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Stroud

THE RADIOLOGICAL CLEANUP OF ENEWETAK ATOLL

DEFENSE NUCLEAR AGENCY
Washington, D.C. 1981

To the People of Enewetak who sacrificed so much on behalf of the peace of the world and the security of free men everywhere;

To the memory of the six U.S. servicemen who lost their lives at Enewetak Atoll during the cleanup; and,

To the thousands of individuals whose unswerving commitment to the people of Enewetak and sustained support to the Department of Defense over the eight years of the project made possible the remarkable success of this great humanitarian effort.

FOREWORD

For 8 years, from 1972 until 1980, the United States planned and carried out the radiological cleanup, rehabilitation, and resettlement of Enewetak Atoll in the Marshall Islands. This project represented the fulfillment of a long-standing moral commitment to the People of Enewetak. The cleanup itself, executed by the Department of Defense (DOD), was an extensive effort, involving a Joint Task Force staff and numerous Army, Navy, and Air Force units and personnel. The rehabilitation and resettlement project, carried out by the Department of the Interior concurrently with the cleanup, added complexity to the task and required the closest coordination — as did the important involvement of the Department of Energy (DOE), responsible for radiological characterization and certification. The combined effort cost about $100 million and required an on-atoll task force numbering almost 1,000 people for 3 years, 1977-1980. No radiological cleanup operation of this scope and complexity has ever before been attempted by the United States.

This documentary records, from the perspective of DOD, the background, decisions, actions, and results of this major national and international effort. Every attempt has been made to record issues as they developed, and to show the results, good and bad, of specific decisions, oversights, etc. Because this documentary may have considerable importance in the future, and because specific needs for data cannot be foreseen with accuracy, every attempt has been made to record in some detail all major facets of the operation and to reference key documents. Throughout the research, collection, and writing, four major types of potential users have been kept in mind. The documentary is designed:

— First, to provide a historical document which records with accuracy this major event in the history of Enewetak Atoll, the Marshall Islands, the Trust Territory of the Pacific Islands, Micronesia, the Pacific Basin, and the United States. To serve this end, the documentary addresses political, legal, administrative, and social issues; and it attempts to put the cleanup in perspective in terms of the prior history of Enewetak Atoll, World War II, the nuclear testing period, and the United Nations Trusteeship.

— Second, to provide a definitive record of the radiological contamination of the Atoll. It addresses the origins of the contamination on a shot-by-shot basis; the types, concentrations, and locations of contamination prior to the cleanup; the radiological cleanup decisions and their rationale; the cleanup processes themselves; and the resulting radiological situation, island-by-island. It is believed that this type of data will be useful over the coming decades as living patterns on the Atoll change, new radiological surveys are taken, improved health physics understanding becomes available, and new risk-benefit decisions are made. For this purpose this documentary will supplement the more technical data published by DOE.

— Third, to provide a detailed record of the radiological exposure of the cleanup forces themselves. As years pass, it will become increasingly important to the cleanup participants, to the U.S. Government, and to health physicists and radiation biologists, to have a meticulously accurate record of the radiological safety policies and procedures; an overview of personnel assignment practices; and a careful summarization of air sampler readings, film badge and thermoluminescent dosimeter exposures, bioassay samples, etc.

— Fourth, to provide a useful guide for subsequent radiological cleanup efforts elsewhere. It seems likely that there will be future requirements for radiological cleanup of extensive areas which present complex contamination problems. Since the Enewetak cleanup was a bellwether effort of its kind, the many lessons learned should provide useful guidance for those who will plan and execute future efforts. Information such as this is quickly lost if not permanently recorded.

In developing this documentary, every effort has been made to be accurate, balanced, and objective. However, since issues can appear in somewhat different light when viewed from different organizational perspectives, the reader should keep in mind that the authors generally have a DOD affiliation.

August 1980

ROBERT R. MONROE
Vice Admiral, U.S. Navy
Director, Defense Nuclear Agency

PREFACE

Field Command, Defense Nuclear Agency has prepared this documentary to provide the general reader a narrative history of the radiological cleanup of Enewetak Atoll and to provide the interested researcher a description of the procedures used to support and accomplish the radiological cleanup. It is intended to present a balanced, objective review of the mistakes made and lessons learned, as well as the many successes achieved during the project. Much of the knowledge and experience gained during the project would be applicable to any military operation in the harsh environment of a tropical atoll, and the radiological cleanup experience represents an invaluable national asset in the Atomic Age. It is the aim of this documentary to record that experience while it is readily available. To complete the description of the United States effort to restore the atoll, the last chapter includes an account of the Rehabilitation Program which was conducted by the Department of the Interior concurrently with the cleanup project.

This report was compiled from historical documents stored in the Enewetak Radiological Cleanup repository at the Defense Nuclear Agency's Field Command in Albuquerque, New Mexico. The bibliographical notes, which are identified by superscripts within the text, are intended to provide future researchers with a guide to documents containing additional data regarding subject matter of the text as well as sources for the text itself.

The compilers have endeavored to arrange events by topics and operational categories as well as in chronological order. As a result, there is some overlapping of chronology between the chapters and sections. To facilitate continuity for the general reader, brief summary paragraphs have been included where appropriate, with the hope that the researcher will overlook these occasional redundancies.

In the use of names, the preference of the group being named has been followed. In Marshallese, the prefix "dri-" means "people of." Thus, "dri-Enewetak" means the people of Enewetak Island in particular, as well as the people of Enewetak Atoll as a whole. The people of Enjebi Island refer to themselves as "dri-Enjebi" in distinguishing themselves from the other people of the atoll, but as "dri-Enewetak" when referring to all the people of the atoll.

In referring to the operational element of the Defense Nuclear Agency (DNA), the term "Field Command" is commonly used for "Field Command, Defense Nuclear Agency" in actual practice and in this documentary. During the period covered by this report, the organization originally known as the Atomic Energy Commission (AEC) has been reorganized and renamed twice. On 1 January 1975, it became the Energy

Research and Development Administration (ERDA); and, on 1 October 1977, it became part of the Department of Energy (DOE). This organization is referred to in this documentary by the name in effect at the time of the event being described.

This report was compiled by members of the Field Command staff with the assistance of Headquarters, DNA; Headquarters Joint Task Group; and other personnel who were involved in the cleanup of Enewetak Atoll. The principal authors were Colonel Robert L. Peters, Director of Enewetak Operations at Field Command for over 2 years of the project, and Mr. David L. Wilson, Chief of Logistics Services Division and one of the principal planners at Field Command from the project's inception. The viewpoint represented is intended to be that of the Defense Nuclear Agency alone, and not necessarily that of the other agencies involved.

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CHAPTER I

DESCRIPTION AND HISTORY 1526 - 1972

GEOGRAPHY

Enewetak Atoll is a small ring of islands approximately 2,500 miles west of Hawaii at latitude 11° 21′ N and longitude 162° 21′ E (Figure I-1). It is the only surface feature of one of the three chains of islands known as the

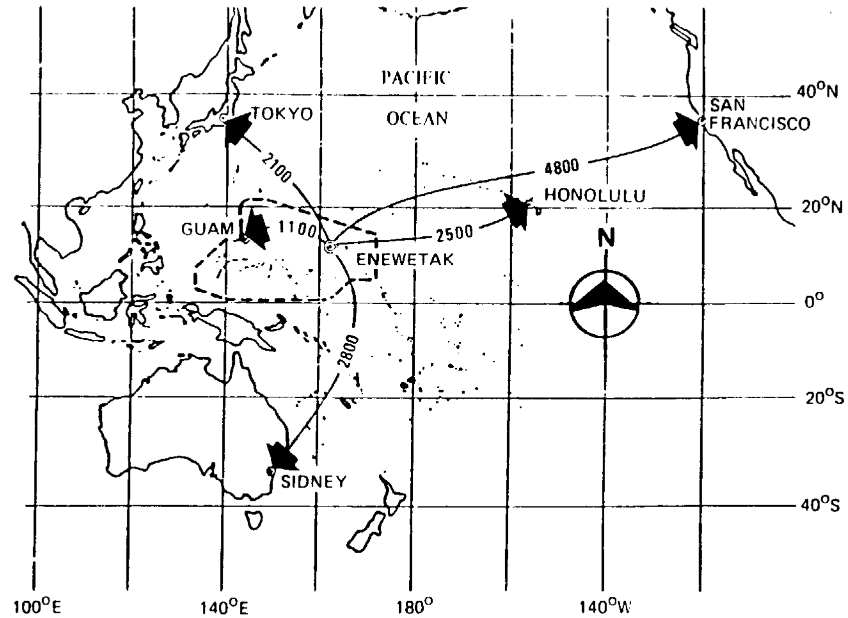


FIGURE 1-1. GREAT CIRCLE DISTANCES FROM ENEWETAK ATOLL.

Marshall Islands Group (Figure I-2). The range of undersea mountains which form this chain was not identified as such until 1950. Prior to that, Enewetak was considered part of the Ralik or "Sunset" chain. The Ratak or "Sunrise" chain is the easternmost of the Marshall Islands Group (Figure I-3).[1]

Enewetak Atoll contains some 40 named islands, two coral heads large enough to have been named by the dri-Enewetak, a number of small unnamed islets, and long stretches of submerged reefs (Figure I-4). During the nuclear test period, the major islands were assigned "site" names by U.S. Government personnel. The northern islands were

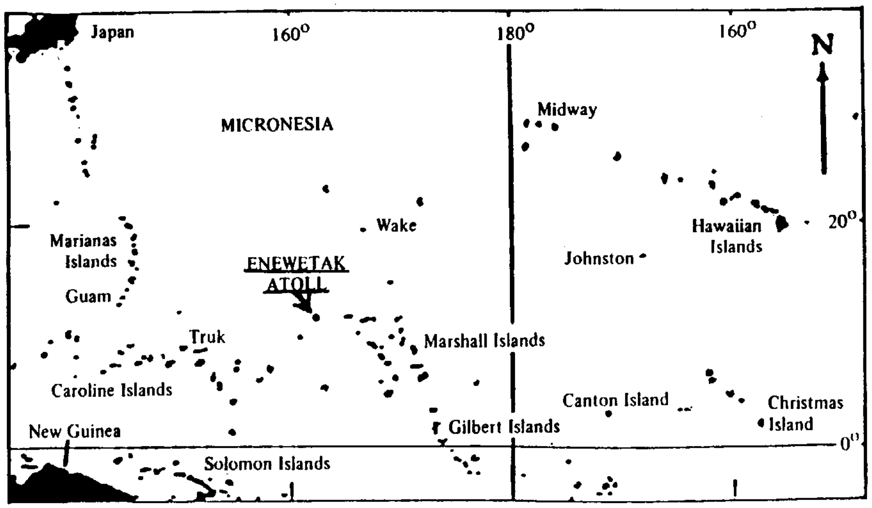


FIGURE 1-2. LOCATION OF THE MARSHALL ISLANDS IN THE WESTERN PACIFIC.

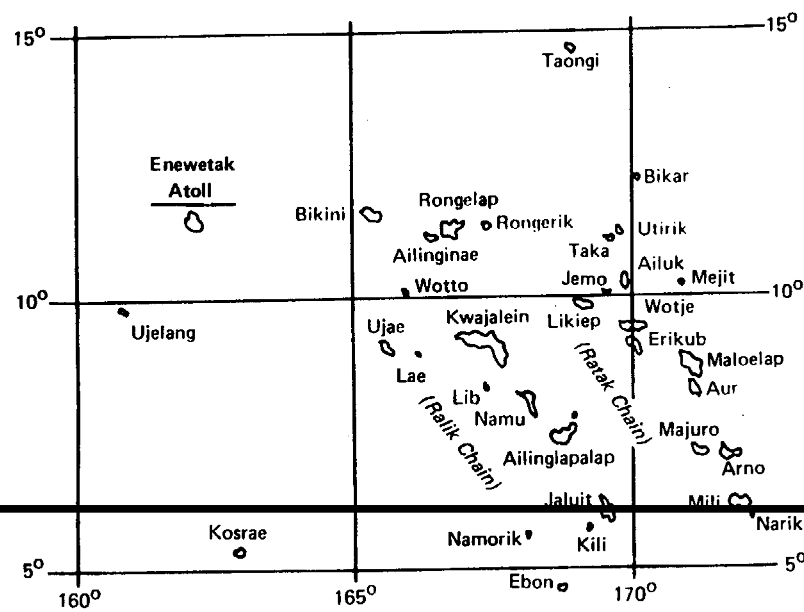
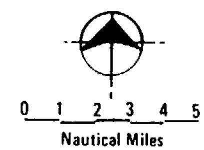


FIGURE 1-3. LOCATION OF ENEWETAK ATOLL IN THE MARSHALL ISLANDS.



	Enjebi	Lojwa	Japtan	Medren	Enewetak
Enjebi		6	17	17	20
Lojwa	6		12	13	16
Japtan	17	12		2	6
Medren	17	13	2		5
Enewetak	20	16	6	5	

MILEAGE TABLE
(Nautical Miles From Dock to Dock)

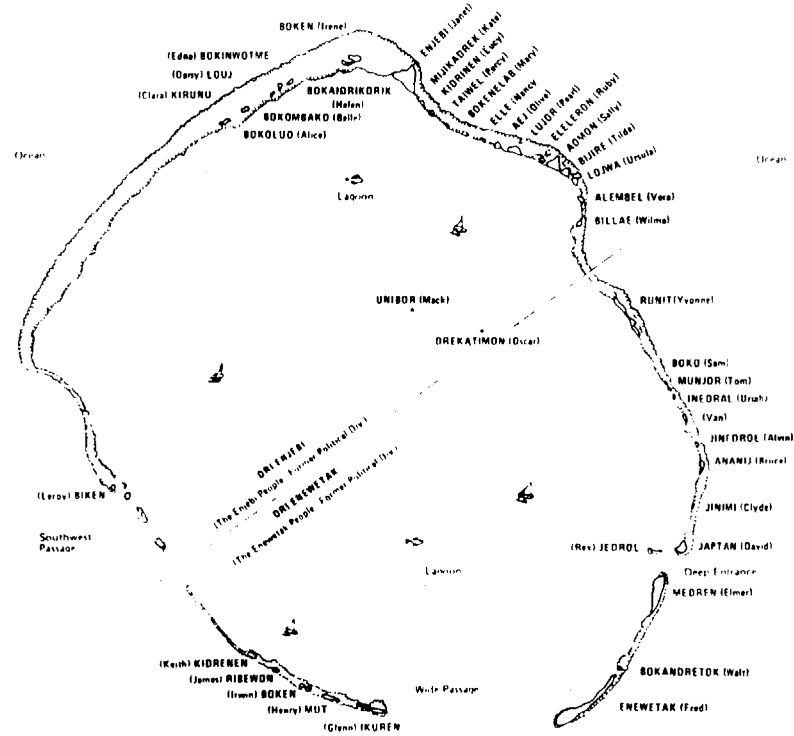


FIGURE 1-4. ISLANDS OF ENEWETAK ATOLL.

assigned female names in alphabetical order beginning with "Alice" and continuing clockwise through "Yvonne." The southern islands were assigned male names beginning with "Alvin" and continuing clockwise through "Leroy." Subsequently, additional sité names were assigned to smaller islands and other features, disrupting the original order of assignment. The site names are shown in parentheses in Figure 1-4. The spelling used for the island names is that adopted in 1974 by the U.S. Board of Geographical Names as best representing the pronunciations of the dri-Enewetak.

The atoll is approximately 23 by 17 statute miles with the long axis running northwest to southeast. The land surface area totals 1,761 acres or 2-3/4 square miles (Figure 1-5). The lagoon has an area of approximately 388 square miles. Its depth averages 160 feet with a maximum of approximately 200 feet.[2,3] There are three entrances to the lagoon: the east channel or Deep Entrance, 180 feet deep, lying between Medren (Elmer) and Japtan (David); the Wide Passage in the south, 6 miles in width; and a 24-foot deep channel called the Southwest Passage. Figures 1-6 through 1-16 provide a pictorial introduction to the islands of the atoll.

GEOLOGY

Enewetak Atoll was formed by the growth of coral reefs on an extinct volcano (Figure 1-17). Coral reefs, and subsequently atolls themselves, consist of limestone which is produced by coral animals (coelenterate polyps), coralline algae, and shelled animals. These living organisms require warm, agitated water and strong sunlight to stay alive. This is particularly important to the coral animal forms since they are attached and can only get food which drifts to them. Corals and other reef builders, including algae, produce limy skeletons which, along with coral rubble, sand and other sedimentary material, are bound together in a rock-like mass by the limy secretions of the coralline algae. This continuous production of limy skeletons and binding by the algae results in the formation and growth of the coral reefs.[4]

The rate of growth of coral reefs is relatively faster on the ocean side of the volcanic mass than on the lagoon side because of more nutrition and aeration in the wind-driven water.[5] Coral may grow vertically at an average rate of one millimeter per year. The rate and direction of growth varies with water depth and ceases completely when the coral is exposed by variances in relative sea level. Such variances are associated with the lowering of ocean levels during periods of glaciation. Thus, the growth rate and morphology are affected alternately by the submersion and subaerial exposure of the reef. Once the coral colonies reach the surface or are

SITE		ACRES*	HECTARES**
Enewetak (Fred)		322	130
Enjebi (Janet)		291	118
Medren (Elmer)		220	89
Aomon (Sally)		99	40
Runit (Yvonne)		91	37
Japtan (David)		79	32
Lujor (Pearl)		54	22
Bijire (Tilda)		52	21
Ikuren (Glenn)		41	17
Lojwa (Ursula)		40	16
Aej (Olive)		40	16
Mut (Henry)		40	16
Boken (Irene)		40	16
Alembel (Vera)		38	15
Bokombako (Belle)		31	12
Boken (Irwin)		29	12
Ananij (Bruce)		25	10
Kidrenen (Keith)		24	10
Bokoluo (Alice)		22	9
Louj (Daisy)		21	9
Kidrinen (Lucy)		20	8
Ribewon (James)		19	8
Mijikadrek (Kate)		16	6
Billae (Wilma)		14	6
Biken (Leroy)		14	5
Bokenelab (Mary)		12	5
Elle (Nancy)		11	4
Bokinwotme (Edna)		10	4
Kirunu (Clara)		7	3
Van		7	3
Jedrol (Rex)		5	2
Bokaidrikdrik (Helen)		5	2
Taiwel (Percy)		5	2
Eleleron (Ruby)		4	2
Inedral (Uriah)		4	2
Jinimi (Clyde)		3	1
Jinedrol (Alvin)		2	1
Munjor (Tom)		2	1
Boko (Sam)		1	.5
Bokandretok (Walt)		1	.5
TOTAL 40 Sites	76,700,000 Sq. FT. (2.75 Square Miles)	1,761 Acres	713 Hectares

*1 Acre = 43,560 Sq. Ft. = .405 Hectares
**1 Hectare = 107,639 Sq. Ft. = 2.47 Acres

FIGURE 1-5. APPROXIMATE LAND AREAS, ENEWETAK ATOLL.

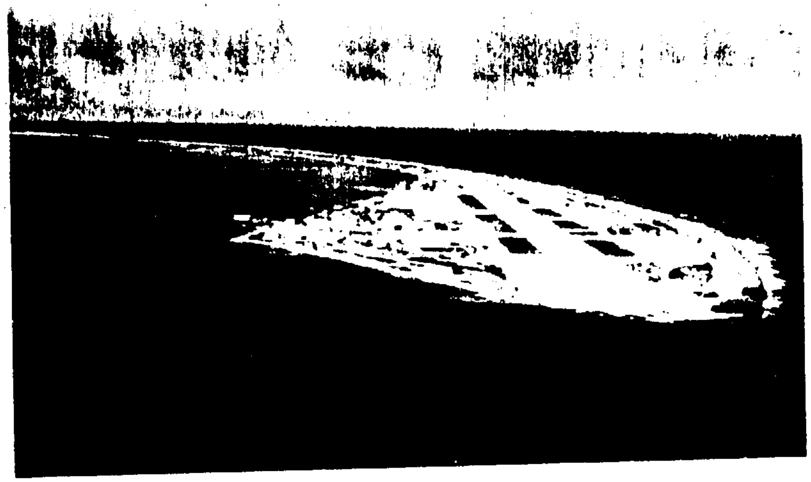


FIGURE 1-6. ENEWETAK (FRED) AND BOKANDRETOK (WALT).

FIGURE 1-7. MEDREN (ELMER) AND JAPTAN (DAVID).

FIGURE 1-8. JINIMI (CLYDE), ANANIJ (BRUCE), JINEDROL (ALVIN), VAN (NO MARSHALLESE NAME), INEDRAL (URIAH), MUNJOR (TOM), AND BOKO (SAM).

FIGURE 1-9. RUNIT (YVONNE).

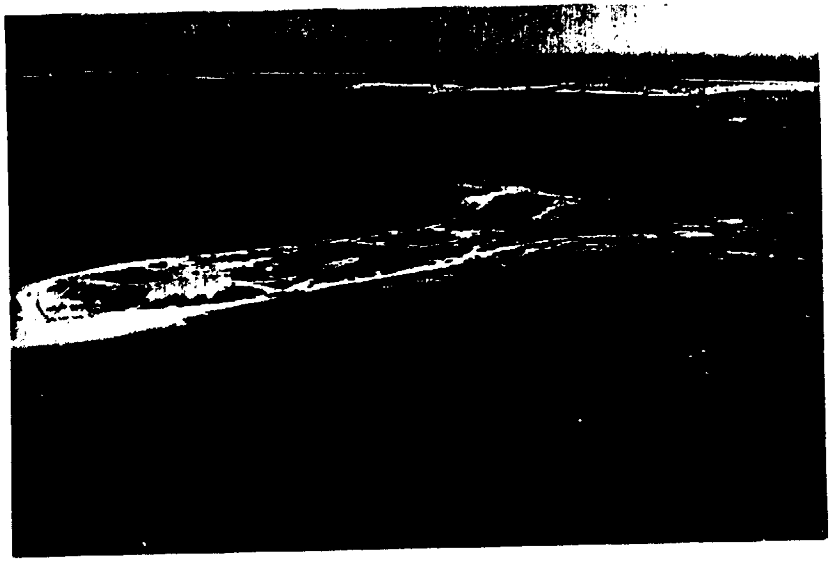


FIGURE 1-10. BILLAE (WILMA) AND ALEMBEL (VERA).

FIGURE 1-11. LOJWA (URSULA), BIJIRE (TILDA), AOMON (SALLY), ELELERON (RUBY), LUJOR (PEARL), AEJ (OLIVE), AND ELLE (NANCY).

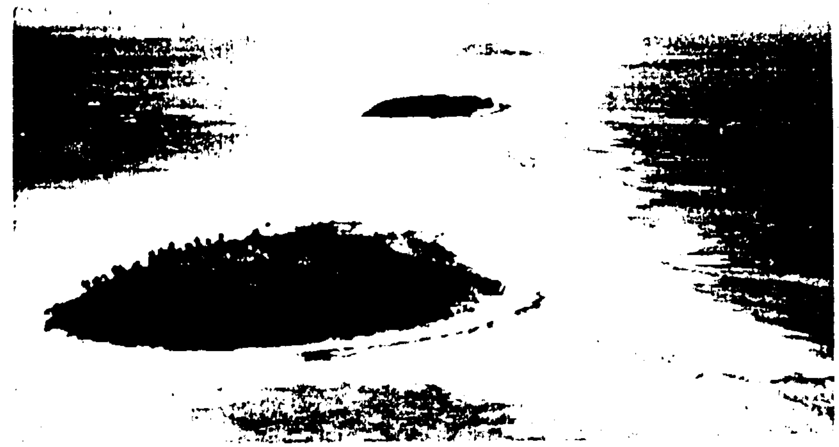


FIGURE 1-12. BOKENELAB (MARY), TAIWEL (PERCY), KIDRINEN (LUCY), MIJIKADREK (KATE), AND ENJEBI (JANET).

FIGURE 1-13. BOKEN (IRENE) AND BOKAIDRIKDRIK (HELEN).

FIGURE 1-14. BOKINWOTME (EDNA), LOUJ (DAISY), BOKOMBAKO (BELLE), KIRUNU (CLARA), AND BOKOLUO (ALICE).

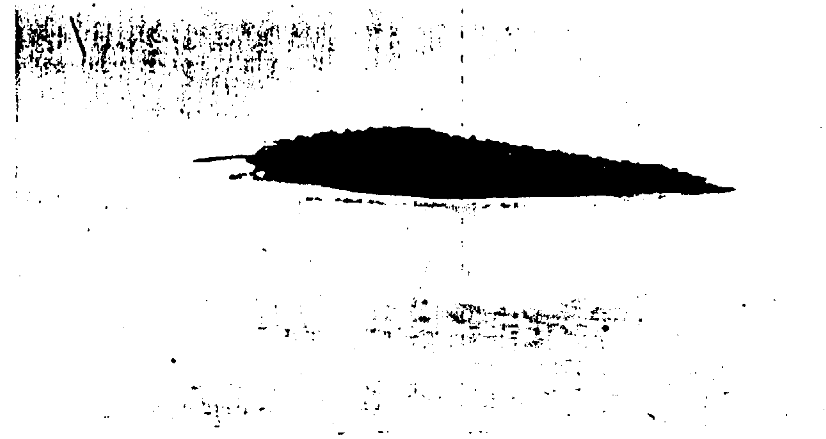


FIGURE 1-15. BIKEN (LEROY).

FIGURE 1-16. KIDRENEN (KEITH), RIBEWON (JAMES), BOKEN (IRWIN), MUT (HENRY), AND IKUREN (GLENN).

