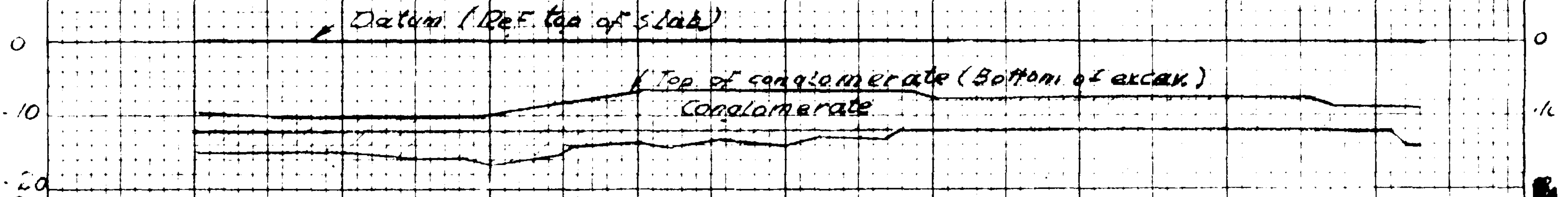
Exhibit "A"

10 X 10 PER INCH

MADE IN U.S.A.



Cross Section at S 0+32



Cross Section at S 0+36

Exhibit "I"