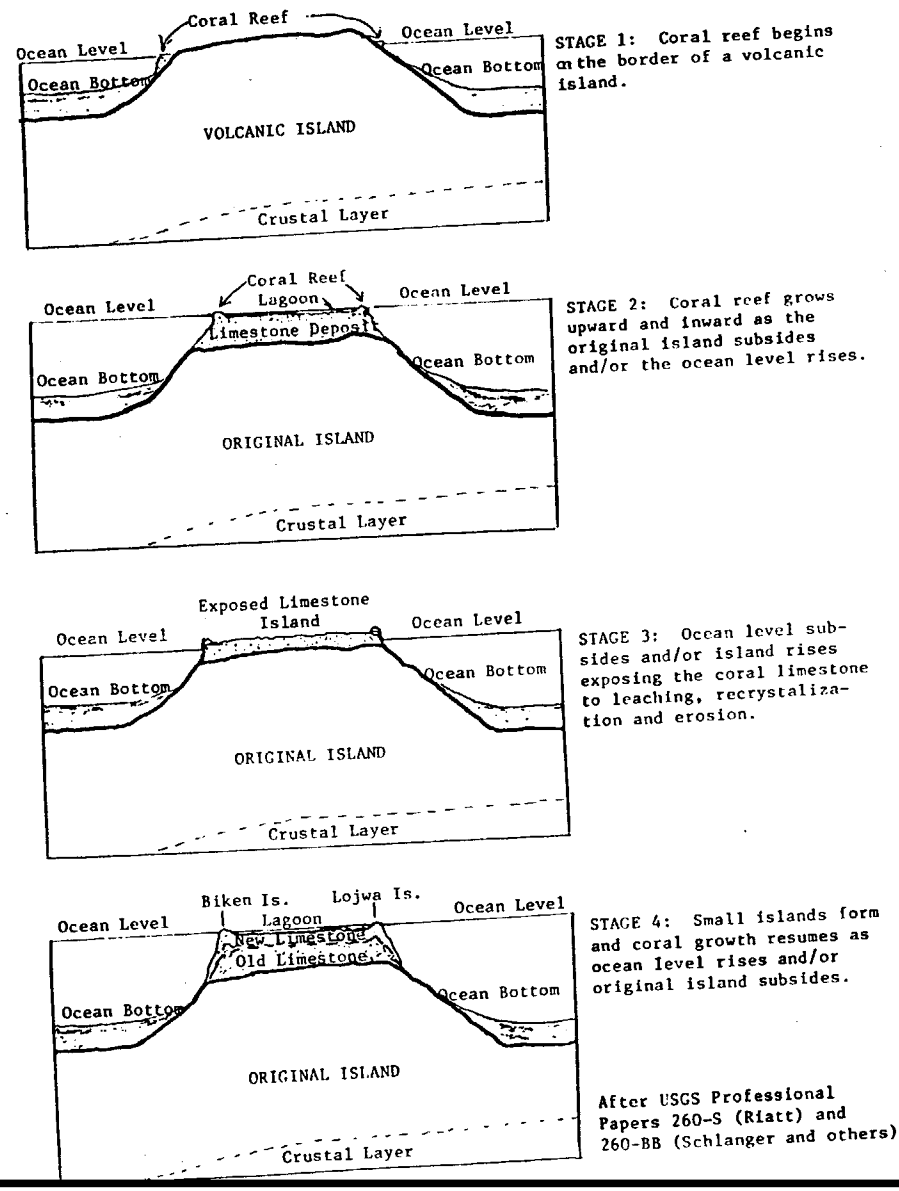


FIGURE 1-17. EVOLUTION OF ENEWETAK ATOLL.

exposed, lateral growth is promoted. Erosion of the coral and cementation of the resulting sediments also affect the formation and geology of the atoll. Enewetak Atoll has been forming for at least 43 million years, resulting in a 4,500-foot stratification of reef-derived carbonate deposits.

Several drilling programs have been conducted to determine the subsurface composition and deposition of Enewetak Atoll. The Atomic Energy Commission (AEC) and Los Alamos Scientific Laboratory drilled 33 holes less than 200 feet deep during 1950-51. The U.S. Geological Survey (USGS) drilled three deep holes, two to the basalt (volcanic rock base), during 1951-52.[6] An additional 174 shallow core holes were drilled in support of Defense Nuclear Agency (DNA) programs[7] to understand the near subsurface geology (less than 300-foot depth) of the atoll in 1972-73.

Based on results of the USGS and DNA drilling programs, the subsurface geology of the atoll is found to be both laterally and vertically variable. In general, the ocean-side reef consists of well cemented limestone, whereas the backreef and lagoon sediments consist of uncemented coralline sands and gravels derived from the ocean reef organisms and the many patch and pinnacle reefs in the lagoon. Holes drilled near the ocean reef edge penetrated predominately moderate to well cemented sediments, whereas holes near the lagoon penetrated predominately uncemented to poorly cemented sediments. This correlation between surface and subsurface distribution of rock types is indicative of little lateral shifting of the reef and associated deposited environment during the past few million years.

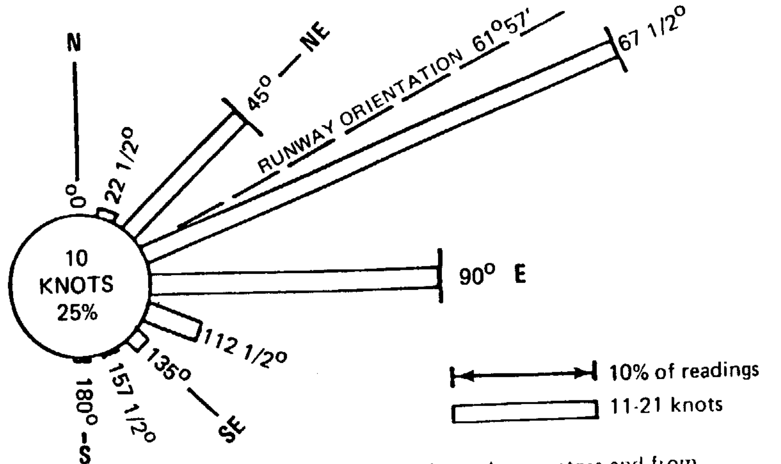
A generalized geologic profile beneath the islands is as follows: unconsolidated coralline sands and gravels between the island surface and the intertidal zone; within the intertidal zone, a layer of well cemented coralline beachrock from a few inches to 8 to 10 feet thick is found. Recent coralline sands and gravels exist between the beachrock and 45-foot depth, whereas an alternating sequence of cemented and uncemented coralline sands and gravels exist to 600 feet.[8] Between 600 and 1,000 feet the sediments again are composed of uncemented coralline sands and gravels, and between 1,000 and 1,200 feet cemented coralline sands and gravels are encountered. Beneath 1,200 feet and to the top of the basalt, the sediments are predominately uncemented coralline sands and gravels with occasional cemented layers.

CLIMATE

Enewetak's climate is of the tropical marine type with temperatures ranging from 71°F to 94°F and humidity in the 73 to 80 percent range.

There is much cumulous cloud cover, a moderate rainfall of 57 inches mean annually, and fairly constant northeasternly trade winds of 0 to 30 knots. A wind rose is shown in Figure I-18.

Most depressions, tropical storms, or typhoons occur in the months of September through December, although they are possible at any time of year. Typhoons are not common but do occur, resulting at times in severe damage.[9]



Note: Wind directions (given in degrees) are along vectors and from outer end toward the center.

25% of all wind velocity readings are at 10 knots or less.

Percentage of readings of velocities of 11-21 knots are indicated by length of vector, e.g. 35% of the time, winds of 11-21 knots will blow from ENE (67½°).

FIGURE 1-18. ANNUAL AVERAGE WIND DIRECTION AND VELOCITY.

HYDROLOGY

Enewetak Atoll must rely upon rainfall as its only source of fresh water. As the soil is extremely porous, drainage of rainwater by downward percolation takes place rapidly. The percolated water interfaces with the marine groundwater that has infiltrated through the porous rock from the sea and lagoon. Fresh water, when poured on an open body of salt water spreads rapidly over the surface of the denser salt water and the two become thoroughly mixed through current and wave action. Porous rock, such as that found under the islands of Enewetak, imposes an obstacle to this rapid spread and restricts the mixing. On a roughly round-shaped island of uniform permeability, the body of fresh water floating upon the

salt water assumes a lenticular or lens-shaped cross section, the edges of which are about at the edges of the island. These lenses serve as a secondary source of potable though brackish water during dry periods when rainwater reservoirs are nearing exhaustion. Figure I-19 is a chart of mean monthly rainfall showing the potential water deficit of the dry period of the year.[10]

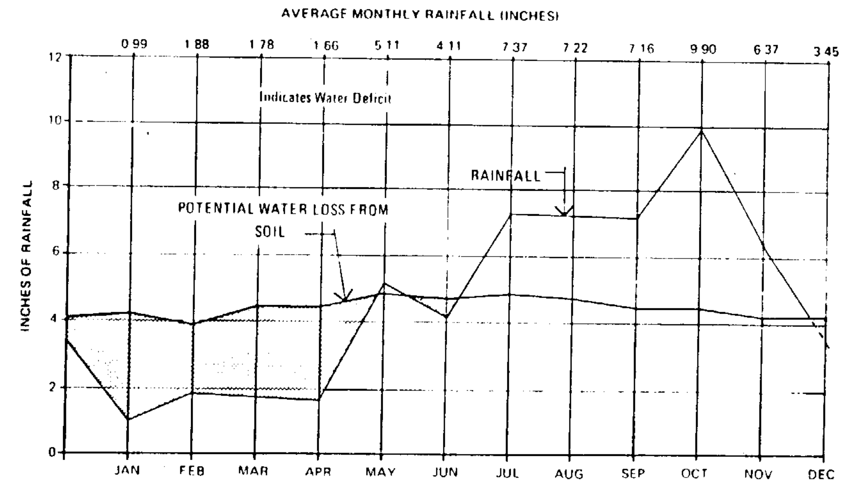


FIGURE 1-19. MEAN MONTHLY RAINFALL OF ENEWETAK ATOLL.

FLORA AND FAUNA

The types and quantities of flora found on the atoll would depend very greatly on the period in history under consideration. For example, before their introduction by German entrepreneurs in the 19th century, there were few coconut palms growing on the atoll. When they were planted to become the source of copra, they became the most conspicuous, if not the most numerous, of the plants to be found on Enewetak. Later, the number of all trees, shrubs, and bushes would be greatly affected by invasion, nuclear weapons testing, and cleanup.

Since Enewetak is located in the northern and drier section of the Marshalls, it does not have dense, lush, damp forests, and the native flora is not large in size or in variety. According to St. John, the indigenous flora totals 42 species. Of these, four are endemic, all being of the genus pandanus. Food crops and ornamentals amount to 26 in number and adventive weeds to 27. Altogether, the living flora totals 95 species. In addition, there are seven species known only by drifted seeds on the beaches.[11]

The most numerous of the larger native plants, other than coconuts, were Scaevola and Messerschmidia (Figures 1-20 and 1-21), the first classified as a large shrub and the second as a tree. Scaevola was the most abundant shrub, especially near the shore. Its leaves had some medicinal value. Messerschmidia is a small tree with edible leaves. The reported maximum height of both plants was 20 feet. The less common Pisonia grew to heights of 35 to 40 feet. These plants were to exert considerable influence on the effort required during cleanup.[12]

The larger plants of the atoll served primarily as windbreaks and as nesting places for fish-eating birds. The latter bring to the islands much needed materials, especially phosphorus, in the form of guano. Smaller plants, such as the creeping morning glory, act as a binder to hold the sand in place.[13]

FIGURE 1-20. SCAEVOLA PLANT.

Food producing plants which have been cultivated on Enewetak in the past include coconut, breadfruit and pandanus (Figure 1-22 to 1-24). Coconut also was a cash crop in the form of copra, the dried meat of the coconut. Vegetable and crop plants which have also been grown on the atoll are tomatoes, chinese cabbage, arrowroot, sorghum, onions and radishes. Most of these were not native to the islands but had been imported by German or Japanese residents.[14]

FIGURE 1-21. MESSERSCHMIDIA PLANT.

FIGURE 1-22. COCONUT PALM GROVE.

FIGURE 1-23. BREADFRUIT.

FIGURE 1-24. PANDANUS TREE.

The fauna of Enewetak may be divided, for convenience, into three groups according to their habitat: sea, land, or air. Certainly, the sea life is the most numerous in variety and number. In 1953, there were some 700 species of fish alone reported in the waters of the lagoon and surrounding ocean.[15] In addition to fish, edible sea fauna includes crabs, lobsters, sea turtles, clams, and oysters.

Besides domesticated dogs, mammals are limited to three species, two of rats and one house mouse. Reptiles include at least four species of geckoes, three skinks, a blind snake, and a monitor lizard introduced by the Japanese to control rats. The turtles are the green and the hawkbill, both inhabitants of the sea. Invertebrates include snails, nocturnal crabs, centipedes, scorpions, spiders, and other insects of considerable variety including cockroaches, scale insects, termites, fruit beetles, fruit flies, ants, and others.[16]

Thirty-two species of birds have been reported from Enewetak Atoll including seabirds, shorebirds, a heron, a cuckoo, and domestic fowl. Of these, nine are definitely known to breed on the islands, and six others are suspected to do so but have not been observed with nests or young birds.[17] Some of these birds serve as food sources in the form of meat or eggs. It will be recounted later in this documentary how concern over the nesting of one species of bird delayed progress in cleaning up contaminated soil. Figure 1-25 illustrates the density of bird population on one island of the atoll.

FIGURE 1-25. SEA BIRDS ON BOKEN (IRENE) ISLAND.

PEOPLE

Most anthropologists are of the opinion that the Marshalls and other islands of Micronesia were settled by people who migrated from the area of Indonesia into the insular Pacific centuries ago. Reflecting the ancient migration patterns in Oceania, the Marshallese language belongs to the large Malayo-Polynesian language family which spreads from Madagascar, through the Indonesian area, and across Micronesia, Polynesia, and most regions of Melanesia. Physically, the Marshallese are relatively short in stature and of stocky build. They have brown skin, brown eyes, broad flat noses, straight to curly black hair, and sparse body hair.[18]

According to their own oral tradition, the dri-Enewetak had always lived on Enewetak Atoll before their relocation to Ujelang in 1947. Because of the atoll's isolated location in the northwestern region of the Marshallese archipelago, the people of Enewetak had relatively little contact with other people prior to the European era. As a consequence, the language and culture became differentiated from those of other Marshall Islanders, and the people no longer identified themselves with the others. Rather, they think of themselves as a people who were separate and unique from the islanders to the east and south.[19]

The past and current accomplishments of the dri-Enewetak indicate intelligence and qualities of ingenuity, self-reliance, and hardiness which have allowed them to meet the challenge of the atoll environment, one that is quite restrictive when compared to the high volcanic islands of Oceania. Long before the advent of Europeans, the Marshallese had developed a culture which represented a sophisticated adaptation to their ecological setting. They were skilled navigators, an art which has largely been lost with the availability of travel on the vessels of foreigners, but they remain expert builders of sailing canoes and are among the world's best fishermen. To traders, missionaries, and the successive colonial governments which have dominated the islands over the past century, they have been quick to respond by learning and adjusting to each of these outsiders. Today, they have achieved a good understanding of the behavior and values of Americans, and several have distinguished themselves in government and mission schools operated by Americans.[20] Figure 1-26 portrays a typical family grouping of the Marshall Islands.

ECONOMY AND POLITICS

Throughout the Marshall Islands the traditional forms of settlement patterns and exploitation of the natural resources are characterized by several general features. The first is that the people on an atoll reside on

FIGURE 1-26. A FAMILY GROUP IN THE MARSHALL ISLANDS.

one or a few of its largest islands. The second is a mobility that is demonstrated by various extended fishing and collecting activities that embrace every niche of the environment. For example, they have a nonintensive form of agriculture in which regular expeditions are made to all islands of an atoll to make copra and collect coconuts, breadfruit, pandanus, arrowroot, and other vegetable foods in season. Clearing of brush and planting are done during these visits. Marine resources are also exploited, with a wide variety of marine animals being utilized. Special expeditions are made to collect shellfish, capture turtles, and gather their eggs, in addition to catching fish. Several species of birds are also captured as a food source. The Enewetak people may be expected to continue this way of life to some degree when they return to their home atoll, although they may remain strongly influenced in many ways by their contacts with western culture.[21] The typical outrigger canoe of the Marshallese is shown in Figure 1-27.

Historically, the people of Enewetak have been divided into two separate and distinct communities which were located on the two largest islands of the atoll. Here "community" is defined as the maximum group of persons who normally reside together in face-to-face association. One community was situated primarily on Enjebi (Janet) Island on the northern rim, and the other was located primarily on Enewetak Island across the lagoon in the southeast quadrant of the atoll. The traditional

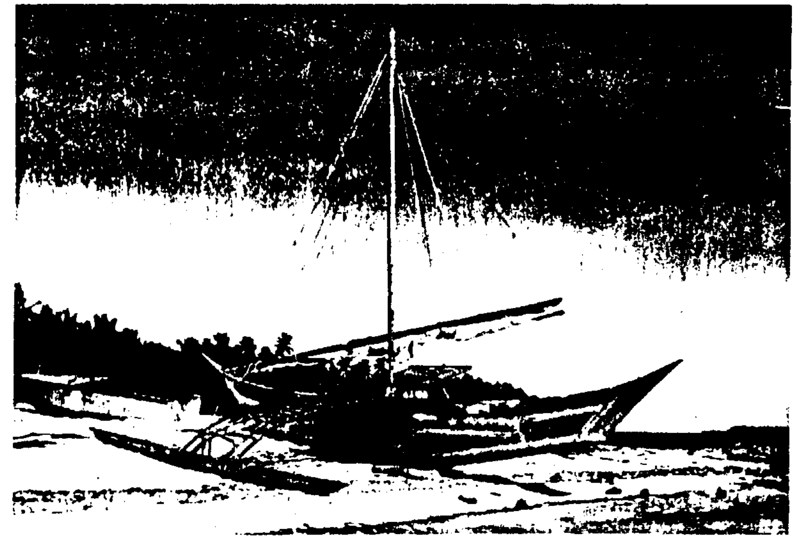


FIGURE 1-27. TYPICAL OUTRIGGER CANOE OF THE MARSHALL ISLANDS.

settlement pattern of both communities was dispersed; residences were located on separate land parcels and were scattered along the length of the lagoon beach.[22]

The sociopolitical structure of the two communities was identical. Each was headed by a hereditary iroij or chief, and succession to the office was patrilineal. The chiefs directed the affairs of their respective communities, arbitrated disputes, and consulted one another with regard to concerns of the entire atoll and the total population's relations with outsiders. The atoll was divided into two geographical areas, and each of the chiefs had authority over one of the two domains. The domain of the Enewetak chief began with the Islands of Kidrenen (Keith), Ribewon (James), Boken (Irwin), Mut (Henry), and Ikuren (Glenn) in the atoll's southwest quadrant, extended counterclockwise around the atoll up to and including Runit (Yvonne) Island, as well as Aomon (Sally) on the northeast rim. With the exception of Aomon, the Enjebi chief's domain extended north of Runit beginning with Billae (Wilma) Island and extended counterclockwise around the atoll's northern and western rim up to and including Biken (Leroy) Island.[23]

Relations between the two communities and the traditional dispersed pattern of residence were altered with the military invasion of Enewetak Atoll in 1944. Because Enewetak and Enjebi Islands had been devastated by the battle for the atoll, the U.S. Navy resettled all of the people in a compact village on small Aomon Island which, as indicated earlier, fell within the domain of the Enewetak Island chief. After several months, the people of Enjebi moved to the adjacent Bijire (Tilda) Island which was within the domain of their own iroij. With these relocations, the dri-Enjebi and dri-Enewetak were no longer separated by the atoll's large lagoon; and, while retaining their dual political structure, they had, in fact, become a single community.[24,25]

The consolidation of the population into one community and the new compact settlement pattern were continued with the transfer of the islanders to Ujelang Atoll in 1947. This atoll has only one sizeable island, Ujelang Island, and the entire population was settled there. Navy officials established a dividing line at the midpoint of the island and allotted the western half to the people of Enjebi and the eastern half to the people of Enewetak Island. A compact village was constructed in the middle of the island with the Enjebi and Enewetak people occupying houses on their respective sides of the dividing line. Later, each group divided the land on its portion of the island. At a still later date, other islands in the Ujelang Atoll were divided among members of the two groups.[26,27]

During the first few years on Ujelang, the traditional political structure remained intact. The chiefs functioned in their accustomed roles and resisted American efforts to introduce democratic institutions. It had been intended by American planners that each atoll population be governed by an elected governmental council of elders headed by an elected magistrate, but this was not acceptable to the iroijs. By the early 1960's, however, some change was observable. Both chiefs were, by then, quite aged men, who had matured in an earlier era. Some of the contemporary problems required that the decision-making process be opened to include younger men who had attended schools and/or had some other experiences with the American administration. Meetings of all males were held occasionally, and some decisions about community affairs were decided by a majority vote. The authority and status of the chiefs declined further in the later 1960's when the old Enjebi chief died and was succeeded in office by his younger brother, who was also elderly and suffered the additional disadvantage of frequent poor health.[28]

These events precipitated a major transformation of the political structure. The chiefs yielded to younger men who desired, and had been gaining, a greater voice in community affairs. In 1968, a magistrate and a council of 12 men were elected. Reflecting the traditional division of the population, the people of Enjebi elected six councilmen from among their ranks, and the people of Enewetak elected six from theirs. The magistrate became the head of the entire community, and the council became the legislative body governing the people's affairs. In a later election, the 12 councilmen were elected from the population at large, not equally from the

two groups. Thus, the current council reflects the demise of the traditional system and indicates that the old division between Enjebi and Enewetak peoples has lost much of its meaning. The council is now a representative body drawn from the entire population and reflects a unified community with acknowledged common goals. The iroijs, however, remain important figures as advisors and men of influence.[29]

RELIGION

The church is the focal point for many community social activities of the Enewetak people. The prevailing religious system is a conservative type of Protestantism in which church services, bible classes, church group meetings, and hymn singing have replaced traditional intertribal wars, sports, games, and dancing.

The minister is the spiritual leader of the community and is supported and assisted by the two chiefs. The church functions are time-consuming and require a considerable effort from the membership. Sundays, in particular, are devoted almost entirely to church services and related activities. From this, it is apparent that the church influences the life of the dri-Enewetak to a great degree.[30]

LAND USE

The atoll soil is basically coral rock and coralline sands with only minimal organic contents, so that the practice of agriculture is limited. For centuries, subsistence has been marginal and precarious for the island inhabitants, requiring hard work on their part. Despite this, the dri-Enewetak have always maintained a deep emotional attachment to their home islands and ancestral holdings. The land parcels, or "watos," on Enewetak Atoll were like those found elsewhere in the Marshalls. Most commonly, each was a strip of land stretching across an island from lagoon beach to ocean reef and varying in size from about 1 to 5 acres. The resources of all ecological zones were thus available to the individuals who held rights to the land. Less commonly, a parcel was divided into two or more portions with transverse boundaries. This usually occurred when an island, Enjebi for example, was very wide. Boundaries were usually marked by slashes on the trunks of coconut trees or, less commonly, ornamental plants. Also, other features of the natural topography, for example, large boulders on the ocean reef or the very configuration of an island, were used to fix the position of landholdings. The latter type of markers have been employed by the Marshallese after all other markings had been obliterated.[31] The map of one of the islands of Enewetak Atoll (Medren) showing wato division lines appears on Figure 1-28.

One facet of Enewetak Atoll culture that differed from that of other Marshall Islands was the system of land tenure and inheritance. In the rest of the Marshalls, matrilineal is the rule. The land tenure system at Enewetak was, in ideal and in practice, a bilateral one. In most cases, a married couple divided the land which each had inherited among their children, and a child usually received some land from both his father and mother. As the younger islanders matured, they worked the land with their parents. As the parental generation died and as members of the next generation married and produced children, the process was repeated with parents allocating land among their offspring.[32] Every individual possessed rights to some land on islands away from the settlements of Enewetak and Enjebi. All land in the atoll was held by someone, with the exception of one parcel on Enewetak Island which was donated for the location of a church.

The people resided on their landholdings on Enjebi and Enewetak Islands. In most cases, households were headed by males and were situated upon land held by them. Ideally, residence was patrilocal, i.e., upon marriage, females moved to their husband's households, although exceptions to the rule did occur.[33]

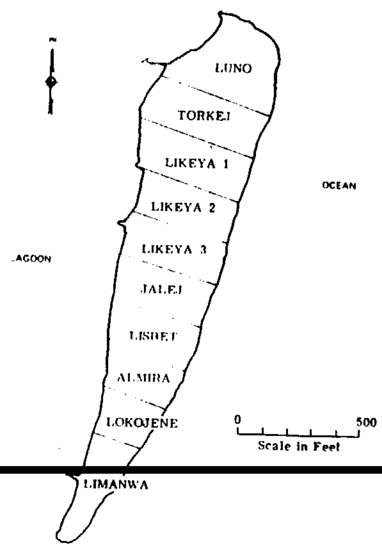


FIGURE 1-28. MEDREN ISLAND SHOWING NAMES AND BOUNDARIES OF WATOS.

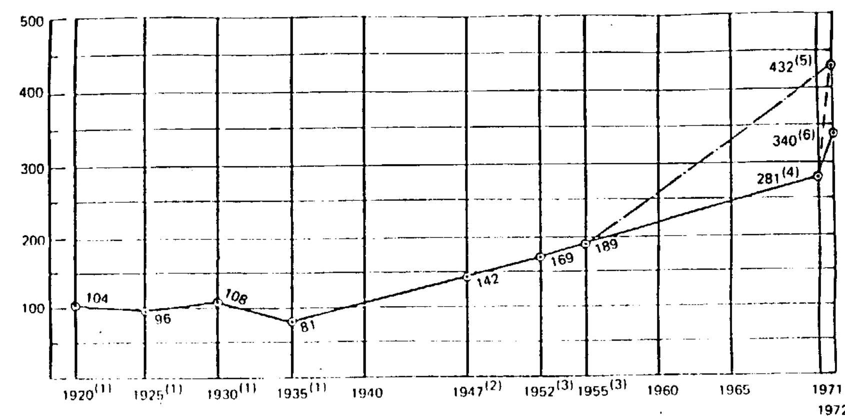
DIET

The diet of the dri-Enewetak was primarily vegetarian, based on coconuts, pandanus, and arrowroot. Breadfruit, taro, and bananas were rare, but the people learned to cultivate some of these plants on Ujelang and will probably bring them back and attempt to continue their use. There may be associated problems caused by the more northern location of Enewetak and the absence of a swamp or bog for growing taro.

The vegetable diet is supplemented by seafood, pork, and chicken, the last two locally raised. Almost all forms of sea life are favored including fish, clams, and turtles, as well as sea birds and their eggs. However, canned fish has largely replaced the fresh fish formerly taken from lagoon and ocean, and foods previously unknown, such as rice, have become staples. This will certainly affect the menu after their return to the atoll.[34]

POPULATION

The growth trend of the Enewetak people from 1920 to 1972 is shown in Figure 1-29. The reduction in population from 1930 to 1935 can be explained partially by the fact that members of the community left the atoll



SOURCE:
(1) Japanese Consul-General, Honolulu (1966).
(2) U.S. NAVY (at the time of relocation to Ujelang).
(3) J. A. Tobin (on Ujelang).
(4) TTPI Official Census (on Ujelang only).
(5) J. A. Tobin (Total – Ujelang & elsewhere).
(6) J. A. Tobin (on Ujelang only).
Data from J. A. Tobin – 1973.

FIGURE 1-29. POPULATION TRENDS OF THE PEOPLE OF ENEWETAK, 1920-1972.

for extended periods at different times to work on the copra plantations on Ujelang and to visit the administrative headquarters on Ponape. Likewise, subsequent increases in population can be attributed to the return of the Ujelang workers accompanied by Ujelang spouses. It should be noted that the 1971 Trust Territory of the Pacific Islands (TTPI) official census of 281 and the 1972 census of 340 taken by J. A. Tobin include only those people of Enewetak in residence on Ujelang at the time. The 1972 figure of 432 includes these people as well as those residing elsewhere.[35,36]

Estimates based on available census data indicate a growth rate of the Enewetak people from 1948 to 1973 of approximately 6 percent per year. Figure 1-30 depicts projected population growth curves based on rates of growth of 3 percent, 5 percent, and 7 percent. If actual population growth lies within this range, these curves show that, in 1983, the population may be between 600 and 900 persons. Limitations on food supply or other resources might reduce population growth below the minimal curve of the chart, and, at some further time, the growth curve might tend to stabilize. At this time, however, there is insufficient data for an accurate projection.[37]

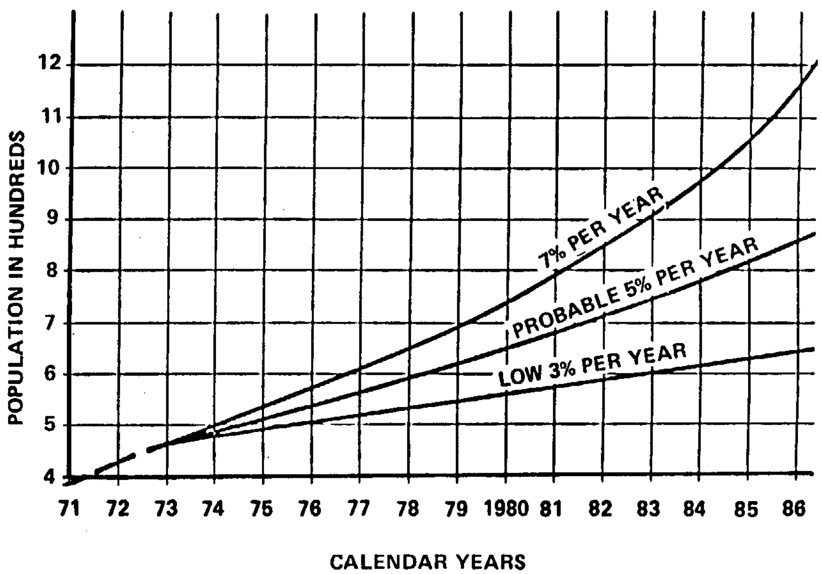


FIGURE 1-30. PROJECTED POPULATION CURVES, 1972-1986.

DISCOVERY ERA: 1526 - 1886

The recorded history of Enewetak begins in the 16th century and may be divided into four distinct eras. The first of these was the era of discovery dating from 1526 to 1886. This was followed by the German Protectorate from 1886 to 1914, the Japanese Mandate from 1914 to 1944, and the United States Trusteeship from 1944 to its expected expiration in 1981. The atoll was first reported as sighted by Spanish explorers in 1526. Three years later, a landing was made on Enewetak by Alvaro de Saavedra in October 1529. It was rediscovered on 13 December 1794 by Captain Thomas Butler who was engaged in the China trade. The atoll was given the name "Browne's Range" for a Mr. Browne, one of the associates in the firm employing Captain Butler. The name persisted, being used by the Japanese and even appearing on recent U.S. Hydrographic charts, although the "e" had been dropped and the islands had become "Brown Atoll." According to one source, the name Enewetak means "Land between West and East," but this is uncertain.[38]

GERMAN PROTECTORATE: 1886 - 1914

In 1886, Germany established a formal protectorate over the Marshall Islands. The people of Enewetak, as well as other Marshallese, were given coconut seedlings by German traders and instructed in the growing, gathering, and converting of the meat of the coconut into copra. The Germans were also interested in whaling and established the Jaluit Company, a trading organization. Political and commercial administration was merged with the imperial administrator acting as the company's chief official in residence. However, the atoll, being isolated, did not have much direct contact with the central government, and visits by foreigners were discouraged.[39,40] German control was, on the whole, benign, and it did not arouse much antagonism in the Marshallese. Roads were built, health and sanitation were improved, and the islands were searched for potential sources of economic wealth. The Germans provided the islanders with protection from unscrupulous traders and helped them to enter the culture of the Western world.[41]

JAPANESE MANDATE: 1914 - 1944

At the beginning of the First World War, Japan seized Enewetak, the other Marshall Islands, and all other German possessions in Micronesia.

When that war was concluded, Japan, having been on the side of the victorious Allies, was awarded the islands lying north of the equator by the Treaty of Versailles. This was in the form of a mandate to control and develop these islands, but not to fortify them.

The Japanese established the South Seas Bureau with headquarters at Kolonia in Ponape, and divided the mandated territory into six districts, one of which was the Marshall Islands. Visits to Enewetak were made by the Japanese Navy and by Japanese traders. Both Enewetak and Ujelang were administered from Ponape, and the only foreign residents on Enewetak were a Japanese trader and his two assistants. A weather station was established there in the 1930's, but other Japanese associations with the atoll languished.

Early in World War II, the Japanese set out, contrary to the terms of the mandate, to make Enewetak Atoll a strategic base in their planned conquest of the Pacific. Japan maintained a guard unit of about 20 men on Enjebi until December 1942, when construction workers arrived to construct an airstrip. This was completed in July 1943, and, in October, the detachment at Kwajalein was moved to Enjebi to act as a maintenance force. In January 1944, 110 aviation officers and men were billeted on Enjebi, and 2,686 soldiers were landed on Enewetak to prepare the defense on the atoll. These were placed on Enjebi, Medren, and Enewetak. About 1,000 laborers and other noncombatant personnel were also present. The aviation personnel were to be evacuated to Truk by flying boat but, for most of them, this operation was begun too late.[42] Noting the preparations for battle, the 30 dri-Enewetak inhabitants of Enjebi moved to islands on the eastern reef.

BATTLE OF ENEWETAK: FEBRUARY 1944

The original U.S plan for invading the Marshalls included amphibious assaults on strongly defended atolls of the Ratak or eastern chain in order to secure airstrips there. Air reconnaissance in December 1943 showed the construction of a Japanese airstrip on Kwajalein Island, so plans were altered to bypass Wotje, Maloelap, and Mili on the Ratak Atolls, and to attack the north and south ends of Kwajalein Atoll simultaneously. Planning included the capture of Majuro Atoll which was very lightly defended. After securing Kwajalein, Enewetak was to be attacked.

The Marshall Islands operation was code-named "Flintlock" and was under the overall command of Vice Admiral Raymond A. Spruance. The capture of Enewetak was considered to be a preliminary step to landing on Truk farther west and was code-named "Catchpole." Many of the lessons learned in the previously completed campaign to capture the Gilbert

Islands were employed in the assault on Kwajalein. This included heavy naval bombardment by battleships, use of infantry landing craft to saturate the landing beaches with high explosive fire, use of tracked landing vehicles to transport assault infantry across the coral reefs to dry beaches, and establishment of field artillery on lightly held islands adjacent to the objective islands to provide close-in artillery support for the main assault groups. The result at Kwajalein Atoll was the capture of Roi-Namur in the north and Kwajalein Island in the south, with the loss of 372 killed and 1,582 wounded. The enemy strength was estimated to be 8,675, of which only 265 remained alive to be taken prisoner and, of these, 165 were Korean laborers. The seizure of Enewetak Atoll was to follow immediately after.[43]

The Enewetak Expeditionary Group was commanded by Rear Admiral Harry W. Hill. The assault troops were under Brigadier General Thomas E. Watson. The plan was to complete the occupation in four phases. Phase One was the seizure of two islets south of Enjebi—Aej (Olive), and Lujor (Pearl)—where field artillery would be emplaced. Phase Two was the landing on Enjebi by Marines, supported by the emplaced field artillery. Phase Three was to be the seizure of Enewetak Island and Medren. Phase Four was a mopping-up operation of the remaining islands to rid them of any remaining Japanese.[44] The map in Figure 1-31 shows the location of these events.

At 0700 hours on 17 February 1944, minesweeping began and was followed by the entry of troop transports into the lagoon. Phase One was completed by 1632 hours with the positioning of Marine and Army artillery on Aej and Lujor. Marine scout company landings on Enjebi took place at 0315 hours on 18 February, and the island was secured by 1600 hours. The third phase, the capture of Enewetak and Medren Islands, began on the morning of 19 February with the 106th Infantry landing on Enewetak Island. The island was not pronounced secure until 1630 hours on the 21st. In the meantime, Marine artillery had landed on Japtan, and guns emplaced there and on Enewetak were registered on Medren by 1200 hours on 20 February. Marines landed on Medren at 1900 hours on the 22nd, and Phase Three was completed by 1930 hours of the same day.[45] Figures 1-32 and 1-33 show some of the action during the battle.

In conducting Phase Four, no opposition was met in landing and occupying the other islands of the atoll. All action had ceased by the evening of 23 February 1944. The toll of the battle is shown in Figure 1-34. Only 64 Japanese were taken prisoner, some of whom were wounded. Most had died fighting.[46] Fifty dri-Enewetak were found on D+1 by American troops and were sheltered in a huge bomb crater. Other people found later in the battle were brought there also, including 17 from Medren. On 24 February 1944, all of the surviving people were moved to

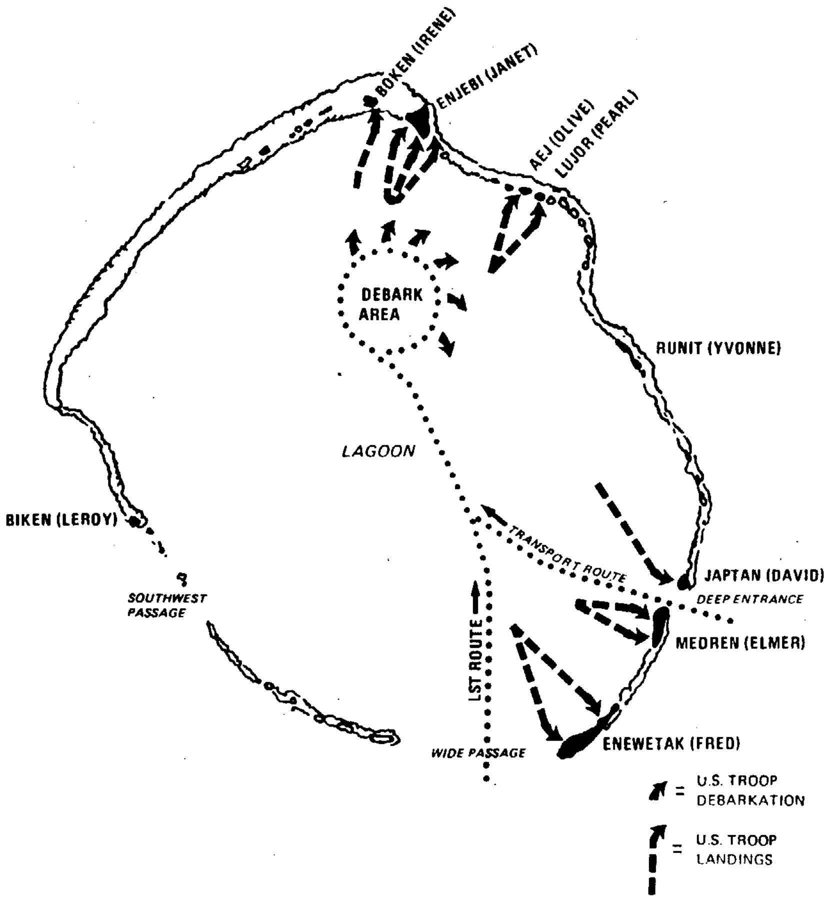


FIGURE 1-31. OPERATION CATCHPOLE—THE SEIZURE OF ENEWETAK ATOLL, 17-23 FEBRUARY 1944.

FIGURE 1-32. U.S. MARINES SEARCHING FOR SNIPERS, ENEWETAK ATOLL.

FIGURE 1-33. MOPPING UP AFTER THE BATTLE, ENEWETAK ATOLL.

	AMERICAN		JAPANESE		
	Killed & Missing	Wounded	Killed & Burial Count	Prisoners	Total
Enjebi Is.	85	166	934	16	1201
Enewetak Is.	37	94	704	23	858
Medren Is.	73	261	1027	25	1386
Other			12		12
	195	521	2677	64	3457

FIGURE 1-34. CASUALTIES IN THE CONQUEST OF ENEWETAK ATOLL.

Aomon, where a few houses and some coconut trees were still standing. The total number of people gathered on Aomon was 117; 18 had been killed during the battle.

After its capture, Enewetak was used primarily as a support or staging area. A 7,000-foot bomber strip was laid down on Enewetak Island. Little or no attempt was made to clean up the debris resulting from the invasion. The beaches contained many rusting hulks of landing craft, tanks, and other vehicles. Ammunition, mortars, and other implements of war littered the land and the reefs. The coconut trees of the islands, which had been bombarded and assaulted, were largely destroyed.[47]

Years later, Iroij Johannes Peter spoke of the battle—the airplanes, the bombs, the fears, the wounded, and the dead. He recalled that these had been very sad times.

After the surrender of Japan, all small naval vessels moving through the Marshalls picked up and carried repatriates back to their home islands. Those who returned to Enewetak Atoll found that the U.S. military forces had placed all people from Enjebi and Enewetak Islands on Aomon in the northeastern part of the atoll chain. The U.S. Navy provided building construction materials, food, and water.[48]

The dri-Enjebi were not content with dwelling on Aomon because, in spite of its northern location, it was under the authority of the iroij of the dri-Enewetak. Consequently, the dri-Enjebi were moved to the neighboring island of Bijire.[49,50] Their stay there was also brief due to major events in other parts of the world.

THE NUCLEAR AGE BEGINS: JULY 1945

The nuclear age arrived with the detonation of an atomic bomb on 16 July 1945 near Alamogordo, New Mexico. That test, known as the Trinity Event, was part of the Manhattan Project organized to develop the military application of atomic energy. In August of the same year, two nuclear

bombs were dropped on the Japanese cities of Hiroshima and Nagasaki, thereby accelerating the end of World War II.

While the use of nuclear weapons already had modified military concepts of war, they still needed further study and development if their full capabilities were to be realized. Interest in their development was shared by the scientific community and the general public as well as the military establishment.

On 10 November 1945, a subcommittee of the Joint Chiefs of Staff (JCS) began developing detailed plans for a series of tests of existing and newly developed nuclear weapons. The tests were to be conducted under very carefully controlled conditions and as a matter of primary concern, were to explore the effects of atomic explosions on naval vessels. The subcommittee proposed a program to be headed by Vice Admiral William H. P. Blandy, Deputy Chief of Naval Operations for Special Weapons. The program was accepted by the JCS, generally as proposed, on 28 December 1945 and approved by President Truman on 10 January 1946. The organization for conducting the program was identified as Joint Task Force One (JTF-1).[51]

An important objective of the program was to obtain and prepare an appropriate test site. Locations in the Atlantic, Pacific, and Caribbean had been considered even before the Task Force came into existence. The basic site requirements were that:

a. It be under the control of the United States.
b. The area be uninbabited or subject to evacuation without imposition of unnecessary hardship on a large number of inhabitants.
c. It be within 1,000 miles of the nearest B-29 aircraft base, as it was expected that one test nuclear device was to be delivered by air.
d. It be free from storms and extreme cold.
e. It have a protected harbor at least 6 miles in diameter thereby being large enough to accommodate both target and support vessels.
f. It be away from cities or other population concentrations.
g. The local winds be predictably uniform from sea level to 60,000 feet.
h. The water currents also be predictable and not adjacent to inhabited shorelines, shipping lanes, and fishing areas so as to avoid contaminating populaces and their food supplies.[52,53]

Several atolls in the Marshall Islands met all of these requirements to a satisfactory extent. The Marshalls had been captured from the Japanese and, by Presidential authority, were under the control of the U.S. Navy military government.

OPERATION CROSSROADS: JUNE-JULY 1946

Bikini Atoll was the one chosen as the site of Operation Crossroads, which was to be the occasion of the first peacetime detonations of nuclear weapons. The climatic, wind, current, and harbor size requirements could be met. The selection was influenced by the fact that the population of the atoll was small and could be relocated easily and that Bikini was close to Kwajalein and Enewetak Atolls, both of which held military support facilities. Under the Presidential authority, the Navy also relocated the people of Enewetak to Meik Island in Kwajalein Atoll while the Bikini tests were being conducted.[54,55]

Three tests were planned for Operation Crossroads, two of which—Able and Baker—were eventually carried out. The first of these was an aerial drop, and the second an underwater shot. The bombs were similar to those which had been used against the Japanese cities and which had produced yields of 13 KT at Hiroshima and 23 KT at Nagasaki.

The yield, stated in KT (thousands of tons), expresses the explosive equivalent of a weight of TNT. For example, a nuclear bomb having a yield of 25 KT would have the same explosive force as a single explosion of 25,000 tons of TNT. A "nominal" yield was one approximately equivalent to that of the bombs used against the Japanese cities.

Test Able occurred on 30 June 1946. The bomb was dropped from a B-29 aircraft and exploded about 500 feet above the lagoon surface. The bomb detonated 1,500 feet west of the center target vessel. The vessel did not sink, but five other vessels were sunk and others were burned or damaged. The sunken ships were two attack transports, two destroyers, and a Japanese light cruiser.[56] The yield of the nuclear device of Test Able was 23 KT.

Test Baker was performed with a nuclear device suspended 90 feet below a landing ship in the center of another array of ships in the lagoon. At detonation, a hollow column of water rose to a height of a mile above the surface of the lagoon. The U.S. battleship ARKANSAS, the aircraft carrier Saratoga, and the Japanese battleship Nagato were sunk, as well as other surface vessels and submarines. Some sank immediately and others took from 7-1/2 hours to 5 days to sink.[57] Test Baker also yielded the equivalent of 23 KT of TNT.[58]

Although these tests were successful, Bikini itself demonstrated a number of deficiencies as a test site. One was the lack of land area, which necessitated the use of surface vessels for planning, administration, scientific laboratory work, and for life support. A second was the combination of island orientation and wind direction, which prevented the installation of an adequate airstrip.

ESTABLISHMENT OF AEC AND AFSWP

The passage of the Atomic Energy Act of 1946 resulted in the restructuring of the Manhattan Project organization. Responsibility for future atomic development was assigned to the AEC, a new civilian agency. Most of the Manhattan Project scientific personnel and laboratories went to the AEC. The Manhattan Project itself was renamed the Armed Forces Special Weapons Project (AFSWP) and remained a military organization. The AFSWP has been renamed twice, as the Defense Atomic Support Agency in 1959 and as the Defense Nuclear Agency in 1971. The first head of this organization was Major General Leslie R. Groves, USA, who had directed the Manhattan Project. He was named Chief, AFSWP on 28 February 1947 and Rear Admiral William R. Parsons, USN, became his deputy. RADM Parsons also had participated in the Manhattan Project and was bomb commander aboard the plane, the "Enola Gay," that dropped the first atomic weapon on Hiroshima. He had also served as Commander, JTF-1, at Bikini Atoll.[59]

The U.S. Army Element of the Manhattan Project at Los Alamos Scientific Laboratory was Company C, Santa Fe Detachment, 38th Engineer Battalion, U.S. Army Corps of Engineers. In the spring of 1947, it was relocated to Sandia Base, near Albuquerque, New Mexico, and established as Field Command, AFSWP, the principal operating element of the project. Later in the year, U.S. Air Force and Navy personnel were assigned, making AFSWP a joint service command. As the central coordinating agency between civilian and military interests in atomic development, AFSWP provided staff and technical assistance to the Secretary of Defense; overall surveillance, storage, and maintenance of the nuclear weapons stockpile; technical, logistics, training and stockpile management support to the Military Services; and, direction of the Department of Defense (DOD) weapons effects test programs. During overseas test operations, JTFs were formed at Sandia Base under the direction of the Chief, AFSWP. Military Service elements were assigned to the JTF to provide support at the proving grounds.[60] The first AFSWP JTF was formed under the command of Captain T. A. Hederman, USN, to conduct a resurvey of Bikini Atoll following Operation Crossroads.[61]

ESTABLISHMENT OF ENEWETAK PROVING GROUND: JULY-DECEMBER 1947

Meanwhile, action was being taken in the United Nations (U.N.) to place the Pacific islands, which Japan had administered under a League of Nations mandate, under the trusteeship of the United States. In

November 1946, President Truman announced that the U.S. was prepared to place the islands under trust. The agreement establishing the TTPI as a strategic area trusteeship was approved by the U.N. Security Council on 2 April 1947 and by President Truman on 18 July 1947. Under the agreement, most of Micronesia was placed under the administration, legislation, and jurisdiction of the United States.[62] The Department of the Interior became the executive agency of the United States, relieving the Navy of its interim control. The United States was to take all appropriate measures to advance the interests of the people of the TTPI and, additionally, the U.S. was authorized to establish military bases in the TTPI.

Concurrently with the establishment of the TTPI, action was being taken by the AEC to establish a nuclear test site at Enewetak Atoll. The AEC had studied several possible locations including island sites in the Indian Ocean, Alaska, and Kwajalein Atoll, as well as in the continental U.S. Bikini Atoll islands were neither large enough nor properly oriented for construction of a major airfield and support base. The AEC selected Enewetak Atoll and, upon approval of the proposal by President Truman, requested that the Military Services prepare the Enewetak Proving Ground and provide logistical support.

On 18 October 1947, JTF-7 was activated under the command of Lieutenant General John E. Hull, USA, to prepare the proving ground and to conduct the next series of nuclear tests, Operation Sandstone. The selection of Enewetak as a proving ground necessitated the removal of the people once again, this time to Ujelang Atoll to the southwest of Enewetak.[63] On 21 December 1947, 136 dri-Enewetak were transported to Ujelang to begin their long residence on that Atoll.

Ujelang lies 124 miles southwest of Enewetak. It had been inhabited by Marshallese, but a typhoon in the late 1800's swept over the atoll and killed all but a few of the inhabitants. The survivors moved to the southern Marshalls, leaving the atoll deserted.

During the German and Japanese colonial eras, the atoll was developed as a commercial copra plantation, with a small group of islanders from the Eastern Carolines serving as paid laborers. In World War II, it was again abandoned. When the U.S. obtained the TTPI, Ujelang became available for the relocation of the populations of other atolls.[64,65]

Ujelang is much smaller than Enewetak, containing less land and less lagoon areas. The lagoon is only 25.47 square miles in extent, compared with Enewetak's 387.99 square miles. The land area is 0.67 square miles or 428 acres, of which only 274 acres are usable. Enewetak has 2.75 total square miles, or about 1,761 acres of land. From these figures, it is possible to see that the potential for the production of food at Ujelang from the reefs, lagoon, and land was considerably less than that at Enewetak. The

limited food potential on Ujelang has made it necessary to import more commodities than might normally be required on Enewetak.[66,67]

"Inem jen jab inebata bwe ankilan Anij."
(But we do not worry for it is the will of the Lord.)
In this way was the attitude of the people of Enewetak expressed.[68]

LIVING ON UJELANG

A village for the people of Enewetak was constructed by the U.S. Navy on the main island of the atoll. Figure 1-35 is a map of the atoll giving the village location. A brush clearing program also had been in progress at the time they arrived on the atoll. The coconut trees planted by the Germans and Japanese still were bearing, and breadfruit and pandanus seedlings had been brought in and planted.

Ujelang was provided a water system, including numerous rain catchments, a church, a council hall, a school, and a dispensary. Supply ships brought in tools, clothing, and food to supplement the meager natural resources. There was, however, no U.S. official remaining on the atoll, and there was no means of communication with the outside world.[69,70]

The people continued to practice nonintensive agricultural operations while utilizing the environment extensively. Coconut was converted into copra for cash sale, and consumer goods were purchased with the proceeds. Interest payments were received from a trust fund provided by the TTPI. Rice, flour, sugar, canned meats, and other canned goods originally were additions to the traditional Enewetak diet, but they had all become staple items over the years. Marine resources were extremely important in the diet of these people, with fish, clams, lobsters, turtles, and sea birds, as well as land animals (domesticated chickens and pigs), continuing to provide the required protein. Coconuts, pandanus, breadfruit, and arrowroot were still the principal vegetables used. Bananas, papayas, and squash were not prominent in the diet because they did not grow well in Ujelang (although better than on Enewetak).[71,72] Figures 1-36 and 1-37 show scenes of the village on Ujelang.

Perhaps the most profound effects of the experience of residing on Ujelang have been in two directions, each related to the style of living of the people of Enewetak. One was in the location of houses and the relationship with other people. On Enewetak, family groups lived scattered along the lagoon shore on watos running, in most cases, from lagoon to ocean. On Ujelang, dwellings were close together and, aside from the area immediately surrounding the house, the land appears to have been held in common.[73,74]

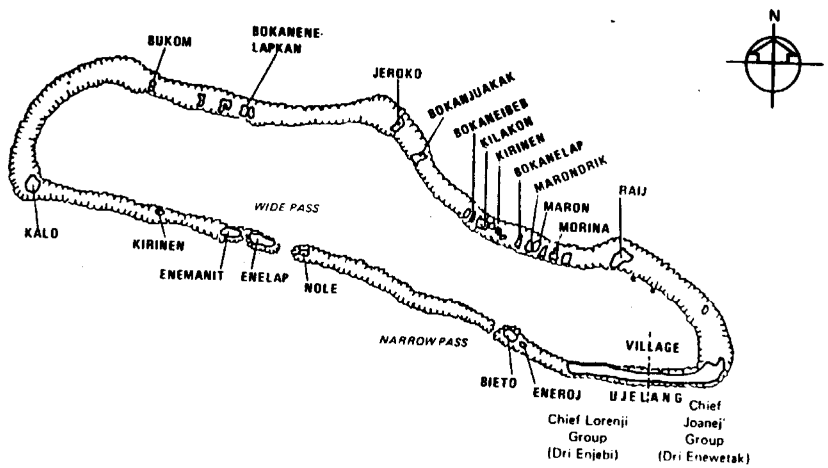


FIGURE 1-35. UJELANG ATOLL SHOWING RESIDENCE ISLANDS.

FIGURE 1-36. DWELLINGS ON UJELANG ISLAND.

FIGURE 1-37. FOOD PREPARATION ON UJELANG ISLAND.

The other drastic change in the lives of the people was the close proximity in which the dri-Enewetak and dri-Enjebi were compelled to live. Traditionally, a distance of more than 20 miles separated the two communities except for a brief period on Aomon. On Ujelang, they occupied two sides of an arbitrary line which had no real significance. One effect of this was more intermarriages and a corresponding increase in crossed land rights, so that the dri-Enjebi acquired more rights in the south than ever before, and vice versa. However, this did not affect the strong desire of the dri-Enjebi to possess a residence on their traditional island.

OPERATION SANDSTONE: APRIL-MAY 1948

Operation Sandstone was conducted by JTF-7, under the command of LTG Hull. The Task Force included Army, Navy, Air Force, and an AEC scientific group. Captain James Russel, USN, AEC's Division of Military Applications (DMA), was Test Director and Dr. Darol Froman, also from AEC-DMA, was Scientific Director. Military Service elements of the JTF were commanded by Brigadier General B. T. Ogden, USA, Rear Admiral Francis Denebrink, USN, and Major General Roger Ramey, USAF.[75] Construction of temporary facilities at Enewetak Proving Ground began in late December 1948 following the relocation of the dri-Enewetak to Ujelang Atoll. The construction work was performed by U.S. Army elements of the JTF.[76] Because of the lack of ground facilities on the atoll, the Task Force was quartered on and operated from U.S. Navy vessels. Three nuclear devices were detonated in this operation. Each was placed on a 200-foot-high tower on one of three separate islands. The first shot, code named X-ray, was conducted on Enjebi on 14 April 1948, with a yield of 37 KT. The next test, Yoke, took place on Aomon on 30 April, with a yield of 49 KT. The last, Zebra, was carried out on Runit on 14 May, with a yield of 18 KT. Details of devices tested and of test results remain classified at this writing.[77]

CONSTRUCTION ACTIVITIES

Operation Sandstone established a pattern that was to be followed in other test series. That pattern was: a rehabilitation phase in which existing facilities were readied to support the upcoming operation; a construction phase devoted to providing support and scientific requirements; an execution phase for actual testing; and a roll-up phase during which the atoll was made secure and preserved for further use. Figures 1-38 through 1-41 show construction activities on various test and test support installations. The activities shown occurred at various times in the test program.

The construction and development work on Enewetak Atoll in support of Operation Sandstone was carried out by U.S. Army construction units with civilian contractor assistance. The construction phase consisted of:

a. Developing Enewetak Island as the administrative and logistic base for all atoll operations.

b. Developing Medren as the scientific and technical control and coordinating center for all atoll operations.

c. Developing construction camps on islands either on or near the islands on which tests were to be conducted.

d. Constructing the scientific and technical facilities on the test islands.

As time went on, Army construction units had smaller and smaller roles, while those of civilian contractors continued to grow. The AEC decided in mid-1949 to carry out major construction projects on the atoll with the view of providing an adequate support base ashore, with more adequate housing and technical facilities. A survey had previously been made by Holmes & Narver, Inc. to determine the existing conditions and the additional facilities required. The results were submitted on 7 January 1949, and a design and construction contract was signed in June of that year.

FIGURE 1-38. UNLOADING MATERIAL AND EQUIPMENT AT MEDREN PIER.

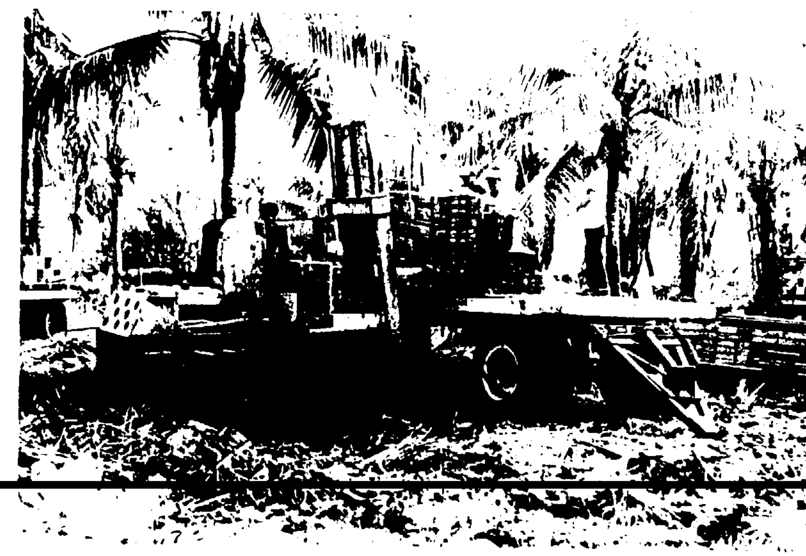


FIGURE 1-39. TRANSPORTING CONSTRUCTION MATERIALS ON ENEWETAK.

FIGURE 1-40. MOVING AGGREGATE FROM MEDREN TO ENEWETAK ISLAND.

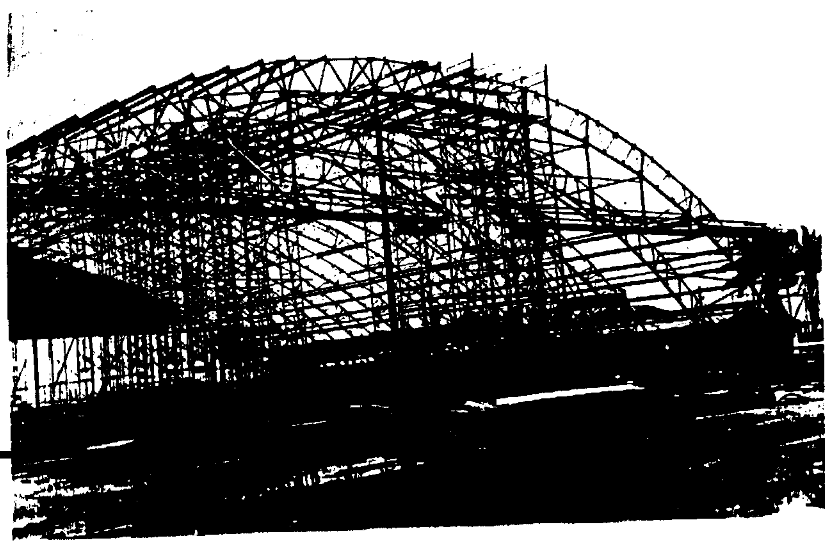


FIGURE 1-41. ERECTION OF AIRCRAFT HANGAR.

The general plan proposed was, as stated earlier, the development of Medren (also called Parry) as the base for laboratory, scientific, and administrative operations, and for the quarters of construction personnel, with the military being housed on Enewetak Island. An important part of the plan was that all possible support functions, including engineering design, prefabrication, procurement, and accounting, would be performed in the United States. The purpose in doing this was to increase productivity, reduce the cost of maintaining personnel living away from their homes, and speed up the procurement of necessary equipment and materials. Construction camps were to be developed on the test or neighboring islands, and the scientific and technical facilities were to be built on the test islands and on islands appropriate for measurement and observation.[78] A section of Enewetak Island as it appeared in full operation is shown in Figure 1-42. This was the military headquarters and residence island. Medren, at a similar phase, appears in Figure 1-43. This island served as the headquarters and residence for civilian scientists and contractors. Construction camps on Lidilbut (Gene) and Enjebi are shown in Figures 1-44 and 1-45.

OPERATION GREENHOUSE: APRIL-MAY 1951

On 31 January 1950, President Truman announced that the decision had been made to develop the hydrogen or thermonuclear bomb, and that the AEC had been directed to continue to work on all forms of nuclear weapons, including the H-bomb. In June of the same year, the Korean conflict began. Both events, though unrelated, created the need for more and faster-paced tests. Enewetak was the obvious place for testing the H-bomb, once developed, but Enewetak could not be expected to accommodate all of the test operations that now loomed in the immediate future. In order to ease this situation, the AEC decided to establish a proving ground in the continental United States which could be used for tests of weapons of nominal yield. The site selected was part of the Las Vegas Bombing and Gunnery Range in southeastern Nevada. This became the Nevada Proving Ground, later the Nevada Test Site.

In 1951, at the time that the next series of tests in the Pacific was to be conducted, the H-bomb was still under development. However, some devices related to thermonuclear bombs were tested in Operation Greenhouse. This operation consisted of four tests (Dog, Easy, George, and Item) conducted during April and May 1951. The only yield published was that of Easy—47 KT. All were tower shots.[79]

One of the important "nuclear weapons effects" tests carried out during this series measured the effect of blast on military and industrial facilities.

FIGURE 1-42. THE CENTER OF ENEWETAK (FRED) ISLAND.

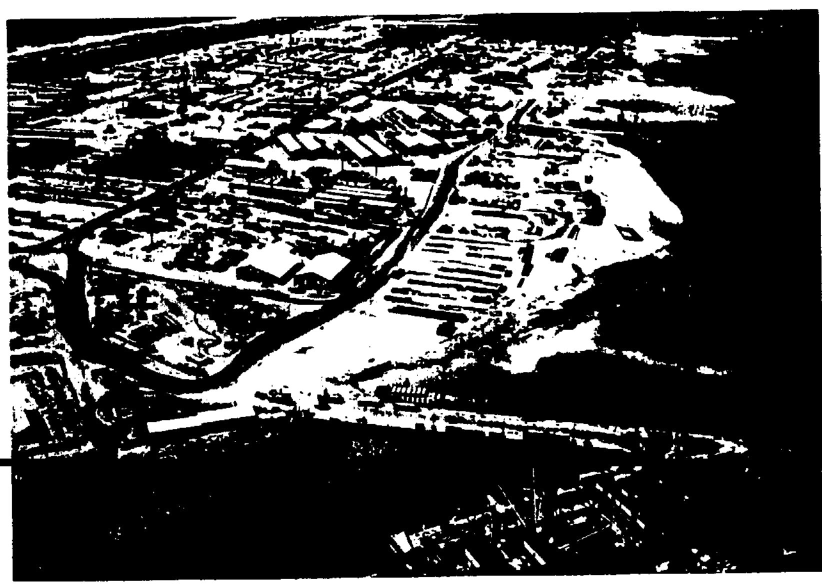


FIGURE 1-43. MEDREN (ELMER) ISLAND.

FIGURE 1-44. CONSTRUCTION CAMP ON LIDILBUT (GENE) ISLAND.

FIGURE 1-45. ENJEBI (JANET) ISLAND CAMP AREA.

Twenty-seven structures of various designs were erected, and blast force and other measurements were made on them.[80] Two of the structures constructed for this purpose are shown in Figures 1-46 and 1-47.

OPERATION IVY: OCTOBER-NOVEMBER 1952

There were only two detonations in Operation Ivy, but the first of these, Event Mike, was especially significant as it was the first test of an experimental thermonuclear device. The test occurred on 31 October 1952, and the device (it was not a bomb in the true sense) was located on the surface of Elugelab, one of the most northern islands of the atoll. The yield was 10.4 megatons (MT), equivalent to 10.4 million tons of high explosives. The general appearance of the device is shown in Figure 1-48.

The island of Elugelab was practically vaporized by the detonation and in its place was a crater more than a mile in diameter and 200 feet deep. A large fireball, 3-1/2 miles in diameter and followed by a wave of water, swept across neighboring islands. Trees and shrubs facing the test site on the island of Biken were scorched and wilted, although they were located 14 miles southwest of the Mike shot site.[81] Figure 1-49 shows the island chain before the shot. The visible causeways were constructed to carry

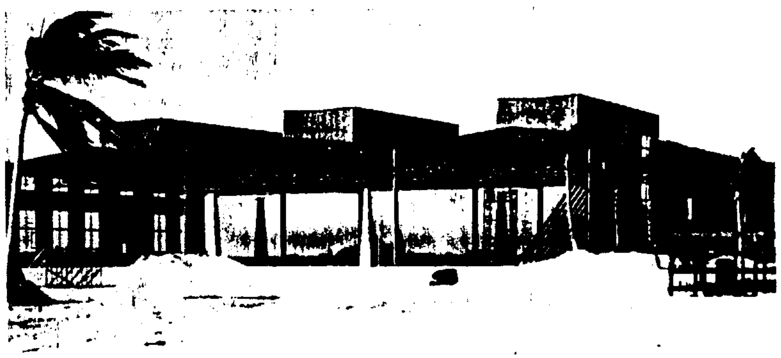


FIGURE 1-46. HANGARS CONSTRUCTED TO STUDY BLAST EFFECTS, ENJEBI.

FIGURE 1-47. STRUCTURE-TEST BRICK HOUSE, ENJEBI.

instrumentation lines, as well as to provide access to the shot island. Figure 1-50 shows the island chain after Event Mike.

The second test of Operation Ivy, Event King, was an air drop 2,000 feet north of Runit. The detonation took place at an altitude of 1,500 feet and the yield was 500 KT.[82] This was the largest fission weapon ever detonated. Weapons with greater energy releases were of the fusion type.

OPERATION CASTLE: FEBRUARY-MAY 1954

In September 1952, the AEC removed Bikini Atoll from the provisional status in which it had been held since Operation Crossroads and made it a part of the Pacific Proving Ground. In the next test series, Operation Castle, five of six shots were carried out at Bikini. Only Event Nectar, a barge shot, was conducted at Enewetak. The shot location was Mike Crater, and the yield was 1.69 MT.[83]

One of the Bikini shots, Bravo, became well known because the fallout from this 15 MT detonation was carried to the east, rather than to the north as had been predicted, and fell on the atolls of Rongelap, Ailinginae, and Rongerik. Fallout was heavy enough to cause serious illness and at least one death among the crew of the Japanese fishing boat Fikuryu Maru, which had not received warning of the test and had sailed into the danger zone. These events produced renewed interest in radiological health

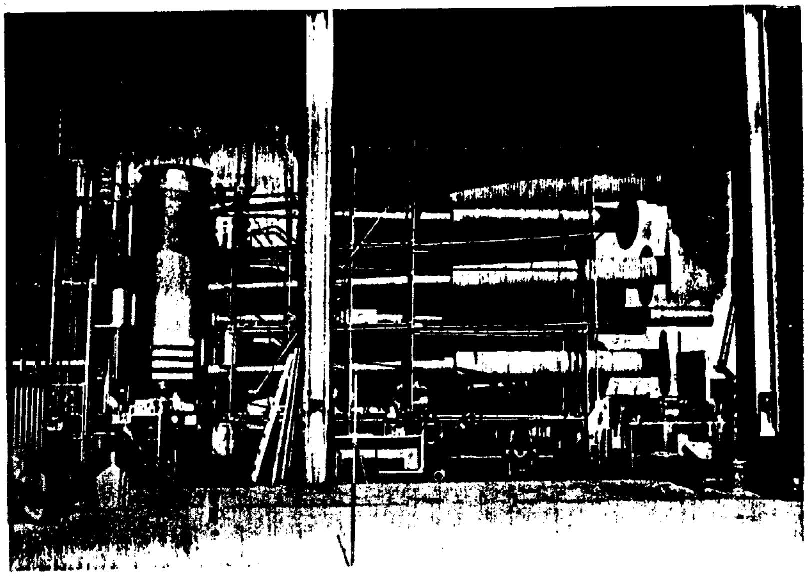


FIGURE 1-48. THE MIKE DEVICE OF OPERATION IVY ON ELUGELAB.

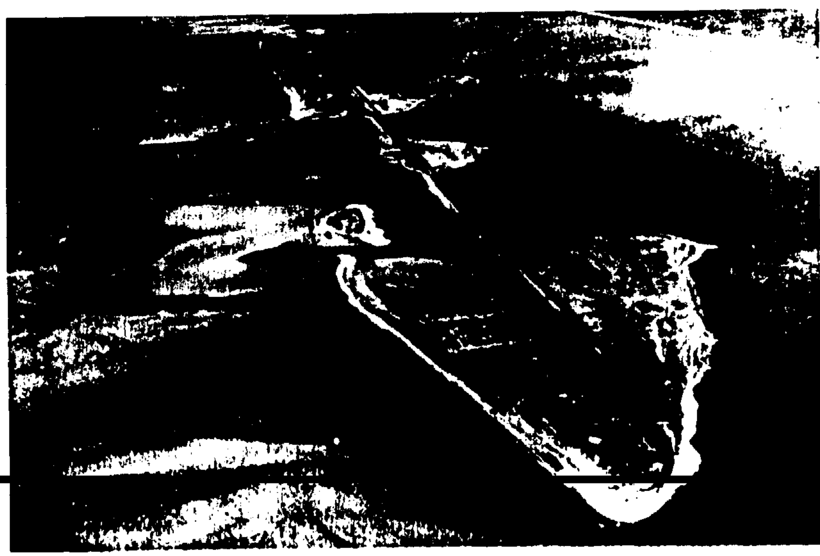


FIGURE 1-49. EVENT MIKE FACILITIES ON ELUGELAB, LIDILBUT, BOKAIDRIKDRIK, AND BOKEN.

FIGURE 1-50. THE ISLAND CHAIN AND CRATER AFTER EVENT MIKE.

effects and caused the United States to enlarge the oceanic area in which fishing and shipping would be excluded.[84]

OPERATION REDWING: MAY-JULY 1956

In 1953, the United States had established the pattern of testing in the Pacific and in Nevada on alternate years. This was continued in 1956, when 11 of the 17 shots of Operation Redwing were fired at Enewetak and the other six were conducted at Bikini. Most of the yields from this series were classified and only the Seminole Event at 13.7 KT and the Lacrosse Event at 40 KT were announced. Of the Enewetak events, two were carried out on island surfaces, six were tower shots, and two were barge shots. Additionally, the first air drop of a thermonuclear bomb was executed, with a yield of several megatons. The Redwing series at Enewetak extended from 4 May to 21 July 1956.

Seminole, one of the surface shots, removed a good part of Boken (Irene) Island in much the same manner as Mike removed Elugelab. The other surface shot was Lacrosse, which formed a large crater on the northern reef of Runit. The shot tower on Aomon for Event Kickapoo of the Redwing series is shown at Figure 1-51.

FIGURE 1-51. EVENT KICKAPOO SHOT TOWER, AOMON.

OPERATION HARDTACK I: APRIL-AUGUST 1958

Though international discussions had been opened on the cessation of atmospheric nuclear testing, the AEC and DOD announced on 15 September 1957 that, in the absence of a disarmament agreement, the U.S. would continue testing in the Pacific with the conduct of the Hardtack I series, beginning in April 1958. Hardtack I consisted of 34 events, 22 of which were at Enewetak, two in the Johnston Atoll area, and ten at Bikini. The first event of the Hardtack I series was carried by balloon to a height of 86,000 feet and detonated over the ocean about 80 miles northeast of the atoll. This event, Yucca, is not classified as an Enewetak shot since it occurred between Enewetak and Bikini. Three surface events took place on Runit, and these were to produce significant effects. Cactus Event formed a crater on the Runit reef, while the Quince and Fig Events caused widespread surface and subsurface contamination of northern Runit. A fourth surface event, Koa, 1.37 MT, was carried out on Lidilbut, vaporizing it in the same manner that Mike had removed Elugelab. Two events, Wahoo and Umbrella, were conducted underwater, the first at a

depth of 500 feet in the ocean, the second at a depth of 150 feet in the lagoon. All other events were barge events in the lagoon, with the exception of the Oak Event which, although a barge shot, was carried out on the western reef. Construction of one of the scientific stations on Runit for the Hardtack series is shown in Figure 1-52. The events conducted during Hardtack I represented slightly more than 50 percent of all nuclear tests conducted at Enewetak. They also were the last nuclear explosions to occur on either Enewetak or Bikini. Figure 1-53 shows the locations of all test events that were detonated during nuclear testing at Enewetak Atoll.[85]

MORATORIUM AND TEST BAN

A conference to explore methods of detection of possible violations during a potential suspension of nuclear weapons testing was held in Geneva, Switzerland, from 1 July through 21 August 1958. The attendees included the United States, the United Kingdom, Canada, France, the Soviet Union, Poland, Romania, and Czechoslovakia. The final report stated that it would be "technically feasible to set up, with certain

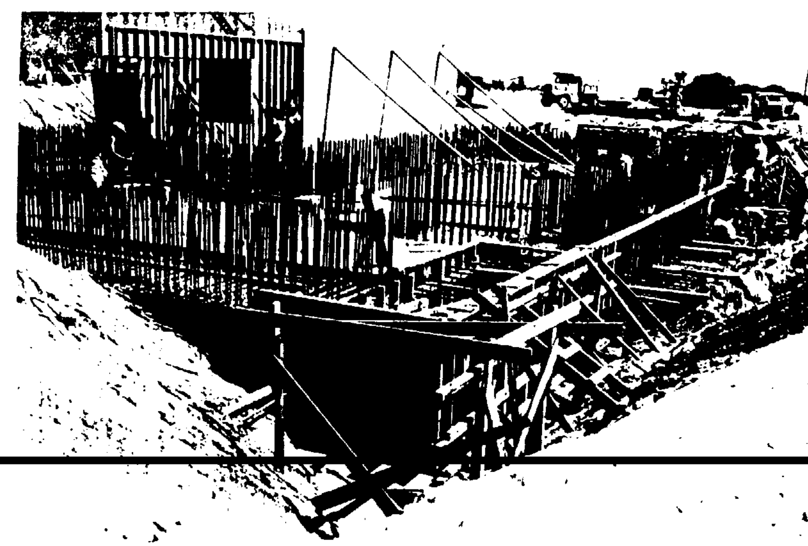


FIGURE 1-52. EVENT HARDTACK SCIENTIFIC STATION 1310, RUNIT.

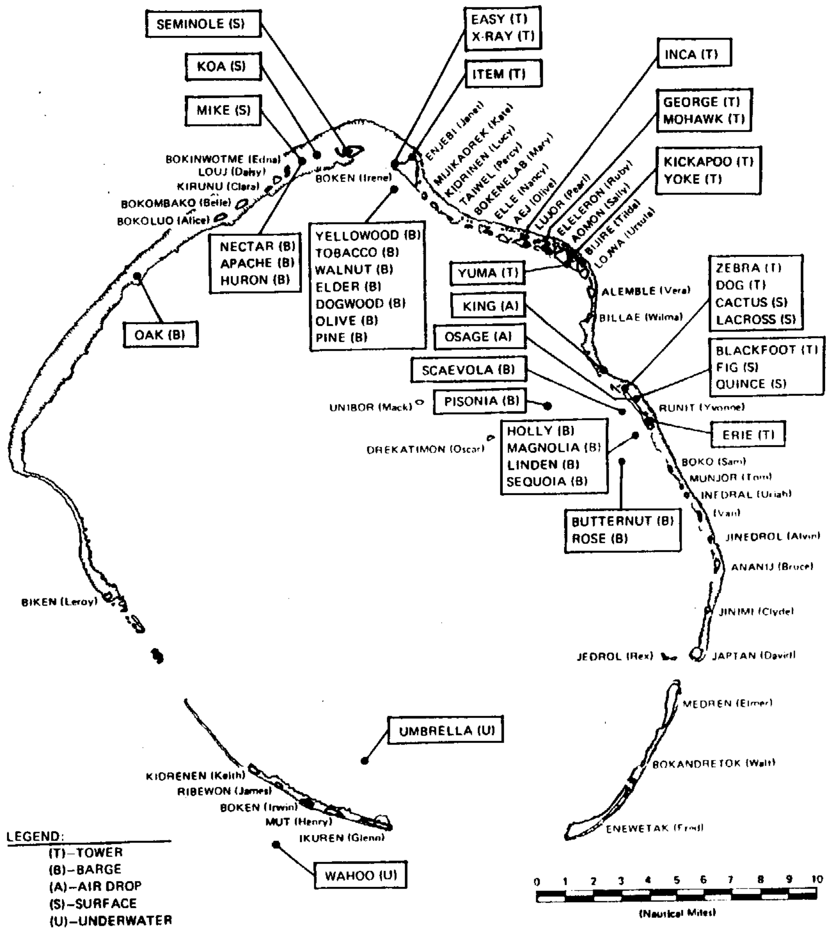


FIGURE 1-53. NUCLEAR DETONATION SITES ON ENEWETAK ATOLL.

capabilities and limitations, a workable and effective control system for the detection of violations."[86] On 22 August, the day after the closing of the conference, President Eisenhower declared the intention of this country to negotiate with any other country on nuclear weapon test suspension. This offer was accepted by the Soviet Union on 29 August 1958. The end of the atmospheric testing of nuclear weapons was set at 30 October 1958.

Hardtack II, a series of 11 events, was conducted at the Nevada Test Site between 12 September and 30 October, with the objective of completing as much of the U.S. atmospheric testing program as possible. Although the joint moratorium on testing by the United States and the Soviet Union started on 31 October 1958,[87] the Soviet test program was concluded later, with one test on 1 November and another on 3 November. Discussions to formalize a ban on atmospheric nuclear testing were then underway in Geneva.

Three years later, on 1 September 1961, the Soviet Union announced its intention to resume nuclear testing, and the Soviets began testing within a few days of the announcement. The United States was not prepared to resume testing immediately, and it was not until April 1962 that the first U.S. test was held. The U.S. program was code named Operation Dominic, and it was conducted in the vicinity of Johnston Atoll and Christmas Island in the central Pacific.[88,89] In all, 34 events were conducted in the eastern Pacific, commencing on 25 April and concluding on 4 November 1962.

The Limited Test Ban Treaty with the Soviet Union was signed in September 1963, prohibiting nuclear weapons tests in the atmosphere, underwater, and in space, and permitting only underground testing. Since then, the only atmospheric tests that have been reported have been held by countries other than the United States, United Kingdom, and the Soviet Union.

SUMMARY OF TEST EFFECTS

Figure 1-54 lists the 43 events which were detonated during nuclear weapons testing at Enewetak Atoll from 1948 to 1958.[90] Each of these tests produced some measurable effects on some part of the atoll, while a number of them caused major changes in the topography of some islands. In addition, noticeable changes were produced by the construction operations required for test preparation and for the measurement and recording of results. The following listing represents most of the visible effects which nuclear weapons tests produced on Enewetak Atoll:

a. The islands of Elugelab and Lidilbut were removed, together with most of Bokaidrikdrik (Helen) and Eleleron (Ruby).

Operation	Event Name	Date (GCT)	Type and Height of Burst	Location	Yield
Sandstone	X-ray	14 Apr 48	Tower 200'	Enjebi (Janet)	37 KT
	Yoke	30 Apr 48	Tower 200'	Aomon (Sally)	49 KT
	Zebra	14 May 48	Tower 200'	Runit (Yvonne)	18 KT
Greenhouse	Dog	7 Apr 51	Tower 300'	Runit (Yvonne)	Class.
	Easy	20 Apr 51	Tower 300'	Enjebi (Janet)	47 KT
	George	8 May 51	Tower 200'	Eleleron (Ruby)	Class.
	Item	24 May 51	Tower 200'	Enjebi (Janet)	Class.
Ivy	Mike	31 Oct 51	Surface	Elugelab (Flora)	10.4 MT
	King	15 Nov 52	Airdrop 1500'	2000' North of Runit (Yvonne)	500 KT
Castle	Nectar	13 May 54	Barge	Mike Crater	1.69 MT
Redwing	Lacrosse	4 May 56	Surface	Runit (Yvonne)	40 KT
	Yuma	27 May 56	Tower 200'	Aomon (Sally)	Class.
	Erie	30 May 56	Tower 300'	Runit (Yvonne)	Class.
	Seminole	6 Jun 56	Surface	Boken (Irene)	13.7 KT
	Blackfoot	11 Jun 56	Tower 200'	Runit (Yvonne)	Class.
	Kickapoo	13 Jun 56	Tower 300'	Aomon (Sally)	Class.
	Osage	16 Jun 56	Airdrop	Runit (Yvonne)	Class.
	Inca	21 Jun 56	Tower 200'	Lujor (Pearl)	Class.
	Mohawk	2 Jul 56	Tower 300'	Eleleron (Ruby)	Class.
	Apache	8 Jul 56	Barge	Mike Crater	Class.
	Huron	21 Jul 56	Barge	Mike Crater	Class.
Hardtack I	Cactus	5 May 58	Surface	Runit (Yvonne)	18 KT
	Butternut	11 May 58	Barge	Lagoon	Low Yield
	Koa	12 May 58	Surface	Lidilbut (Gene)	1.37 MT
	Wahoo	16 May 58	Underwater 500'	Ocean	Class.
	Holly	20 May 58	Barge	Lagoon	Class.
	Yellowwood	26 May 58	Barge	Lagoon	Class.
	Magnolia	26 May 58	Barge	Lagoon	Class.
	Tobacco	30 May 58	Barge	Lagoon	Class.
	Rose	2 Jun 58	Barge	Lagoon	Class.
	Umbrella	8 Jun 58	Underwater 150'	Lagoon	Class.
	Walnut	14 Jun 58	Barge	Lagoon	Class.
	Linden	18 Jun 58	Barge	Lagoon	Class.
	Elder	27 Jun 58	Barge	Lagoon	Class.
	Oak	28 Jun 58	Barge	Reef	8.9 MT
	Sequoia	1 Jul 58	Barge	Lagoon	Class.
	Dogwood	5 Jul 58	Barge	Lagoon	Class.
	Scaevola	14 Jul 58	Barge	Lagoon	Class.
	Pisonia	17 Jul 58	Barge	Lagoon	Class.
	Olive	22 Jul 58	Barge	Lagoon	Class.
	Pine	26 Jul 58	Barge	Lagoon	Class.
	Quince	6 Aug 58	Surface	Runit (Yvonne)	Class.
	Fig	18 Aug 58	Surface	Runit (Yvonne)	Class.

Notes: Dates are determined from the Greenwich Civil Time (GCT) of the detonation. Tests are given as kilotons (KT), megatons (MT), or as "Classified" (Class.) Height or depth of burst are from other sources.

FIGURE 1-54. NUCLEAR EVENTS AT ENEWETAK ATOLL.

b. Large craters were formed on the reefs on the north end of Runit, to the Northeast of Bokinwotme (Edna) where Elugelab and Lidilbut had been, and on Boken (Figures 1-55, 1-56 and 1-57).
c. Surface profiles in the vicinity of ground zeroes were changed by blasts as well as by efforts to restore the area for continued use.
d. Coconut palms and other vegetation were destroyed in many areas.
e. The construction of causeways, landfills, and the excavation of borrow areas in the course of test preparation had modified the atoll topography.
f. Large structures and bunkers for test measurement or observation remained after testing was completed.
g. Semipermanent buildings were left standing, especially on the islands of the southeast.
h. Tons of concrete and metal debris remained.

Conditions that were not readily visible included contaminated soil on many islands of the atoll and contaminated sediments on the bottom of the lagoon. The lagoon also contained many miles of cable that had been laid between islands for instrumentation, communication, and the activation of the nuclear devices.

The principal radioisotopes that made up the residual radioactivity on Enewetak Atoll following the test period were:

a. Cobalt-60, an emitter of gamma rays and beta particles, with a half-

FIGURE 1-55. CRATERS ON RUNIT.

FIGURE 1-56. CRATERS RESULTING FROM MIKE AND KOA EVENTS (SEMINOLE CRATER IN THE BACKGROUND).

FIGURE 1-57. SEMINOLE CRATER ON BOKEN.

life of 5.3 years.

b. Strontium-90, an emitter of beta rays, with a half-life of 29 years.
c. Cesium-137, an emitter of gamma rays and beta particles, with a half-life of 30 years.
d. Plutonium-239, an emitter of alpha particles, with a half-life of 24,000 years.
e. Plutonium-240, an emitter of alpha particles with a half-life of 6,600 years.
f. Americium-241, an emitter of gamma rays with a half-life of 433 years.

In addition to the radionuclides present in the soil and lagoon sediments of Enewetak Atoll, other radioactive materials were present on some of the islands in the form of contaminated debris. Some of this debris was on the surface and some was in burial sites on certain islands. All of these evidences of the nuclear test program were to have some influence on the cleanup operation. In chapters to follow, the condition of each individual island is described. These descriptions are based on the conditions of the island in 1977, almost 20 years after the last test shot was fired and before any cleaning operations had begun.

WESTERN TEST RANGE: 1958 - 1972

The years between the termination of the nuclear weapons test program and the commencement of cleanup planning were not without activity. For a short time, the atoll lagoon was used as a target area for missiles fired from Vandenberg Air Force Base in California. Later, that function was transferred to the much larger lagoon of Kwajalein Atoll. In the 1960's, explorations and experiments on the upwelling of deep-ocean water were conducted by the University of California at San Diego. Neither of these operations had much effect upon the effort that would be required in the cleanup project, although some structures were erected to provide operations and maintenance support.

PROJECT HIGH ENERGY UPPER STAGE (HEUS)

During the time that the atoll was under the control of the U.S. Air Force, two test firings of a developmental HEUS rocket motor were conducted. One was conducted in 1968 and the other in 1970, both on Enjebi. The rocket motors tested each contained 2,500 pounds of propellant of which 300 pounds was beryllium. The first firing, in April

1968, resulted in a high-order detonation which scattered propellant over the western tip of Enjebi.[91] The location of the HEUS operation is shown in Figure 1-58.

The engine started operating normally but, after a short time, it exhibited uncontrolled burning which resulted in destruction of the

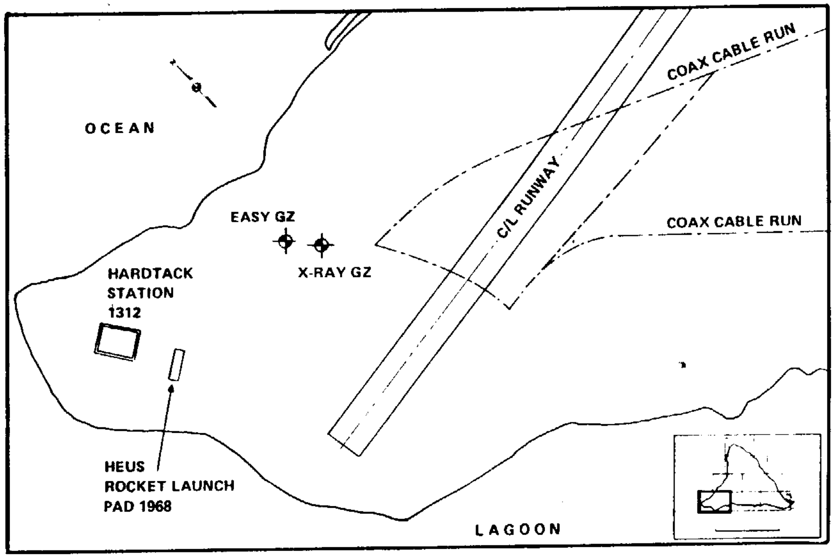


FIGURE 1-58. PROJECT HEUS, ENJEBI.

engine, spalling of the concrete blockhouse to which it was attached, and the spreading of beryllium metal and oxides over a wide area in a nonuniform manner. After wetting the area thoroughly, a decontamination crew scraped dirt from the surface inside a circle of 100 feet radius. The dirt was buried in the crater resulting from the explosion. In addition to soil contamination, some beryllium was plated on the surface of a concrete blockhouse. No attempt was made at that time to determine the exact location or extent of contamination. An investigation was made in May 1969 and, although the area was indicated to be safe without protective clothing or breathing apparatus, the results also were considered to be equivocal because of the random nature of the contamination pattern.

A second firing conducted in January 1970 was successful and did not result in an explosion. The U.S. Air Force Environmental Health Laboratory took soil samples before, during, and after firing. The results were published in the Laboratory's Report Number 71M-2.[92] Sampling

after decontamination showed the cleaning operation to be "quite successful" or "reasonably successful," the beryllium content of the soil being, in many cases, less than the contamination that was present before the second test.[93]

Beryllium is toxic to man when inhaled and lodged in the lungs. The threshold level for such toxicity was defined in 1971 as 0.01 microgram per cubic meter of atmospheric air.[94] The area was rechecked in 1971 by AEC contractor personnel. Soil sample analysis showed no surface contamination greater than 0.05 microgram of beryllium per gram of dry soil. It was believed that decontamination and erosion of the western tip of Enjebi had reduced contamination such that there would be no problem with beryllium on the surface.

CHAPTER 2

PLANNING AND PROGRAMMING 1972 - 1977

DECISIONS FOR THE FUTURE: APRIL 1972

The agreement under which Enewetak was used by the United States for nuclear testing required a review on 30 June 1961 and every 5 years thereafter to determine the need for its continued use.[1] During the June 1971 review, it became apparent that the need had dramatically declined and that the atoll could be returned to the Trust Territory of the Pacific Islands (TTPI). Nuclear testing at Enewetak had ended in 1958 when it was realized that atmospheric testing, even at that remote atoll, was affecting much of man's environment. Enewetak's remoteness then became a liability for most other test programs, in that it was less economical and less practical than other available sites. For example, Johnston Atoll and Christmas Island replaced Enewetak as the main bases for a series of nuclear tests the United States conducted in 1962 after Russia had resumed nuclear testing in the atmosphere in violation of the 1958 moratorium.

By 1971, only two military test programs were still scheduled at Enewetak: (1) a U.S. Air Force space research program; and (2) the Defense Nuclear Agency's (DNA's) proposed Pacific Cratering Experiment (PACE). Both were to be completed in 1973. There also were two long-term biological studies being conducted by civilian agencies; however, they did not conflict with the return of the atoll to the TTPI. Based on the June 1971 review, the decision was made to terminate use of Enewetak as a test range and return the atoll to the TTPI.[2] Under the original agreement, the United States had 30 days to remove any improvements and structures it desired to retain, after which everything remaining reverted with the land to the TTPI. Since immediate departure would have left much debris, many dilapidated buildings, and numerous radiologically contaminated islands, the United States recognized a moral, if not legal, obligation to restore the atoll to a more habitable condition.

An interagency conference on the return of Enewetak Atoll was held in February 1972 in Washington, D.C., and attended by representatives from the Office of Micronesian Status Negotiations (MSN), the Department of Defense (DOD), the Department of the Interior (DOI), and the Atomic Energy Commission (AEC). DNA also was represented, since it had managed the cleanup of Bikini Atoll and was preparing to use Enewetak for one last weapons-related experiment, the PACE program, before return of the atoll by the United States. This conference marked the beginning of DNA's involvement in the Enewetak Cleanup Project.[3] Shortly after the conference, DOI formally notified President Nixon's personal representative for the MSN, Ambassador Franklin Haydn Williams, of the following decisions:

a. The United States was phasing down research programs to permit an early return of the atoll to the TTPI.
b. Cleanup and rehabilitation of three islands—Medren (Elmer), Japtan (David), and Ananij (Bruce)—could begin in 1973.
c. Subject to TTPI permission to continue the four test programs then scheduled, the United States was prepared to release the atoll at the end of 1973.[4]

These decisions were made public on 18 April 1972 in a joint statement by Ambassador Williams and the High Commissioner of the TTPI, the Honorable Edward E. Johnston. The announcement stated that, prior to actual resettlement of the atoll, it would be necessary to carry out the same type of survey, cleanup, and rehabilitation that had been carried out at Bikini. It also stated that the United States planned to commence the survey later that summer.[5] The survey did begin in 1972; however, due to unforeseen events which are described in subsequent sections, the atoll was not released until 16 September 1976, and formal cleanup operations did not begin until 1977.

DETERMINING THE SCOPE OF WORK: MAY 1972

On 10-24 May 1972, a preliminary radiological survey and initial reconnaissance of the atoll was made by representatives from AEC, DNA, the Environmental Protection Agency's (EPA) Western Environmental Research Laboratory, and the University of Washington. They were joined on 18-20 May 1972 by representatives of the U.S. Air Force, TTPI, and the dri-Enewetak and their attorneys, Micronesian Legal Services Corporation (MLSC), for conferences and tours of some major islands. Dri-Enewetak representatives included Iroij (Chief) Johannes Peter of the dri-Enewetak, Iroij Lorenzi Jitiam of the dri-Enjebi, and the Ujelang Community Council. This was their first visit to their homeland since they were removed in 1947. The tour party included several key participants in the subsequent planning and cleanup efforts, such as Mr. Peter T. Coleman, the Deputy High Commissioner of the TTPI, Mr. Oscar DeBrum, the TTPI District Administrator of the Marshall Islands, Mr. Roger Ray of the Nevada Operations Office of the AEC (AEC-NV), and Mr. Theodore R. Mitchell, Executive Director of the MLSC. What they found were badly deteriorated test and support facilities, which had been evacuated in 1958 almost as if for a fire drill rather than the end of an era. On Medren,

unfinished memos lay on the desks in some buildings, while landing craft sat rusting where they had been pulled from the water. Everywhere, nature—in the form of impenetrable brush, termite burrows, rot, and rust—was reclaiming the atoll from the ruins of an advanced technology.[6,7,8] What many had not believed when the nuclear test moratorium began in 1958 was an obvious fact in 1972—nuclear weapons testing had ended at Enewetak Atoll.

Nuclear testing had left its unmistakable mark. The preliminary radiological survey found potentially significant radiation hazards on the islands of Bokombako (Belle), Enjebi (Janet), Aomon (Sally), and Runit (Yvonne). More detailed surveys would be required to identify locations and to determine degrees of contamination. More study and planning would be necessary to develop removal and disposal procedures for the contaminated soil and debris.[9]

PACIFIC CRATERING EXPERIMENT: 1971 - 1972

Preparation for PACE had been underway at Enewetak for almost a year prior to AEC's preliminary radiological survey in May 1972. PACE was a DNA-funded program conducted by the U.S. Air Force Weapons Laboratory (AFWL) at Enewetak Atoll from June 1971 to October 1972. The program had two basic objectives: (1) PACE I, to define the geology, geophysics, and material properties of the near subsurface (0-100m depth) of the atoll rim; and (2) PACE II, to conduct a series of high explosive cratering experiments, ranging from 1,000 pounds to 500 tons, to establish nuclear explosive/high explosive equivalence for cratering and ground motions.[10] The PACE operations were preceded by two separate radiological surveys, neither of which indicated any serious hazards, and they were supported by a radiological safety program.[11] Measurements during the PACE program indicated no significant radiation hazard, no need to decontaminate equipment, and no requirement for radiological protective clothing or equipment. Nevertheless, bioassay samples were taken as an added precaution, and none showed any indication of plutonium uptake.[12,13]

AFWL personnel drilled the first test hole in the rim of the Cactus Crater on Runit on 30 September 1971. They continued drilling holes and digging trenches on Runit for the next 8 months before the preliminary AEC radiological survey began in May 1972. During the same period, researchers from the Enewetak Marine Biological Laboratory (EMBL), an AEC contractor, were camped on the Cactus Crater rim and conducting biological surveys around Runit using no special protective clothing.

QUARANTINE OF RUNIT: MAY 1972

During the May 1972 AEC survey, several bits of metal with centimeter-range dimensions were found on Runit. Three fragments were hand-carried to the University of Washington for analysis, where they were identified as plutonium-contaminated beryllium. They appeared to be residue from the nonnuclear detonation of the Quince shot or the very-low-order Fig shot and similar to residue found on Johnston Atoll after two low-order detonations there. The presence on Runit of discrete pieces of metal contaminated with plutonium presented a new and serious concern.[14] The senior AEC representative, Mr. Roger Ray, recommended immediate quarantine of Runit; i.e., to cease all operations thereon and to not remove any vehicles, equipment, or materials until adequate decontamination procedures could be established. The AEC's recommendation was intended primarily to prevent further aggravation, through dispersion, of an already difficult contamination problem and did not imply that activities to date had caused any significant personnel exposures.[15] In response to the AEC's recommendation, the U.S. Air Force Space and Missile Test Center (SAMTEC), which then managed the atoll, put the quarantine into effect on 22 May 1972.[16]

Considering previous results, the quarantine seemed somewhat severe to DNA. Since the quarantine stopped PACE operations on Runit, DNA asked the AEC Nevada Operations Office (AEC-NV) for additional data on the nature of the hazard which might then allow completion of PACE.[17] On 30 June 1972, DNA and AEC representatives met and agreed that an additional survey should be made to determine if PACE might safely resume on Runit. That survey was carried out from 26 July to 2 August 1972 by AEC and DOD personnel. Safe zones were identified in and around the Fig/Quince area. The quarantine was lifted to permit work in those zones, and PACE operations on Runit continued until September 1972 when the program was again halted, this time by a restraining order issued by the U.S. District Court in Honolulu at the request of Mr. Mitchell, the dri-Enewetak's legal counsel. The principal bases of the complaint were that the PACE Project had been started before DOD had filed a final environmental impact statement; that DOD had refused to hold hearings on Ujelang Atoll; and that the decision to conduct PACE on Enewetak was a violation of both the National Environmental Policy Act (NEPA) and the Trusteeship Agreement.[18,19]

On 5 October 1972, the District Court ruled that the plaintiffs were entitled to an injunction because of the violation of NEPA and, therefore, PACE activities, including core drilling and seismic surveys at Enewetak, were prohibited. The injunction included a prohibition on excavation of land, reef, or beach areas; core drilling; detonation of explosives of any kind; clearing of vegetation; and construction of roads in connection with PACE. From October 1972 until a court hearing in June 1973, AFWL prepared a draft Environmental Impact Statement (DEIS), held public hearings at Ujelang Atoll in an attempt to obtain dri-Enewetak support, and reorganized the PACE test plan. The court hearing resulted in cancellation of the cratering experiments; however, the geological portions of PACE were permitted to continue as the Exploratory Program on Eniwetok (EXPOE) which is described in a subsequent section.[20]

Before the restraining order and injunction halted PACE activities on the atoll, a 19-acre area covering approximately one-fifth of Aomon had been excavated to form a large depression for use as a bed for a 1000-pound high explosive parametric test shot. The court ordered that the area be restored to its original profile. DNA obtained Mr. Mitchell's approval of a modified stipulation to accomplish the restoration in conjunction with the forthcoming radiological cleanup project or, if the project were cancelled, as a separate action.[21] When the cleanup project was approved and funded, restoration of the PACE test bed was included in the cleanup project operation plan.

During preparations for PACE, large quantities of high explosives were stockpiled on Medren. These became excess when PACE was cancelled, and they were transferred to the TTPI for use in channel clearance in the Marshall Islands District. Unfortunately, the ship chartered by the TTPI to remove the explosives was overloaded, foundered, and sank a few hundred miles from Enewetak Atoll; however, the crew was rescued.

ASSIGNMENT OF RESPONSIBILITIES: JULY-NOVEMBER 1972

On 17 July 1972, the Assistant Secretary of Defense for International Security Affairs, ASD(ISA), advised DNA that DOD planned to conduct the cleanup of Enewetak Atoll with the technical support of AEC. He requested that DNA initiate planning actions with AEC to identify the scope of work and the resources necessary for this mission.[22] During the next month, DNA presented a series of introductory briefings on the project for officials of the Office of the Secretary of Defense and Joint Chiefs of Staff (JCS) and met with AEC representatives to develop a preliminary planning strategy.[23] The Director, DNA, Lieutenant General Carroll H. Dunn, USA, went to Enewetak on 2 September 1972 for a personal survey of the situation.[24] The following week, on 7 September 1972, there was a major conference in Washington, D.C., attended by representatives from over a dozen departments and agencies. The primary results were agreements on planning actions and basic responsibilities for the cleanup and rehabilitation efforts as follows:

- DOD would fund the precleanup engineering survey; the monitoring and surveys required to support cleanup operations and to insure the safety of personnel involved in the cleanup; and the actual radiological and nonradiological cleanup efforts.
- AEC would fund the precleanup radiological survey of Enewetak; any other survey activities required to understand radiological exposure of the people and development of standards; and periodic radiological surveys after cleanup. DOD would reimburse for any subsequent AEC field and/or laboratory work done in support of cleanup.
- DOI would fund the rehabilitation work.[25]

DNA and AEC did not wait for the completion of supporting paperwork. Both organizations began their precleanup surveys in October 1972 while formal agreements and tasking documents were being developed.

On 14 November 1972, the Secretary of Defense formally advised the Chairman of the JCS of DOD's responsibilities for cleanup and requested that the Director, DNA be designated as Project Manager.[26] The formal designation was made by the JCS on 30 November 1972. It contained specific guidance and authorizations from the Secretary of Defense, including: (1) authorization to act for the Secretary of Defense in planning and—if approval was granted—in accomplishing the project, including direct liaison with other agencies and development of agreements with them; (2) direction to keep the Secretary and the Chairman, JCS informed throughout the planning and execution of the project, specifically including any requirements for military service support; (3) tasking for preparation of an Environmental Impact Statement (EIS); and (4) guidance to not commit the DOD to financing or executing the cleanup project until further funding guidance was received.[27] Formal funding guidance was not received from the Office of Management and Budget (OMB) until October 1973, almost a year later.[28]

DNA and AEC formalized the agreement on the conduct and support of the radiological and engineering surveys on 8 December 1972, about 2 months after the surveys began.

ENEWETAK ENGINEERING SURVEY: OCTOBER 1972-APRIL 1973

DNA contracted with Holmes & Narver, Inc. (H&N) to conduct the engineering survey of Enewetak Atoll and provide the results in an engineering study, to include recommendations and cost estimates for

cleanup of the atoll. H&N was selected because of their long experience in providing technical and logistics support at Enewetak during the nuclear test period and because the firm had a large repository of data and maps pertinent to the locations and effects of the tests.[29]

The Enewetak Engineering Survey began on 12 October 1972. Field work was accomplished by three two-man teams working in conjunction with the AEC radiological survey team. They used motor launches for transportation across the lagoon and rubber rafts to travel from the launches across the shallow reefs to most of the islands. The H&N teams' first effort on each island was to locate the buildings and other facilities shown on maps from the nuclear testing era. Then they recorded each object's present condition and their recommendations for its disposition. When all previously recorded objects had been accounted for, each island was resurveyed to assure that any other hazardous objects had been located and recorded for the survey report. Vegetation was so dense on some islands that it prevented a thorough search for hazardous objects. On islands where radiological contamination was suspected, the AEC radiological survey personnel checked each object for contamination. Readings were marked on the Engineering Survey maps. Material which showed radiation measurements greater than measurements of local background was shown as contaminated.[30]

The surveys were severely hampered by adverse weather. Heavy sea conditions prevented actual survey of Boken (Irwin) and Ribewon (James) Islands; however, they had been adequately covered by the May 1972 survey. Typhoon Olga struck the atoll on 23 October 1972, and the Commanding General, SAMTEC, ordered an air evacuation of all personnel to Kwajalein Missile Range. Little time was given to protect the base camp from the effects of the typhoon, and several facilities were severely damaged. After the return to the atoll, AEC-NV had two turbine generators from the Nevada Test Site flown in to restore power for essential life-support facilities. Engineering Survey field work resumed on 8 November and was completed on 21 December 1972. Results of the survey, together with some data from the AEC Radiological Survey, were published in April 1973 as the Engineering Study for a Cleanup Plan.[31]

The Engineering Study contained the results of the field survey and conceptual plans for accomplishing the cleanup project using a commercial contractor or, as an alternative, using military forces. It was published in three volumes.

Volume I showed the results of the island-by-island site survey, with aerial photographs of each island and a listing of all structures, other construction, and major debris on each. The condition of each item was indicated, along with a recommended disposition; e.g., remove, leave as is, make safe, or rehabilitate. Each recommendation was based on potential use of the item by the dri-Enewetak and took into account criteria established by the TTPI and DNA. This volume also contained proposals for mobilization, base camp construction, cleanup, and demobilization, using contractor forces. Cost estimates and cleanup work estimates were based on preliminary standards furnished by DNA for both radiological and nonradiological cleanup. The nonradiological criteria served as a basis for future plans and much of the actual cleanup. The radiological criteria were changed many times before that part of the cleanup could begin.[32]

The Engineering Study described several options for disposition of contamination, none of which were adopted, but which continued to be proposed as alternatives in subsequent planning conferences. These included:

a. Covering contaminated soil with a blanket of clean soil.
b. Dumping contaminated debris in the craters on Runit.
c. Dumping contaminated debris and soil in the lagoon.
d. Dumping contaminated debris and soil in the ocean.
e. Shipping contaminated debris and soil to the continental United States (CONUS) for storage.[33]

Volume II was an assembly of large maps of each of the islands. Each map showed the location of each structure, item of construction, junk pile, concrete strip, and test station, as well as stands of vegetation and other natural features. Also shown were such items of radiological interest as contaminated burial areas, contaminated scrap piles, and other radioactive debris.

Volume III contained detailed and summary cost estimates. The total estimated cost (in 1972 dollars) for cleanup, including dumping contaminated debris in the Runit craters and spreading 62,000 cubic yards of clean soil on Enjebi, was $28.8 million using foreign contractor personnel and $18.4 million using military troops. Options added $1.4 million for ocean dumping of contaminated material or $4.3 million for its return to the United States.[34]

Before the Engineering Study data could be incorporated in an EIS, more information was required on DOI's rebabilitation plans and AEC's radiological cleanup criteria.

ENEWETAK RADIOLOGICAL SURVEY: OCTOBER 1972-OCTOBER 1973

On 13 September 1972, AEC-NV was directed to plan, organize, and conduct a radiological field survey to develop sufficient data on the total radiological environment of Enewetak Atoll to: (1) locate and identify

contaminated and radiologically activated test debris; (2) locate and evaluate any significant radiological hazards which could complicate cleanup activities; and (3) identify sources of direct radiation and food-chain-to-man paths having radiological implications.[35]

The Enewetak Radiological Survey began at Enewetak on 16 October 1972, and final samples were taken on 14 February 1973.[36] The scope and plan of the survey were influenced by measurements which had been made during the preliminary cursory surveys in 1971 and 1972, by review of historical records pertaining to nuclear testing at Enewetak Atoll, and by comparisons with the 1969 cleanup of Bikini Atoll.

The survey goals were to provide all the data needed for ranking the relative importance of radionuclides and pathways leading to dose and to provide data for guiding the cleanup.[37] The major dose pathways considered were: (1) external radiation; and (2) internal radiation from ingestion of terrestrial foods and water, ingestion of marine foods, and inhalation of air.

The survey required a radiological safety plan only for the sampling program on the northern portion of Runit.[38] A radiation exclusion area was established there, and complete radiation safety controls (protective clothing, bioassays, etc.) were in effect continuously. Radiation safety requirements for other areas of the atoll were limited to personnel dosimeters and checks for external gamma radiation during sampling efforts on northern islands.[39] All samples packaged for transport to Enewetak Island and then off the atoll were monitored and determined to be free from external contamination.

Data for assessing external radiation doses were obtained from dosimeters placed at fixed locations throughout the atoll for extended periods and from portable radiation survey meters used in radiation detectors suspended from a helicopter. Measurements were for gamma radiation only. The aerial in situ measurements were considered valuable for reducing the possibility of missing any contaminated areas and for increasing efficiency of the survey. Areas identified as "clean" from the air did not require survey from the ground.[40] The aerial and ground measurements were in excellent agreement.[41] Key products of the aerial survey, in addition to gamma radiation measurements, were high-resolution photographs of each island and adjacent reef. These proved useful for orientation of ground surveyors and for displaying results in the final survey report.

There were limited terrestrial foods available for sampling. Although coconuts are the staple food of the dri-Enewetak, very few coconut trees were growing at Enewetak Atoll. Therefore, only 23 coconut (meat) samples were obtained during the initial survey. An additional six samples, including coconut meat and milk, were obtained in July 1973, and their analyses were included in the survey report.[42] Secondary foods such as pandanus, breadfruit, and arrowroot were even less plentiful. Therefore, the survey sampled the wild, inedible plants which were available; e.g., Messershmidia and Scaevola. Since there were no domestic animals at Enewetak, the survey included extensive sampling of rats as an alternative. Wild birds, bird eggs, crabs, and turtles were also part of the sampling effort, to provide data for terrestrial food ingestion dose estimates. Although survey plans included the sampling of wells and rain for drinking water,[43] no such samples from these sources were taken. (A water sample was taken from the distillation plant on Enewetak (Fred) Island. No radioactivity was in the water, but two samples of sludge from the plant showed positive strontium-90 and plutonium-239. The high plutonium-239 value was 56 pico curies per gram, pCi/g.).[44]

Since most of the edible plants which would be consumed by the dri-Enewetak after resettlement were not growing at Enewetak Atoll at the time of the survey, the major terrestrial sampling effort involved soil. Expectations were that, with an understanding of the amount of radioactivity in the soil, estimates could be made of the amount of radioactivity in plants when grown in that soil. Soil samples were collected from random locations on the surface (top 15 cm) of each island at a frequency which averaged about 1.5 samples per hectare. Sampling locations were estimated relative to landmarks, as engineering surveyors were not available. Profile samples, extending to depths of 1.8 meters, were taken at a frequency averaging about 0.2 samples per hectare. The radiological exclusion area on Runit was much more intensely covered. Profile samples were taken at each location on a uniform grid.

The marine sampling program concentrated on fish which are commonly eaten by the Marshallese. This includes the reef and bottom (lagoon) feeders as well as pelagic species. Approximately 800 samples of fish and other marine life were obtained.[45] Sediment and water samples from the lagoon and from water-filled craters were also taken.

Air sampling was limited.[46] Samples had been collected for 5 days when the program was interrupted by Typhoon Olga on 23 October 1972. Following the typhoon, samples were collected for 3 weeks. Samplers included low- and ultra-high-volume types, as well as a particle spectrometer. The samplers were operated at six locations on five islands.

Samples were processed initially at Enewetak (scanned, homogenized, packaged, etc.) and then returned to CONUS for analysis.[47] A gamma spectral analysis was made on each sample at the Lawrence Livermore Laboratory (LLL), and then samples were analyzed radiochemically for radionuclides which are not amenable to gamma spectral analysis. These later analyses were conducted at a number of commercial and governmental laboratories. Quality control of these laboratories consisted

of interlaboratory analyses of fractions (aliquots) from common samples over the course of the analytical program.[48,49]

The survey included debris monitoring primarily for estimating cleanup requirements: the results would not be needed for dose estimates if the debris was to be removed during cleanup. Debris sampling was carried out on ten islands which were considered most likely to contain contaminated debris.[50] The debris sampled was that which was visible and accessible.[51] One gamma exposure rate was reported for each item.[52] (In the absence of specific guidance, some monitors identified debris as noncontaminated while others recorded actual readings no matter how low.)[53] Alpha radiation monitoring was not feasible, as the survey was performed during the rainy season.[54]

The Enewetak Radiological Survey is reported in a three-volume document identified as NVO-140, October 1973. The principal portion is Volume I, which describes the survey, summarizes data, and presents dose estimates based on various combinations of contamination removal (cleanup) and lifestyle. Volumes II and III display terrestrial surface sample analyses at their respective sampling locations on aerial photographs and profile analyses on semilogarithmic plots (concentration as a function of sample depth). Volume III also contains an attached envelope of microfiche cards which show concentrations (or upper limits) and relative errors for analysis results of all samples processed during the survey.

The dose estimates in NVO-140 were of fundamental importance, as they established the framework for subsequent cleanup and rehabilitation planning. The estimates were designed around six "living patterns," each of which included a specific location in the atoll, where "living" allowed for residence, agriculture, fishing, or visiting. The locations considered for residence were limited to the two largest southern islands (Enewetak and Medren), the largest northern island (Enjebi), and Bokombako (Belle). The latter island was included to provide an example which would lead to highest dose estimates, not necessarily to represent an island where people desired to reside. Agricultural locations considered were limited to a group of southeast islands, a group of northeast islands, Enjebi, and Bokombako. The entire lagoon was available for fishing; and visits were allowed to various groups of islands. Runit was not considered in NVO-140 as available for any function for any living pattern.

Dose was estimated for each function at the allowed locations, and then doses were added to give overall doses for a living pattern. In adding the doses, components were weighted according to amount of time assumed for each function.

External dose estimates for the various allowed locations were determined using exposure rates measured by the aerial survey. An average exposure rate was defined for each island. When an average rate was needed for a group of islands, it was obtained by weighting individual island rates according to the area of each island in the group. The exposure rates were converted to absorbed dose based on assumed duration of exposure.

Inhalation dose estimates were determined using the International Commission on Radiological Protection (ICRP) lung model. Intakes to this model were derived from concentrations of plutonium in soil and an assumed air-mass loading. (Average concentrations for plutonium in soil of islands/group of islands were used.) This method was considered preferable to using the survey air sample data, which were representative only of a very short period of time. Had actual air sample data been used, inhalation dose estimates would have been several orders of magnitude lower than reported.

Ingestion dose estimates were based on an assumed diet (including local marine and terrestrial food and imported food) and measured or derived concentrations of radionuclides in components of the diet. Significant radionuclides for ingestion dose were determined to be cesium-137 and strontium-90. A concentration for these nuclides was determined for the average fish of the atoll, for use in estimating doses via the marine food pathway. The concentration of the significant radionuclides in terrestrial foods was estimated primarily by correlation between concentrations of radionuclides in soil and in indicator plants or animals.

The survey report included estimates of annual dose rate and accumulated dose over extended periods of time for the various living patterns. The effect on possible dose due to cleanup modifications; e.g., covering contaminated soil with clean soil, plowing soil to mix contaminated surface layers with cleaner subsurface layers, was assessed. The report ranked dose pathways in the following order of decreasing dose: ingestion of terrestrial food; external gamma exposure; ingestion of marine food; and inhalation of contaminated air. The most significant contribution to dose via the terrestrial food chain was determined to be strontium-90 in pandanus, breadfruit, and coconut.[55]

The Enewetak Radiological Survey provided a data base and general concepts for radiological cleanup. Considerable effort was still required, however, to evaluate and adapt the data for actual cleanup operations.

AEC TASK GROUP REPORT: JULY 1973-JUNE 1974

In July 1973, an AEC Task Group was appointed by the Director, Division of Operational Safety of the AEC, to review NVO-140 and to prepare cleanup and rehabilitation recommendations. Members of the

Task Group were Mr. Tommy F. McCraw (AEC Operational Safety), Drs. W. Nervik and D. Wilson (LLL), and Mr. W. Schroebel (AEC/ Division of Biomedical and Environmental Research). The Group was assisted by seven consultants. All members and consultants worked either directly for the AEC or for an AEC laboratory, and most had been associated with AEC efforts at Bikini Atoll. Liaison representatives of DNA, EPA, and DOI attended the Task Group meetings.

The AEC Task Group's findings were compiled in a "Report by the AEC Task Group on Recommendations for Cleanup and Rehabilitation of Enewetak Atoll," which was circulated in draft form for comment in February 1974 and, after revisions, again in April 1974. There was lively debate, even among the AEC staff, over aspects of the report. Typical points at issue were: the appropriate contamination threshold for removal of soil from Runit and Boken; the scientific or technical basis for making a judgment that plutonium levels in the soil on Runit and Boken were high enough to justify removal of large amounts of soil; and the limited (3 weeks versus an annual program) air sampling data which indicated that airborne plutonium levels at Runit were quite low, comparable to some levels in the United States.[56]

Dr. William Ogle, an eminent scientist long associated with the nuclear test program, was consulted by DNA on the Task Group Report. He questioned the recommendation that the dri-Enewetak be kept off Enjebi until subsequent AEC measurements and analysis indicated that they could return to that island. His concern was based on the belief that the U.S. would not be in control indefinitely. He recommended that cleanup actions be taken which would allow the dri-Enewetak free use of the atoll in the future. Regarding Runit, he felt there was every reason to suspect that the problem was caused by small particles of plutonium. He questioned the need for the dri-Enewetak to stay off Runit.[57] He realized that the AEC recommendations assumed there was a genuine hazard, but he felt that the information available did not fully support that assumption. He felt that Runit should be cleaned as well as possible and turned over to the people.[58]

DNA believed that the recommended cleanup standards (in terms of residual radiation) were too low (that is, too conservative), that cleanup to these levels was not necessary, and that the funds likely to be made available for cleanup would not permit reducing residual radiation to these levels.

In commenting on the April 1974 draft, one AEC office expressed the belief that the plutonium cleanup could be generally characterized as "reduction of plutonium contamination accessibility" and recommended that no numerical guides be published for residual plutonium levels in soil except those essential for guidance of a group of experts in the field to advise on plutonium cleanup operations.[59] Others in AEC expressed concern that numerical standards provided for Enewetak would be misconstrued or misapplied to other locations such as the Nevada Test Site or Bikini Atoll.

After consideration of comments on the drafts, the AEC Task Group recommendations (discussed below) were published in final form on 19 June 1974. At a meeting of the Commissioners of the AEC on 12 August 1974, the recommendations were approved and subsequently forwarded to DNA on 16 August 1974.[60] The Director, DNA responded on 20 August 1974, advising the AEC that the recommendations had been adopted and would be reflected in the DEIS.[61]

The Task Group Report pointed out that the tasks required for Enewetak were similar to those carried out for the Bikini cleanup and rehabilitation,[62] and it stated that its recommendations for Enewetak were therefore similar to those that guided cleanup and rehabilitation of Bikini Atoll.[63]

The Task Group Report adopted radiation protection criteria for evaluation of the significance of dose estimates, and it recommended that the same criteria be used for planning the cleanup and rehabilitation. The criteria for dose limit to individuals were set at 50 percent of the Federal Radiation Council (FRC) annual rate limit, and 80 percent of the FRC 30-year genetic limit. These more stringent criteria were deemed appropriate so that individuals would not receive doses at the maximum level of current U.S. standards from weapon-test residue alone and to account for uncertainty in predicting doses.[64] Although the Task Group Report discussed the FRC annual rate limits for population as a whole, it did not use or recommend these FRC criteria. Instead, the Task Group Report recommended that the population dose "should be kept to the minimum practicable level."[65]

The Task Group Report noted that no criteria existed for radiological contamination of soil and food and that there were definite pathways whereby such contamination could lead to dose to individuals. The Enewetak Radiological Survey had obtained environmental data especially for evaluating dose via these pathways, and for all significant radionuclides at Enewetak. The Task Group Report singled out the soil-resuspension-inhalation pathway for plutonium as a key one on which experts could not agree how to estimate dose properly. Guidance on plutonium in soil was therefore considered needed, and the Task Group Report was careful to point out that any guidance it offered would not apply to the AEC at other locations. Thus, the Task Group Report recommended guidance on plutonium in soil that was unique to Enewetak Atoll. This guidance was that soil should be removed if the plutonium concentration exceeded 400 pCi/g of soil, and that it could be left in place if the concentration was less

than 40 pCi/g. For concentrations in the range of 40-400 pCi/g, decisions should be made on a case-by-case basis, considering the potential island use, the plutonium concentration near the ground surface, the potential for erosion, and the amount of effort involved in removing soil.

The NVO-140 Report had presented integrated dose estimates for periods of time ranging from 5 to 70 years. Since the Task Group adopted annual rate criteria to evaluate estimates, additional calculations were made, and the results of these calculations were included in the Task Group Report. Additionally, doses were estimated for bone marrow, rather than entire bone as had been done for the NVO-140 Report.

The Task Group Report added the dose estimates in numerous ways to obtain total estimates for various living patterns. The living patterns were structured to include preferences expressed by the dri-Enewetak. In combining estimates to produce total dose, the Task Group Report tested the improvements gained by adding clean soil to contaminated soil, by plowing contaminated soil, and by restricting the growing of certain crops. The Task Group Report was not enthusiastic about these alternatives or about soil removal as a dependable and feasible method for reducing dose via the dietary pathway.[66]

After comparing dose estimates against adopted criteria, and considering the desires of the dri-Enewetak, the Task Group Report recommended a living pattern which would not actually require any cleanup. Key features of this living pattern were that:

a. Residence and agriculture (except coconuts) would be restricted to southern islands.
b. Coconuts could be grown on northeast islands for subsistence and commercial purposes.
c. Fishing could be conducted anywhere.
d. Any island except Runit could be visited.

Minimum cleanup recommendations were offered to provide better assurance that the dose for the recommended living pattern would be minimized. These recommendations were that:

a. All radioactive scrap metal be removed.
b. Contaminated debris in "burial sites" be removed.
c. Runit be quarantined until plutonium contamination thereon was removed.
d. Plutonium contamination on Runit and Boken be removed.

The AEC Task Group Report also recommended that additional studies be conducted prior to rehabilitation to determine radioactivity in coconut and other food crops, in lens water, and in air under conditions approximating human habitation; and that after rehabilitation, continuing checks be made of the people and environment to assure that exposure criteria were not being approached or exceeded.

ENEWETAK ATOLL MASTER PLAN: MAY-NOVEMBER 1973

The Government agencies realized the importance of having the dri-Enewetak involved in every step of cleanup and rehabilitation of their homeland. On 20-23 February 1973 (the week after field work on the NVO-140 was completed), representatives from DNA, DOI, and AEC met in Honolulu with dri-Enewetak community council members, their attorney, and the Marshall Islands District Administrator to brief them on results of the recent surveys and to discuss their desires. The parties met again at Majuro, the Marshall Islands District Center, on 2-4 May 1973, this time with representatives of the TTPI. At this meeting, the idea of a Master Plan for rehabilitation and resettlement was proposed to provide information for the DEIS and for funding estimates. The Master Plan was to be developed by the TTPI, based on the expected results of the cleanup project and the desires of the dri-Enewetak. Conferees proposed that the people elect a Planning Council to work with TTPI in developing the Master Plan and with DNA in planning the cleanup project.[67]

The TTPI contracted with H&N to develop the Enewetak Master Plan. A survey team consisting of Mr. Carleton Hawpe, TTPI architectural consultant under contract to H&N, Mr. John Stewart, of AEC, and Mr. Ken Marsh, of LLL, visited Ujelang Atoll in July 1973 to coordinate with the Enewetak Planning Council. Mr. Hawpe was engaged by H&N at the request of the dri-Enewetak. He was a Peace Corps volunteer in the Marshall Islands, who had made his home in Majuro, and was well liked and fluent in Marshallese. Together, they covered all aspects of rehabilitation, resettlement, and development of the atoll. This survey, together with results of the Enewetak Engineering Survey, provided a basis for the first draft of the Master Plan, which was issued in November 1973.[68]

Since the AEC's Radiological Survey Report had not yet been completed, the draft Master Plan was based on certain assumptions derived from preliminary results of that survey. Upon issuance of the final Enewetak Radiological Survey Report, some of the assumptions proved not to be valid. Key among these was the draft Master Plan's assumption that Enewetak Atoll could be sufficiently cleaned of all radiological hazards so that Enjebi would be safe for habitation.[69] These changes in the radiological dose estimates and predictions required that the Master Plan be revised and republished in January 1975. Thus, the final Master Plan called for all residence to be on the southern islands, whereas the draft

Master Plan had been based on the dri-Enjebi returning to their home-island. Further details of the final Master Plan are contained in Chapter 10.

Information obtained from the meetings with the dri-Enewetak, plus data from the Engineering Study and from preliminary results of the Radiological Survey, was enough to begin preparing a DEIS for the project and to develop initial funding estimates. H&N was engaged by DNA to compile the DEIS, and they started work on 19 June 1973. On 21 June 1973, LTG Dunn testified before the House Subcommittee on Appropriations, seeking Fiscal Year (FY) 1974 funds to complete the planning studies and surveys.[70] A total of $270,000 was provided in FY 1974 for the EIS and other planning studies.

THE EXPLORATORY PROGRAM ON ENIWETOK: JUNE 1973

In June 1973, DNA decided to abandon the PACE II high explosive cratering program at Enewetak and so stipulated in the U.S. District Court in Hawaii. The court order preventing PACE II authorized the continuation of the PACE I geological studies, which were renamed the Exploratory Program on Eniwetok (EXPOE).[71]

Field studies for EXPOE began in October 1973 and included the core drilling of 46 bore holes (50-100m depth) on ten islands. The purpose was to define the near-subsurface geology of the atoll in order that preevent geologic models could be made at each of the six nuclear crater sites. In addition, seismic refraction profiles were conducted on the same islands to define seismic velocities. Also in the program approved by the District Court was a 40-foot, cylindrical, high explosive, in situ test, which was conducted at the PACE test bed on Aomon to provide dynamic material properties of the PACE media. Several miles of over-water seismic reflection profiles also were conducted during EXPOE. These over-water seismic studies centered on the three high-yield nuclear craters (Oak, 9 megatons; Mike, 10.4 megatons; and Koa, 1.37 megatons) and provided significant information concerning the subsurface morphology of the craters. In addition to the EXPOE field studies, a comprehensive search was conducted of old photos, films, drawings, etc., to define the exact crater dimensions, device emplacement details, device yield and performance details, and ejecta and debris distribution for the cratering events.[72]

Several significant studies were conducted in support of the PACE and EXPOE programs. These additional studies included: soil and water surveys in the northern part of the atoll for radioactive debris location and characterization; analysis of previous studies on cratering and testing in general; flora and fauna ecological studies; and identification of water-well sampling sites for DOE. These studies proved useful in planning the cleanup and rehabilitation of Enewetak. The most valuable by-products of PACE and EXPOE for the cleanup project were geological data for the selection of quarry sites and design of crater containment for radiological contamination; and soil chemistry analyses applicable to contaminated soil surveys.[73]

A NEW DIRECTOR'S NEW MISSION: SEPTEMBER 1973

In September 1973, LTG Dunn completed his 3-year assignment as Director, DNA and was replaced by Lieutenant General Warren D. Johnson, USAF, who had been at the Agency since July 1973 as Deputy Director for Operations and Administration. The new Director was confronted by a new mission. The Air Force proposed that DNA assume responsibility for operation and maintenance of the austere base camp at Enewetak Atoll.[74,75] LTG Johnson did not concur and presented DNA's case to the ASD(ISA). The Agency had transferred the last of its installations to the Military Services in July 1971, based on a Secretary of Defense policy decision that DNA would not operate installations.[76] The Air Force was proposing that an exception be made in this case, and DNA did not have the resources to manage a base. In July 1973, the Air Force had transferred management of Johnston Atoll to DNA, and now, before DNA had time to assimilate that new mission, the Air Force was proposing to transfer another installation. Nevertheless, ASD(ISA) decided to transfer Enewetak Atoll to DNA,[77] and the change of responsibility occurred on 1 January 1974. In accepting the mission, DNA and the Air Force agreed to the transfer of three Air Force manpower positions to help manage the new mission in the Pacific.[78]

FY 1975 MILITARY CONSTRUCTION PROGRAM: 1973 - 1974

Formal guidance on funding responsibility was received from OMB on 18 October 1973, in a memorandum which confirmed the decisions made during the previous year (see "Assignment of Responsibilities," above). It recognized the incomplete state of planning for cleanup and rehabilitation but advised the agencies to request sufficient funds to initiate some cleanup effort in FY 1975 to show continuing Administration commitment to the cleanup and rehabilitation of the atoll. The FY 1975 President's Budget was to reflect the following agency responsibilities: DOD for maintaining ongoing facilities and operations in Enewetak and for cleanup operations; DOI for rehabilitation; and AEC for radiological monitoring and survey.[79]

The first problem for DNA was to decide which appropriation should fund the cleanup project. Operations at Enewetak Atoll during the various tests had been financed primarily with Research, Development, Test and Evaluation (RDT&E) funds. RDT&E funds could be requested for the cleanup project, since their purpose was to close out an RDT&E facility and since the radiological cleanup certainly would require research and development of new technology. However, the use of such funds for cleanup might conflict with, and dilute, DNA's normal RDT&E program funding. For this and other reasons, it was decided to treat the cleanup project as a site-restoration and site-preparation project; i.e., preparing the site for DOI's construction work in the Rehabilitation Program. On this basis, the cleanup project was treated as a Military Construction (MILCON) Program.[80] Since MILCON channels within DOD and the Congress are accustomed to traditional construction projects, there were many difficulties in explaining and justifying the more unorthodox Enewetak Cleanup Project request through these channels.

DNA's initial FY 1975 request was for a $35.5 million authorization for a MILCON program for radiological and other cleanup efforts.[81] A revised estimate was submitted on 21 November 1973 to include an additional $1.5 million to reimburse AEC for radiological support of cleanup, as agreed at the 7 September 1972 conference. The revised request of $37 million was to be appropriated as follows: $12.5 million in FY 1975, $21.7 million in FY 1976, and $2.8 million in FY 1977.[82]

OMB/DOD Program Budget Decision Number 166 reduced the FY 1975 request to $4 million and recommended $21.2 million for FY 1976 and $10.3 million for FY 1977. The additional funding to reimburse AEC was not addressed in the decision.[83] DNA requested that funding for this support be included, giving new totals of $21.7 million in FY 1976 and $11.3 million FY 1977.[84] The President's Budget for FY 1975 requested an initial MILCON appropriation of $4 million to provide for initial mobilization and base camp rehabilitation. The authorization request was approved by the Senate Armed Services Committee; however, the House Committee on Armed Services denied authorization of FY 1975 funds for the initial phase of cleanup on the grounds that "insufficient planning had been completed to permit a firm estimate of overall costs."[85] The Joint Conference Committee upheld the House Committee's position, thus ending action on the matter in the first session of the 93d Congress.[86] Meanwhile, other preparations for the cleanup project were progressing.

FY 1975 CONCEPT PLANNING: 1974

DNA's original concept for accomplishing the cleanup was to contract it out to a private construction company. Defense Agencies such as DNA normally cannot directly let construction contracts financed by MILCON funds but must go through the military construction agencies; e.g., the Naval Facilities Engineering Command or the Army Corps of Engineers. Therefore, DNA planned to have the Pacific Ocean Division (POD) of the Corps of Engineers accomplish the actual contracting, including design, preparation, award of the contract, and monitoring of the contractor's performance. As the using agency, or client, for whom the work would be done, DNA was to furnish basic concepts for accomplishing and supporting the cleanup project. Responsibility for developing these concepts was assigned to DMA's operational element, Field Command, DNA.

Field Command, DNA, a joint service organization located in Albuquerque, New Mexico, was commanded in 1974 by Rear Admiral L. V. Swanson, USN. In addition to being responsible for developing cleanup concepts, Field Command was tasked to assume the responsibility for operation and maintenance of the base camp at Enewetak Atoll, effective 1 January 1974. Field Command's Logistics Directorate, under Colonel Alan C. Esser, USA, was assigned primary staff responsibility for both efforts. On 23-25 January 1974, representatives from DNA's Headquarters and Field Command traveled to Enewetak Atoll to inspect base camp operations and maintenance and to confer with POD officials on cleanup project concepts. Major General John McEnery, USA, Deputy Director for Operations and Administration, DNA, headed the conference, which included Mr. Earl Eagles, of DNA; COL Esser, Lieutenant Colonel Donald B. Hente, USAF, and Mr. David Wilson, of Field Command; Commander Fritz Wolff, of AEC Headquarters; Mr Roger Ray, of AEC-NV; Mr. Harry Brown, of DOI; Colonel John Hughes, USA, of POD; and Mr. Earl Gilmore, of H&N. While radiological planning awaited several key decisions, the conference established several basic concepts for base camp rehabilitation and noncontaminated cleanup including:[87]

a. A Joint Task Group (JTG) would be formed to coordinate and control the cleanup operation.
b. A temporary base camp would be established in the northern islands to support cleanup in that area and reduce transportation time and requirements.
c. Costs would be reduced by using existing military equipment.
d. There would be only one contractor at Enewetak who would operate the base camp as well as accomplish the actual cleanup described in the Engineering Study.
e. POD would serve as contracting office for the cleanup contract.
f. DOI would have POD contract for their rehabilitation program, possibly using the same contractor as DOD used for cleanup.

Subsequent Congressional actions precluded use of a contractor for the cleanup itself; however, the first three concepts remained valid throughout subsequent cleanup planning.

On 30 January 1974, Field Command formed the Field Command Planning Group of civil engineering, finance, and supply and services experts to develop concept plans, cost estimates, and MILCON program documents for the cleanup project.[88] Major Earl Kinsley, USAF, of AFWL, who had been the radiological safety officer for the PACE program and who had participated in the radiological cleanup at Palomares, Spain, served as radiological advisor to the Field Command Planning Group until his retirement when he was replaced by Dr. E. T. Bramlitt of Field Command.

The group's first planning effort was to develop plans and recommendations based on the January 1974 conference at Enewetak. They included the proposed manning for a JTG staff, some of whom would be assigned on a 3- to 4-year permanent change of station (PCS) basis to Hawaii and work at Enewetak on a rotational temporary duty (TDY) basis to provide engineering and management continuity. Had other planning and funding efforts remained on schedule, this PCS group would have initiated and completed the entire cleanup project. The concept later was dropped when funding problems made it difficult to implement. The group also recommended that Field Command be delegated responsibility and authority at the earliest moment to manage the cleanup project and to coordinate with POD on project definition and base camp rehabilitation.[89] Headquarters, DNA did not accept that recommendation in its entirety;[90] however, Field Command was subsequently assigned responsibility for operational management of the cleanup project.[91]

During the 2d session of the 93d Congress, Headquarters, DNA continued its efforts to obtain authorization and appropriation, with hearings before committees of both Houses.[92,93,94,95,96] At the same time, work was progressing on development of the EIS.

THE DRAFT ENVIRONMENTAL IMPACT STATEMENT: APRIL-SEPTEMBER 1974

The NEPA requires that an EIS be prepared for any major action which significantly affects the quality of the human environment.[97] The act covers not only actions which might have adverse effects but also those intended to have beneficial effects, such as the cleanup, rehabilitation, and resettlement of Enewetak Atoll. DNA assumed the responsibility for preparation of an EIS which covered not only the cleanup project but also the rehabilitation and resettlement efforts. In January 1973, DNA engaged H&N to develop a DEIS.[98]

The NEPA requires utilization of a systematic interdisciplinary approach which insures integrated use of the natural and social sciences in planning and decision-making. To satisfy this requirement, extensive information was needed on the condition of the atoll, social and economic background of the people, plans for future use of the atoll and, above all, guidelines on the cleanup and disposition of radiological contamination. Some of this information was available in the Enewetak Engineering Study; however, much of the material was just then being developed in the Master Plan, the Enewetak Radiological Survey, and the AEC Task Group Report and would not be available for more than 18 months. Meanwhile, there was pressure to provide plans and cost estimates for MILCON program authorization and appropriation requests. In response to these pressures, a preliminary DEIS was prepared, based on the best available, albeit incomplete, information. Thus, when this preliminary DEIS was circulated to the participating federal agencies for review in April 1974,[99] it did not reflect an approved position on radiation exposures and cleanup guidelines (since the AEC position had not yet been defined). Rather, it contained alternative solutions developed to show minimum and maximum required resources. Some of the information in the preliminary DEIS concerning potential impacts was quite controversial. The Director, DNA had planned to publish the formal DEIS for comment by 15 May 1974 and the final EIS on 15 September 1974.[100] As a result of the critical nature of some comments on the preliminary DEIS and the concern over public acceptance of the concepts, publication of the formal DEIS was delayed until approved radiological guidelines were available on 16 August 1974. Instead of 15 May 1974, it was 7 September 1974 before the formal DEIS was issued for public review and comment.[101]

The DEIS consisted of three volumes. Volume I included a review of the radiological and physical condition of the atoll and described several cleanup and habitation alternatives, an evaluation of their effects, a selection of a preferred cleanup operation, and a proposed rehabilitation and resettlement plan. Volume II contained extracts from related reference documents, including the 1972 Enewetak Radiological Survey and the 1973 Master Plan for Rehabilitation and Resettlement, plus calculations and other supporting data. Volume III was a resume of the DEIS in the Marshallese language and a direct retranslation of that resume into English.[102]

The approach taken in the DEIS was to identify all reasonable courses of action, evaluate the advantages and disadvantages of each, and arrive at the safest and most effective solution. The AEC had established recommended guidelines for use in the radiological cleanup (Figure 2-1).

Critical Organs	Individual in Population (AEC Task Group Report)
Whole Body	0.25
Bone	0.75
Bone Marrow	0.25
Gonads	4 rems in 30 years
Thyroid	0.75

These guides are Atomic Energy Commission Task Group Report recommendations applicable to the Enewetak Atoll Situation. They are derived from the Federal Radiation Council (FRC) Radiation Protection Guides (RPG) by using 50 percent of the FRC RPG for individual exposure and 80 percent of the FRC RPG guide for gonadal exposure. These reduced values are recommended as a necessary precaution to allow for uncertainty in prediction of annual exposures to individuals in the alternative programs.

FIGURE 2-1. DOSE GUIDELINES FOR ENEWETAK ATOLL (REM/YR).

The cleanup would remove as much radioactivity as possible from the islands, after which other remedial measures would be relied upon to reduce the predicted dose to lower levels, if necessary. If the cleanup did not result in a predicted dose less than the AEC guidelines for Enewetak Atoll, the return of the dri-Enewetak to the atoll would not be recommended.[103]

In accordance with the recommendations of the AEC Task Group Report, options for cleanup of radiological hazards were limited to removal of contaminated scrap and removal of plutonium-contaminated soil. A third possibility, that of removing soil contaminated with fission products; i.e., cesium-137 and strontium-90, was determined to be counterproductive at best and possibly irrevocably destructive. It required removal of such vast amounts of soil that it would result in severe ecological damage and would not positively assure the radiological safety of the people.[104] It was decided to leave the fission products to decay naturally. (The fission products have half-lives of about 30 years in contrast to the plutonium half-life of about 24,000 years.)

Following the alternatives and recommendations of the Enewetak Radiological Survey, the Master Plan, and the AEC Task Group Report, the DEIS outlined several options for habitation as a means of minimizing predicted doses. These were based on restricting the use of various islands; i.e., using only the cleanest for residence; the next cleanest for agriculture, and the next for visiting and food gathering (Figure 2-2).[105]

The cleanup and rehabilitation alternatives considered in the DEIS were based on three possible cleanup actions and four habitation plans. The cleanup actions were identified as:

I. No cleanup.

II. Removal of all hazardous, obstructive, and radioactive scrap; plutonium concentrations greater than 400 pCi/g from four islands, Lujor (Pearl), Aomon, Boken, and Runit; and other soil with plutonium concentrations between 40 and 400 pCi/g on a case-by-case basis.

III. Extensive cleanup of residential and agricultural islands. The four habitation plans were identified as:

A. No restrictions on island or food usage.

B. Live on southern islands and Enjebi; visit northern islands; use food from southern islands or Enjebi, plus coconuts from 12 northeast islands, and pandanus and breadfruit from Enjebi farm plots or imported.

C. Live on southern islands; visit northern islands; use food from southern islands plus coconuts from 12 northeast islands.

D. Live on southern islands; visit southern islands only; use food grown on southern islands only.

Habitation Plan	Residence Islands	Food Sources	
		Agriculture Islands	Foods[a]
A	All[b]	All[b]	All[b]
B	Southern islands and Enjebi	Southern islands	All
		Enjebi	Pandanus and Breadfruit[c]
C	Southern islands	Southern islands	All
		Northern islands	Coconut only
D	Southern islands	Southern islands	All

[a]Foods grown in existing soil, except where noted.

[b]People should not be permitted to return to Enewetak Atoll if cleanup does not result in dose reductions equivalent to or less than the AEC criteria, Figure 2-1.

[c]Foods grown in farming plots produced by removing radioactive soil and replacing it with nonradioactive soil in sufficient volume to contain mature root systems of these plants.

FIGURE 2-2. EXPLANATION OF HABITATION PLANS.

There were 12 possible combinations of cleanup actions and rehabilitation plans. Some were found to be incompatible, and others were rejected for basic deficiencies. Of those remaining, a matrix was constructed (Figure 2-3) to show a reasonable range of alternatives. Five representative combinations were chosen for detailed analysis of dose reduction, health effects, cost, and general acceptability. The five cases (shown in Figure 2-3) are described briefly as follows:

Case 1: No cleanup; use of all islands without restriction as indicated in the 1973 Master Plan. This case was rejected as it would expose the people to all of the radiological and physical hazards existing in the atoll.

Case 2: No radiological cleanup; removal of physical hazards and obstructions to use on the southern islands, Jinedrol (Alvin) through Kidrenen (Keith); residence on the southern islands only; use of food grown on only southern islands. This case was rejected as it did not permit eventual use of the northern islands.

Case 3: Removal of hazardous and obstructive scrap from all islands and removal of an estimated 79,000 cubic yards of plutonium concentrations from Boken, Lujor, Aomon, and Runit (Figure 2-4); disposal of contaminated debris and soil by one of several options including crater containment; residence on southern islands only; use only coconuts from northern islands. (Enjebi was regarded as a special case by the AEC Task Group, and Case 3 did not include removal of plutonium concentrations in

Cleanup Actions \ Habitation Plans	A All islands used in accordance with Enewetak Master Plan	B Live on Enjebi and southern islands, use food grown on Enjebi; use pandanus and breadfruit grown only in farming plots on Enjebi or imported to Enjebi	C Live on southern islands; use only coconut from nothern islands	D Live on southern islands; use food grown on only southern islands
I No cleanup	Case 1 AEC Option I[a]			Case 2[b] AEC Option II
II Removal of hazardous and obstructive nonradioactive scrap, and radioactive scrap from all islands. Removal of Pu concentrations from four islands.[c]		Case 4 AEC Option IV	Case 3 AEC Option III	
III. Extensive cleanup of residence and agriculture islands[d]	Case 5 Approximately AEC Option V			

[a] "Report by the AEC Task Group on Recommendations for Cleanup and Rehabilitation of Enewetak," June 19, 1974

[b] Case 2 differs from other programs in Row 1 by removal of physical hazard and obstructive debris categories of radioactive and nonradioactive scrap on southern islands.

[c] Plutonium concentrations refer to burial grounds and soil dispersions of concentration in excess of 40 pCi/g. Areas of soil concentration in excess of 400 pCi/g should be removed without question; areas of soil concentration between 40 and 400 pCi/g should be considered on an individual basis.

[d] Removal of all scrap from all residence islands specified in each column and removal of specific amounts of soil in specific areas to achieve external and internal doses no greater than would be absorbed from naturally occurring sources.

FIGURE 2-3. ALTERNATIVE CLEANUP AND HABITATION PROGRAMS.

Island		Remarks	Level of Pu Concentration*
Local Name	Code Name		
Boken	IRENE	Isopleth J**	1, 2
Runit	YVONNE	Northern half, Pu burial grounds	1, 2
Lujor	PEARL	Hot spot	1, 2
Aomon	SALLY	Pu burial grounds	1
Bokuluo	ALICE		2
Bokombako	BELLE		2
Kirunu	CLARA		2
Louj	DAISY		2
Mijikadrek	KATE		2
Kidrinen	LUCY		2
Aej	OLIVE		2
Eleleron	RUBY		2

*Actions assumed for specific ranges of Pu concentration are tabulated as follows:

Level	Plutonium Concentration (pCi/g Soil)	Action
1	>400	Soil removal by repetitive scraping
2	$40 \leq C \leq 400$	Individual case consideration

All other islands have Pu concentrations < 40 pCi/g and do not require cleanup action.

**TAB A, Volume II, NVO 140, Enewetak Radiological Survey.

FIGURE 2-4. ISLANDS REQUIRING PLUTONIUM CLEANUP PROCEDURES.

soil on this island.) Case 3 was preferred based on the premise that safeguarding the Enewetak people from harmful radioactivity was of prime importance, and it was uncertain that Case 4 or Case 5 actions would be effective in reducing exposure potentials so that more of the northern islands could be used.

Case 4: Same cleanup and disposal as Case 3 plus removal of 239,000 cubic yards of soil from Enjebi and replacement with imported soil; same island use as Case 3 plus use of Enjebi for residence and some controlled agriculture. This case was rejected because predicted doses from the proposed use of Enjebi exceeded AEC criteria and because of the great

uncertainty of maintaining the controls necessary to reach those reduced doses.

Case 5: Same cleanup as Case 3 plus removal of over 700,000 cubic yards of soil from other islands; disposal of contaminated debris and soil by ocean dumping; replacement of soil from scraped areas with imported soil; and use of all islands with no restrictions as indicated in the 1973 Master Plan. This case was rejected because of the uncertainty that it would actually reduce exposures and because it was inordinately expensive.[106]

The preferred Case 3 combined Cleanup Action II and Habitation Plan C and permitted reasonable use of the entire atoll (Figure 2-5). Not all reviewers agreed with the selection of Case 3 as the optimum case or even that it was an acceptable case. Some AEC officials argued strongly for the cleanup of Enjebi and further study of the Runit cleanup problem. Most of those involved, however, believed that Case 3 provided a practical basis for cleanup, rehabilitation, and resettlement.

LTG Johnson personally presented copies of the DEIS to the Enewetak people and their attorney, Mr. T. R. Mitchell, at a high-level meeting on Enewetak on 7 September 1974. Other attendees included: Mr. Stanley S. Carpenter, Director, Office of Territorial Affairs, DOI; Mr. William Rowe, Deputy Assistant Administrator, EPA; Mr. Peter T. Coleman, Deputy High Commissioner, TTPI; Messrs. Martin Biles, William W. Burr, Jr., and Mahlon E. Gates, of AEC; RADM Swanson, Brigadier General Wesley E. Peel, USA, POD Engineer; Mr. Earl Gilmore, H&N; and Mr. Amata Kabua, then Senator in the Congress of Micronesia and subsequently President of the Marshall Islands. Representatives from the Marshalls District Legislature and the Bikini Atoll Council also participated. Motion pictures and illustrated briefings covering nuclear testing, the Radiological Survey, the Engineering Survey, the Master Plan, and the DEIS were presented in both English and Marshallese to the over 100 dri-Enewetak who attended.[107] The Government's plans were generally well received by the people; however, they had misgivings about some aspects, particularly not being able to live on Enjebi, the plan for on-atoll disposal of radiological contamination, and the possibility that Runit might not be cleaned enough to preclude the need for quarantine.[108] Upon his return to Washington, LTG Johnson was forced to send the people more discouraging news: Congress had again denied funds to begin cleanup in FY 1975 on the grounds that insufficient planning had been completed to permit a firm estimate of overall cost.[109,110]

During the conference, it had been agreed that some 50 dri-Enewetak, including the Planning Council, should return to the atoll early and live on Japtan during the cleanup project to consult and advise on cleanup and rehabilitation problems. The early return was contingent on Congress

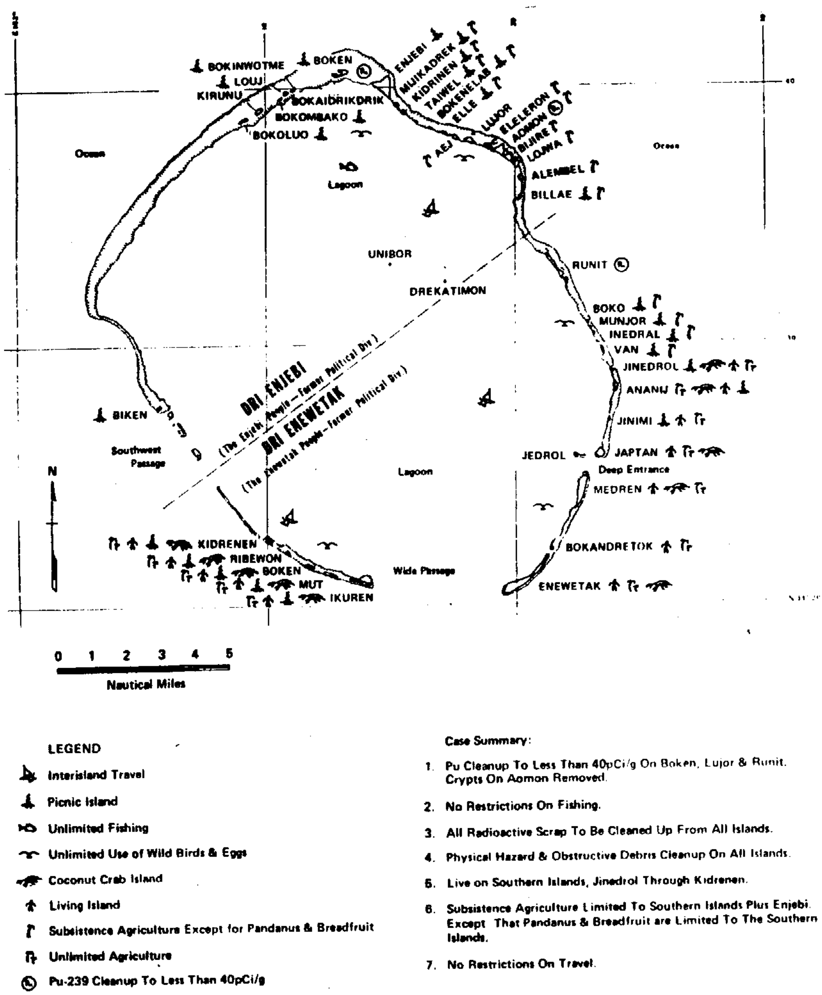


FIGURE 2-5. ENEWETAK ATOLL, CASE 3.

approving and funding the project; and this, in turn, was contingent on the action agencies resolving the radiological cleanup problems and developing more complete cleanup plans and funding programs.

RADIOLOGICAL PROBLEMS AND ISSUES: 1974

The cleanup and disposal of radiological hazards at Enewetak Atoll posed problems which still have worldwide interest. Cleanup of radioactive contamination and disposal of radioactive waste are potential peacetime problems for the nuclear nations, as well as attendant problems during nuclear war. Enewetak Atoll was not the first peacetime radiological cleanup project. It was preceded by more limited efforts at Palomares, Spain; Thule, Greenland; Bikini Atoll; and Los Alamos, New Mexico. They all posed the same basic questions:

- How much radioactivity is there?
- How much radioactivity is too much?
- How can one remove any excess radioactivity?
- How can one dispose of any excess radioactivity?

The data on locations and amounts of radioactivity provided by the Enewetak Radiological Survey were adequate for development of general plans and gross cost estimates for removal of all or part of it. However, as the DEIS indicated, detailed field surveys would be required to provide the precise data needed before radiological cleanup could begin. Identifying contaminated debris is relatively simple compared to the problem of detecting and measuring contamination in soil. The Enewetak Radiological Survey and DEIS referred to soil contamination in terms of activity level per unit weight of soil; i.e., measurements of pCi/g. Sampling every gram on every island was clearly impractical, even if it had been possible. The technology for conducting radiological field surveys of contaminated soil was still in the developmental stage and it remained so until well into the actual cleanup operations. This problem did not delay development of the EIS or MILCON program, however.

Probably the most complex radiological question was (and still is): What amounts of radioactivity constitute a hazard? Answering that question requires data on the potential sources of exposure (air, water, soil, food, etc.); access to exposure (lifestyle, diet, etc.); organs affected (lungs, bone, etc.); and potential adverse effects. All of these factors must be known before a dose assessment can be made and the hazard can be evaluated. Many of the comments on the DEIS recommended actions to quantify these factors, such as including the contribution from ground water in the dose estimates,[111,112,113] conducting an air sampling program,[114] and establishing long-term monitoring programs.[115,116,117] These recommendations were adopted by DNA and the AEC.

DEIS criteria for contaminated soil were strongly challenged by the MLSC, the Natural Resources Defense Council and others. They suggested that criteria for cleanup should not be set until either the ICRP, the EPA, or the United Nations Scientific Committee on the Effects of Atomic Radiation set standards.[118] Some suggested that the "hot particle" theory must be used in determining contaminated soil criteria. These suggestions would have delayed the soil cleanup indefinitely. DNA believed the delay was unnecessary, since the AEC and DOD had set decontamination standards in 1968 for plutonium-in-soil in the event of a nuclear accident. These standards directed that plutonium concentration should be reduced, if possible, when levels are greater than 1000 micrograms per square meter. This value equates to about 265 pCi/g when averaged over a 15-cm depth of soil whose density is 1.5 gram per cubic centimeter. The Enewetak Cleanup DEIS specified removal of plutonium-contaminated soil when the "proximate" surface concentration (top 15 cm) is greater than 40 pCi/g and when the concentration at any depth is greater than 400 pCi/g. Thus, the DEIS criteria were much more conservative than existing DOD guides for cleanup of areas anywhere in the world.[119]

MLSC comments contended that the criterion of 40 pCi/g averaged over the top 15 cm of soil was too great and recommended that the State of Colorado standard of 0.91 pCi/g averaged over the top 1 cm should be adopted for the cleanup.[120] However, DEIS cleanup criteria were based on adherence to reasonable constraints on living patterns and diet by the people after they returned to Enewetak. Colorado criteria assumed no constraints, and they were not based on known or estimated radiation effects to man but on the arbitrary basis of approximately 25 times the level of plutonium in Colorado soils as a result of worldwide fallout.[121]

DEIS soil cleanup criteria also were challenged on the basis that they did not consider the "hot particle" theory which, according to Tamplin, Cochran, Geesaman, and Martell, indicated that existing plutonium exposure standards were too low.[122,123] DNA responded that the theory had not yet been accepted in the national or international standards for radiological protection and that only the existing guidance could be considered.[124] Soil cleanup criteria remained a highly controversial matter throughout the planning phases of the project, and even into the actual cleanup, as is described in subsequent sections.

Disposition of radioactive debris and structures can be accomplished by standard construction techniques such as cutting, sandblasting, encasing, or sealing. Removal of plutonium contamination in soil has two solutions: (1) remove the plutonium from the soil (extraction); or (2) remove the

plutonium with the soil (excision). Extraction of plutonium from waste or soil is theoretically possible, and the technology has been explored by other countries. It was suggested by the AEC Task Group,[125] but a practicable technique was not available for field use since national policy precluded development or use of such technology. Thus, the only practicable process was excision—the stripping of successive layers of soil using earth-moving equipment until acceptable radiation levels were reached.[126]

Disposal of radioactive waste is one of the most controversial problems this nation faces. This was especially true as it applied to the Enewetak Cleanup Project. The Enewetak people's position was made clear in their earliest meetings with DNA[127] and was restated in their counsel's comments on the DEIS: Disposal on the atoll was rejected, and off-atoll disposal was the only acceptable solution. Several other solutions had been suggested during the radiological surveys, including use of a small island as a disposal dump,[128] packaging and shipping to the Nevada Test Site,[129] burial in place, and dumping in the lagoon.[130] The DEIS considered four alternatives for disposal:

- Level 1 - Crater Dumping, by which radioactive materials would be dumped in Cactus Crater (and in Lacrosse Crater, if required) with no further action to fix the materials in place. (The craters were named for the nuclear test shots which had created them.) The estimated cost for disposal of materials from a Case 3 cleanup using this method was $320,000.
- Level 2 - Ocean Dumping, by which radioactive materials would be containerized and dumped in the ocean at a deep-water site. The estimated cost for disposal of materials from a Case 3 cleanup using this method was $9,989,000.
- Level 3 - CONUS Disposal, by which radioactive materials would be sealed in containers and shipped to the United States for disposal. The estimated cost for disposal of materials for a Case 3 cleanup using this method was $18,910,000.
- Level 4 - Crater Entombment, by which contaminated soil and debris would be entombed in Lacrosse Crater (and in Cactus Crater, if required) by sealing the cracks in the crater, mixing the plutonium-contaminated soil with cement to form a slurry, and pumping the slurry into the crater around the contaminated debris, thereby encasing all the radioactive materials in a solid mass. The mass would be covered by an 18-inch thick concrete cap or lid, to provide an erosion resistant crypt which would seal off the radioactive material. The estimated cost for disposal of materials from a Case 3 cleanup using this method was $6,968,000.[131]

The dri-Enewetak and their attorney were on record as being opposed to any disposal of radioactive material on the atoll. AEC-NV strongly supported their position in commenting on the preliminary DEIS.[132]

Considering the relatively short radiological half-lives of the fission products and the induced radioactivity found on much of the debris, the AEC Task Group suggested that the debris be disposed of in shallow burial crypts on the land, in underwater craters, or in the deeper portions of the lagoon. The Task Group recommended that plutonium-contaminated soil and debris be stockpiled on Runit, pending determination of a final disposal method. Several methods were suggested, including returning it to the United States, casting it into concrete blocks, dumping it into a crater with a concrete cap, or dumping it in the ocean or lagoon.[133]

The EPA objected to the lagoon-dumping or ocean-dumping options contained in the draft AEC Task Group Report, citing Title I, Sec. 101(c) of Public Law 92-532 which states: "No office, employee, agent, department, agency, or instrumentality of the United States shall transport from any location outside the United States any radiological, chemical, or biological warfare agent or any high-level radioactive waste for the purpose of dumping it into ocean waters." EPA's response to AEC also pointed out that a United States national policy prohibiting ocean-dumping of radioactive wastes had been in effect since 1970. Any proposal to reverse such a policy would have to involve the Department of State because the United States had already ratified the International Ocean Dumping Treaty.[134]

DNA's overriding consideration on this issue was the identification of an option which could gain eventual approval so that the cleanup project could proceed. EPA and DNA officials conferred on 8 August 1974 regarding disposal options in the DEIS. EPA took the same position it had taken with AEC on the ocean-dumping option.[135] The intent of Public Law 92-532 was to prohibit ocean-dumping of materials produced for radiological warfare.[136,137] Even though materials had been used for radiological testing instead of warfare, their toxicity and effect on the environment was unchanged. Even if, by some unusual logic, the contaminated materials were considered an unprohibited waste eligible for ocean dumping, the law required extensive research and special actions before EPA would authorize ocean dumping.[138] The materials would have to be placed in a container that would remain intact until contamination radiodecayed to an environmentally innocuous material, which EPA interpreted to be five half-lives.[139] This would have required the plutonium-contaminated soil containers to last for nearly 125,000 years. Ocean dumping appeared to be legally difficult.

After the radiological cleanup at Palomares, Spain, 1,310 cubic yards of contaminated soil and vegetation in 55-gallon drums had been returned to the United States for retrievable storage at Savannah River.[140] The 79,000 to 779,000 cubic yards of contamination the radiological cleanup of Enewetak might generate clearly represented a much greater problem. The conferees agreed that CONUS disposal was uneconomical, would generate considerable political resistance, and would adversely affect the entire project.[141] This option was dropped from further consideration in planning for the disposal of contaminated material.

The conferees discussed the remaining options contained in the DEIS: use of the craters on Runit, with or without cement slurry and cap. It was decided that stabilizing the radioactive contaminants in cement would provide retrievable storage. Until a more permanent solution was found, retrievable storage continued to be the only method acceptable to the United States for disposal of such waste. It had been placed in covered trenches in Los Alamos, and in caves in Nevada; but both DNA and EPA believed that cement stabilization would be necessary at Enewetak Atoll to minimize access of the contaminants to the population and environment.[142]

The question of crater volume also was considered at the 8 August 1974 EPA-DNA conference. The April 1974 preliminary DEIS had indicated that Cactus Crater would be used, then Lacrosse Crater if required. It had been estimated that there were approximately 101,800 cubic yards of material to be placed in the crater (7,300 cubic yards of debris and scrap, 87,800 cubic yards of contaminated soil-cement mixture, and 6,700 cubic yards in the concrete cap). It was estimated that Cactus Crater would hold less than half of that amount (about 52,000 cubic yards). Lacrosse Crater had an estimated volume of 105,225 cubic yards.[143] The conferees agreed that Lacrosse Crater should be filled first, even though Cactus Crater was closer to the island. This made covering the cap with soil, as proposed in the preliminary DEIS, less practical (since Lacrosse was on the reef), and that proposal was abandoned. Entombment in Lacrosse Crater was the method prescribed in the September 1974 DEIS for disposal of radiologically contaminated soil and debris. The conferees also agreed that uncontaminated scrap and debris should be disposed of in the deepest part of the Enewetak Atoll lagoon.[144] This was omitted from the September 1974 DEIS[145] but was included in the final EIS.[146]

OCEAN DUMPING VERSUS CRATER CONTAINMENT: DECEMBER 1974

The AEC remained unconvinced that ocean dumping was not a viable option for disposal of plutonium contamination. In separate letters on 9 and 23 December 1974, they argued in favor of ocean dumping instead of crater entombment.[147,148] They recommended that the crater entombment option be deleted from the EIS and that the contaminated soil be stored temporarily on Runit while other options for eventual disposal were studied by AEC.[149] However, they advised that AEC was not committed to provide any additional recommendation on the eventual disposal of contaminated soil and that disposal was a DNA responsibility.[150]

The basic argument presented by proponents of ocean dumping was one commonly heard: compared to the amount of long-lived alpha contamination already dumped in the ocean, the amount from Enewetak would be insignificant. The AEC estimated there were only a few hundred grams of actual plutonium in all of the contaminated soil of Enewetak, and that at least a hundred kilograms of plutonium had already been dumped in the ocean from 1947 through 1974.[151] In other words, the additional damage that might be done was negligible compared to the possible damage that had already been done. The counterargument was also familiar: past damage probably cannot be undone, but any additional abuse to the system should be stopped completely. DNA continued planning on crater containment of contaminated soil and debris because this seemed to be the only option that would be acceptable.

On 14 February 1975, representatives from the action agencies met with the POD in Honolulu to refine plans for cleanup and rehabilitation. Conferees included: Mr. Peter T. Coleman, Deputy High Commissioner, TTPI; Mr. Oscar DeBrum, District Administrator, Marshall Islands; BG Peel, Division Engineer, POD; Mr. Earl Eagles, HQ DNA; Mr. Tommy McCraw, Energy Research and Development Administration (ERDA, formerly AEC); Mr. Harry Brown, DOI; COL Esser, Field Command; and Mr. Earl Gilmore, H&N. Much of their discussion concerned development of POD contracts for the cleanup and rehabilitation effort. (These were never written due to subsequent Congressional actions.) More useful discussions were held on the matter of crater entombment. DNA requested that POD develop a design for the crater and cost estimates for that part of the project. Also, POD was asked to provide cost estimates for the complete (Case 5) cleanup which MLSC desired. DOD and DOI tasks in the cleanup and rehabilitation efforts were reviewed in detail. The conferees also agreed that DNA and ERDA would develop a much needed Radiological Support Plan.[152]

On 24 February 1975, DNA, ERDA, and EPA representatives conferred again on the disposal method for radiologically contaminated materials. ERDA was able to present its case directly to EPA. No allowance had been made in the AEC Task Group's dose assessment for any radioactivity that might leak from the crater-entombed matrix into the lagoon or nearby ocean. For this and other reasons, ERDA preferred ocean dumping. EPA pointed out that the amount of plutonium which had already been deposited in the lagoon and was circulating in its waters was probably much greater than any that might leak from the crater.[153,154] In fact, there was a far greater amount of fallout in the lagoon than there was left on the islands to be cleaned up. The lagoon had a far greater area than the islands, and material from the islands tended to be washed into the lagoon.

EPA described the measures necessary to obtain a permit in the unlikely event the plutonium contamination could be considered something other than "material in any form produced for radiological warfare purposes." The criteria for issuance of a permit were summarized as: (1) establishment of a need to dump; (2) lack of an alternative means of disposal; (3) definition of the potential damage that could result to the marine environment; and (4) the effect of the proposed dumping on other users of the area. Permits could be granted only for an approved dump site. Obtaining approval for a dumping site required selection of a definite site, a survey of the dumping area (including the benthic community) and the ocean currents, and definition of the monitoring process to be used while the dumping is carried out. A minimum of 4 months would be required after receipt of a properly executed application before final action could be expected from a request to EPA. Involved in the process was the requirement for a public notice of 30 days and then a public hearing 30 days after publication of the public notice, followed by allowance of another 30 days for the EPA hearing officer to reach a finding. No assurances could be provided that the finding would not be adverse, particularly if any controversy existed. If the DEIS identified another feasible disposal method, it would virtually eliminate one of the requirements for an ocean-dumping permit, namely the lack of an alternative disposal method.

The ERDA representative contended that EPA was overly conservative in applying the United States ocean-dumping law, since the International Ocean-Dumping Agreement would permit other countries to dump quite large amounts of long-lived alpha contamination. EPA countered that the United States law, which predated the international agreement, was based on the philosophy of preventing further pollution rather than facilitating cleanup and disposal of radiological contamination resulting from a past event. Public laws and EPA regulations did not envision a disposal effort of the magnitude of the Enewetak radiological cleanup and provided no solution to the problem.

ERDA representatives responded that, while ERDA had several test sites which someday must be decontaminated, ERDA had no intention of adopting ocean dumping for those wastes. However, there was considerable concern that, if crater containment was used, ERDA would inherit yet another temporary storage facility, one constructed contrary to ERDA's advice.[155] The 24 February conference ended with no change in the Agencies' positions on disposal, but it helped set the stage for a top-level policy conference.

FINALIZING THE ENVIRONMENTAL IMPACT STATEMENT: APRIL 1975

The normal period for review and comment on the DEIS, which was filed on 7 September 1974, ended on 11 November 1974.[156] However, MLSC, the legal counsel for the dri-Enewetak, was allowed almost 5 months to prepare comments out of consideration for the gravity of the commitments that would be made based on the document. Mr. Mitchell, Executive Director of MLSC, submitted the comments on 1 February 1975. These comments confirmed the basic position the people had taken at Majuro in 1973 and from which neither they nor the MLSC had wavered throughout the project. They demanded total cleanup of the atoll, disposal of the radiological contaminated material away from the atoll, and restoration of the atoll, insofar as practicable, to its original state.[157]

LTG Johnson called a conference of action agency officials on 25 February 1975 to discuss the MLSC position and to make policy decisions necessary to establish the future course of the project. Conferees included: Dr. W. A. Mills, of EPA; Major General Ernest A. Graves, USA, Dr. William Forster, Mr. Joseph Maher, Mr. Joe Deal, and Mr. Tommy McCraw, of ERDA; Mr. Harry Brown, of DOI; Captain E. D. Whalen, USN, of ASD(ISA); Colonel A. M. Smith, USA, of MSN; and senior DNA staff officials.[158]

LTG Johnson opened the meeting with his analysis of the situation. The plans for cleanup described in the DEIS of September 1974 appeared to be technically and economically feasible, and, although they imposed some unwanted restrictions on the dri-Enewetak, these restrictions represented a reasonable compromise between the goal of maximum freedom and the need to guard the people's health and well-being. The AEC guidelines had been adopted, although there were some who felt they were excessively restrictive. Although ocean dumping of radioactive material was preferred by some, it had to be recognized that this might be legally impossible or, at best, require several years to obtain authorization. Thus, crater entombment was adopted as a reasonable alternative. Based on these compromises, there had appeared to be a reasonable consensus among those involved at the time the DEIS was published.[159]

Now, according to the Director, it appeared that the consensus was disappearing. It seemed there was no consensus even within ERDA, and

he had lost confidence that the original AEC guidelines could be cited as authoritative. They had been challenged by some at AEC-NV. Ocean dumping continued to be proposed by some in AEC. There were demands that the craters be lined with thick walls of concrete and steel liners. With the apparent lack of consensus within the Government, the engineering and fiscal feasibility were becoming more and more doubtful.[160]

The new proposals were both time-consuming and expensive. With inflation at 10 percent per year, the additional time and effort required to authorize and accomplish ocean dumping could cost an additional $11 million. The Director estimated that, if the complete cleanup demanded by MLSC were adopted, the project would cost between $200 and $300 million. The Congress had opposed a $40 million price for the project. LTG Johnson was beginning to believe that he might be compelled to recommend to the DOD that the project was economically and technically infeasible. He felt very strongly, however, that the Government had a moral obligation to do everything within reason to accomplish the cleanup. Therefore, he proposed to reject the more stringent and expensive proposals and to publish the final EIS essentially as it appeared in the draft. If opposition to that proposal were sufficiently strong, then he must find some acceptable lesser alternative, such as returning the dri-Enewetak to the southern islands only, or conclude that the project was infeasible.[161]

LTG Johnson received the support he sought. MG Graves advised that he saw no problem with crater disposal. ERDA had felt all along that, if it were not for the law, deep-ocean dumping would be preferable. However, they believed crater entombment was acceptable provided it was done carefully. MG Graves mentioned the possibility of the crater leaking and added that the effectiveness of crater containment could be a problem. All those present seemed to realize that radioactive material was leaking out of the crater even then and would continue to do so.[162] However, the discussion raised the question, "If this crater containment breaks up in time, who is responsible to right this wrong?" LTG Johnson quickly answered that it was not DNA's responsibility after the cleanup was finished; it would be the responsibility of the United States. It was assumed that by the United States he meant ERDA.[163]

LTG Johnson asked if there was still a consensus on the AEC standards. His question was evoked by remarks attributed to an ERDA-NV official that the standards adopted by the AEC Task Group might not stand up. MG Graves assured him that there was still a consensus at ERDA and that ERDA would support DNA on the standards.[164]

Dr. W. A. Mills, EPA, stated that entombment was the way to go in disposing of the radioactive debris for two reasons: (1) it would be recoverable from the crater, if the need or desire ever arose to do so; and (2) EPA was generally not in favor of ocean dumping.[165] After further discussion, LTG Johnson said that he proposed to meet with Mr. Mitchell and tell him that if he demanded that DNA go for a $190M project (Case 5), it would kill the project. He felt morally obligated to push for the project as currently agreed, even if Mr. Mitchell served notice he would fight for the maximum degree of cleanup. COL Smith, of MSN, stated that there was a necessity to retain reasonableness to the project if it was to get by Congress. LTG Johnson stated that, on the basis of the discussions at this meeting, DNA would press ahead with the final EIS, seeking all the help they could get from ERDA. Also, he would go to Honolulu and discuss DNA's position with Mr. Mitchell and seek an accommodation with him. He invited representatives of the DOI, ERDA, and EPA to accompany him on his trip during the week of 17 March 1975.[166]

The Honolulu conference was held on 19 March 1975. LTG Johnson opened with comments to the effect that insistence on ocean dumping of contaminated material and a Case 5 cleanup would delay, if not cancel, the project. He advised that he had consulted with Representative Ichord, Chairman of the House MILCON Subcommittee, who foresaw difficulty in obtaining approval of even a modest program and wanted assurance that Mr. Mitchell, of MLSC, and the dri-Enewetak Iroijs would appear before the subcommittee to support the project.[167]

Mr. Mitchell accepted fhe invitation to appear at the Congressional hearing on the MILCON appropriations for the Enewetak Cleanup but stressed the importance of having Mr. Oscar DeBrum, District Administrator for the Marshall Islands, also present for the hearings. Mr. Mitchell also stated that:

a. The MLSC comments on the DEIS asked for the "ideal" cleanup based upon their duty to seek the best possible solution for their clients.
b. The dri-Enewetak would make the ultimate decision, not the MLSC or himself.
c. He remained unconvinced that he should recommend acceptance of Case 3, but he did not propose to engage in a lengthy court fight to achieve Case 5. He indicated a desire to get on with the cleanup at Case 3 level, if necessary, without foreclosing other possibilities.

Mr.Mitchell stressed that he intended to strive for as much as could reasonably be done to insure the safety and health of the people. He did not want to be facing a situation similar to that of Bikini in which the lack of thorough investigation could be claimed.[168] He reiterated the point made in the people's comments on the DEIS that they did not want money in any amount. They wanted their land in safe and habitable condition, regardless of cost. The cost of cleanup would be a fraction of the total cost of the nuclear test program and should be considered and funded as an extension of that program.[169]

The 25 February 1975 meeting of agency representatives in Washington and the meeting with Mr. Mitchell on 19 March 1975 cleared the way for publication of the final EIS. It was published and filed with the Council on Environmental Quality on 15 April 1975. The final EIS was nearly identical to the September 1974 draft, with only a few technical and clerical corrections, and the addition of Volume IV which contained comments received on the September 1974 DEIS and DNA's responses to them.

DNA requested authorization and funds from Congress for complete cleanup of physical and radiological hazards in accordance with Case 3 of the EIS.[170] The EIS description of Case 3 cleanup, which the JCS subsequently approved as the DNA mission statement,[171,172] was contained in paragraph 5.5.3.2 as follows:

Cleanup Actions. The following actions would be taken to clean up the atoll:

- Physical hazards would be removed from all islands.
- Obstructions to development of habitations and agriculture would be removed.
- Radioactive scrap would be removed from all islands in the atoll.
- Boken, Lujor, and Runit plutonium concentrations greater than 400 pCi/g would be excised and all other concentrations between 400 and 40 pCi/g would be dealt with on an individual basis as described in AEC Task Group Report. Concentrations of less than 40 pCi/g would not be disturbed. Cleanup of plutonium was expected to be performed iteratively until a sufficiently low concentration level well below 40 pCi/g was attained. Some 79,000 cubic yards of soil were estimated to be in this removal.
- Plutonium would be removed from the three burial crypts on Aomon.
- Unsalvable nonradioactive and noncombustible material would be disposed of by dumping in the lagoon at selected locations for forming artificial reefs.

Radioactive materials would be disposed of as discussed in Section 5.4.3.2.3, namely by containment in Lacrosse and, if necessary, Cactus craters on Runit.[173]

FY 1976 CONCEPT PLANNING: 1974 - 1975

DNA's original concept of implementing the EIS by having the Corps of Engineers contract out the cleanup had begun encountering cost problems in September 1974. Lack of detailed plans and cost estimates had led Congress to decline authorization of DNA's original request which had been based on the 1973 Enewetak Engineering Study estimate of $35.5

million total cost. A review of the study by H&N and POD on 18 September 1974 revised the cost estimates upward to $57.3 million to cover crater containment of contaminated scrap and soil, increased cost of runway repair, replacement soil for Aomon and Enjebi, marine craft, radiological monitoring, and decontamination. They indicated that these costs could be reduced to $42.5 million by elimination of helicopter support, use of foreign labor, use of temporary camps on the outer islands, and other means.[174] The escalation was disturbing since DNA had been advised by Congressional staff members that more austere cost estimates were required. When DNA so advised the Corps of Engineers,[175] they revised the scope of work to bring the cost estimate to $43.2 million.[176] After discussions with DNA, POD submitted a further revised estimate of $39.9 million for cleanup, based upon DNA's financing runway repair and other base camp rehabilitation work with other funds.[177] However, this estimate lacked essential detail, and it was apparent that the contracting-out concept was in difficulty.

Meanwhile, suggestions had been made in the Field Command Enewetak Planning Group that the only feasible means of reducing MILCON costs drastically enough to meet Congressional guidance was through use of military labor. COL Esser proposed that Army engineer troops be used, while Mr. Thomas Flora suggested use of Navy Construction Battalion (Seabee) personnel. On 24 December 1974, Field Command recommended to DNA that troops be used to reduce MILCON costs for the cleanup project[178] and, subsequently began refining the concept. It seemed probable that engineer troops from the U.S. Army Support Command, Hawaii (USASCH) would be selected. Since the U.S. Army had not officially been assigned that responsibility, Field Command could not contact that organization directly. The Pacific Support Office of Field Command's Logistics Directorate, which had been working with POD on the contracting-out concept, was tasked to work with USASCH on an informal basis to identify probable military personnel and materiel requirements, as well as those USASCH resources which might be available for the project. In late 1974 and early 1975, the Pacific Support Office was augmented by three Army officers to assist in planning and initiating the project. They were Colonel Howard B. Thompson, Lieutenant Colonel Paul F. Kavanaugh, and Major William Spicuzza.

At a general planning conference in Anaheim, California, on 13-15 January 1975, COL Esser advised the other agencies of Field Command's intention to study the use of troops to accomplish the Enewetak Atoll cleanup. TTPI and H&N representatives discussed the problems of rehabilitation and resettlement at Bikini Atoll as well as Enewetak matters. Mr. Dennis McBreen, Marshall Islands District Planner, presented the Ujelang Field Trip Report. The dri-Enewetak there had generally accepted all radiological recommendations of Case 3 of the EIS. The stockpiling of scrap was discussed, and ERDA indicated that there would have to be a firm requirement to monitor these materials for radioactivity when collected. A meeting was proposed for 14 February 1975 in Honolulu to further consider cleanup and rehabilitation interfaces.[179] At that conference, which has been described previously, POD was asked to concentrate on designing crater entombment and to defer work on engineering design of the cleanup work itself.[180] From this point on, Corps of Engineers' participation in the project was limited to providing some base camp rehabilitation, designing the crater containment, and providing necessary permits.

Field Command's Enewetak Planning Group compiled a series of Concept Plans (CONPLANs) based on input from the Hawaii group, budget guidance from HQ DNA, and results of their own staff coordination and planning. These CONPLANs provided basic concepts, policies, and procedures for review and approval by the JCS and development of an implementing operations plan.

The first CONPLAN developed was for a JTG using troops to accomplish the cleanup, with civilian contractors to rehabilitate and construct base camps, operate and maintain the base camps, provide radiological support, and accomplish the crater containment. LTG Johnson was briefed on the plan during his visit to Hawaii in March 1975. Upon his approval, it was completed by the Field Command Enewetak Planning Group and issued with a blue cover in April 1975. Total cost under this CONPLAN was estimated at $30.6 million.[181] Although this "blue" CONPLAN was to undergo numerous, major revisions, it formed the basis for the final CONPLAN which was to control the cleanup.

Anticipating that a plan using troops alone would be required to further reduce project costs, COL Esser and the Field Command Enewetak Planning Group developed a second CONPLAN using a JTG of military personnel for all cleanup and support work. It also was printed in April 1975 but with a red cover. It reflected a significant increase in man-years to accomplish the work with troops alone (122 man-years) as opposed to a mixed work force (91 man-years); however, it reduced MILCON costs to an estimated $20.4 million.[182] In the event Congress did not authorize enough funds to cover the "blue" CONPLAN, DNA would be prepared to respond with the "red" CONPLAN.

MILITARY CONSTRUCTION PROGRAM: 1974 - 1975

In March 1975 (prior to completion of the CONPLANs), DNA furnished Congress new estimates of the total costs for cleanup and rehabilitation of Enewetak Atoll. DOD cleanup costs were estimated as $39.9 million, including $1.5 million to reimburse ERDA for radiological support as agreed in the 7 September 1972 meeting. DOI rehabilitation and resettlement costs were estimated as $12 million.[183] The revised DNA request for MILCON Program authorization was to be allotted as follows: $14.1 million in FY 1976, $24.7 million in FY 1977, and $1.1 million in FY 1978.[184,185]

Meanwhile, LTG Johnson had begun marshalling efforts to obtain FY 1976 Congressional funding during a conference on 17 October 1974 with officials from DOI, ASD(ISA), and MSN. LTG Johnson felt that Representative Otis G. Pike of the House Armed Services Committee was the key Congressman who had to be convinced that the United States was obligated to return the Atoll, that the people wanted to return, and that cleanup plans and cost estimates were sufficiently detailed to justify the funds requested. Ambassador Williams, MSN, and Ambassador Ellsworth, ASD (ISA), agreed to meet with Mr. Pike on the matter.[186] By December 1974, it appeared that Mr. Pike was convinced of the obligation but not of the sufficiency of DNA's plans and cost estimates.[187]

LTG Johnson arranged to have the Enewetak people's representatives testify before Mr. Pike's committee as well as before Senator Symington's committee.[188,189] Iroij Johannes Peter of the dri-Enewetak and Iroij Binton Abraham of the dri-Enjebi appeared before the Military Construction Subcommittee of the Senate Armed Services Committee on 25 April 1975.[190] Their statement told of how the people had been taken from Enewetak to help the United States develop its nuclear arsenal and how strongly all of them wished to return to their homeland as soon as it could be cleaned up and rehabilitated. They related how important these small islands were to a people who lived in the midst of an immense ocean and how no amount of money could replace their homeland. Mr. Tony DeBrum acted as their interpreter. Also at the hearing were the dri-Enewetak Magistrate, John Abraham, and their legal counsel, Mr. Mitchell. The same delegation appeared before the Military Installations and Facilities Subcommittee of the House Armed Services Committee on 7 May 1975 and reiterated their desire to return to Enewetak Atoll.[191]

During the Senate subcommittee hearings, DNA was asked to develop the most austere cost estimate possible based on the use of troops (Army engineers or Navy Seabees) who were trained in nuclear decontamination. Field Command developed a revised (May 1975) CONPLAN similar to the April 1975 "blue" version except that troops were to be used to accomplish the crater containment as well as the cleanup. This and other refinements lowered the cost to $25 million.[192] The remaining support functions were still to be accomplished by contractor personnel.

In the Senate Armed Services Committee hearing on 22 May 1975, the matter was discussed at length. Although the moral obligation to permit the Enewetak people to return to their atoll was a consideration, the committee's decision, as noted in their report, was based ". . .primarily on the premise that the United States could not walk away from a testing program which cost several billion dollars without making a responsible effort to make the atoll habitable." The committee agreed to a one-time authorization of $20 million and charged the DOD to accomplish the cleanup within that amount, using every possible economy measure. The committee insisted that the radiation standards established by ERDA be met before any resettlement was accomplished.[193]

In June 1975, the House Armed Services Committee approved authorization of $14.1 million for the cleanup program.[194] House and Senate conferees met in September 1975 and, after much discussion, authorized $20 million.[195] The conferees expected the DOD to minimize the total cost through the use of Army engineers and/or Navy Seabees and by limiting the scope of the cleanup as much as possible within the constraints of radiation exposure established by ERDA. The $20 million total limit set by the Senate was changed to a target amount for completing the project.[196] Public Law 94-107, enacted on 7 October 1975, provided authorization for DNA to perform the Enewetak Atoll Cleanup Project at a cost of $20 million.[197] However, the appropriation action, which was necessary to provide MILCON funds for the project, did not fare so well.

The House Committee on Appropriations, chaired by Representative Robert L. F. Sikes, meeting in October 1975, denied funding for the project because the committee believed the minimum cost had not yet been presented to the Congress. The committee report recalled that DNA had requested $14.1 million as the first increment of a program that was estimated to cost $40 million for cleanup and another $10 million to rehabilitate the atoll for some 450 people. The committee did not believe it prudent to spend $50 million—over $100,000 per person—to reclaim the atoll at a time when tax dollars were so scarce. The committee pointed out that the dri-Enewetak had already been given title to Ujelang Atoll, plus over $1.3 million in payments for leaving Enewetak. The committee believed that the American taxpayers had a right to expect that any additional effort on behalf of the dri-Enewetak be accomplished at the lowest cost possible.[198]

The Senate Committee on Appropriations strongly supported funding the project for the full $20 million authorized and did not feel that uncertainty as to the absolute final figure should delay starting the cleanup effort. DNA's studies had indicated that $20 million might not be sufficient to complete the project, but Congress would have had ample opportunity to adjust the funding as the project proceeded.[199] (This was in line with the thinking of the Senate-House authorization conference which had authorized $20 million as a target rather than a limit.[200]) In the Senate-House appropriations conference to resolve the Committees' differences on funding, the Senate conferees, after lengthy discussion, ". . .reluctantly agreed to defer funding. . ." and conceded that other alternatives for restoration of the atoll should be explored before vast sums were spent on what could be an ineffective program.[201] This ended chances for funding and beginning the cleanup project in FY 1976.

That autumn also saw the first of many changes in Field Command management of the Enewetak Atoll Cleanup Project. RADM Swanson, the Commander, retired and was replaced by his deputy, Brigadier General Thomas E. Lacy, USAF; COL Esser, the Director of Logistics and Chairman of the Enewetak Planning Group, retired and was replaced by Colonel J. R. Schaefer, USA. Since BG Lacy and COL Schaefer had already been involved for more than a year in planning the project, this changeover did not have major impact on the management continuity.

FY 1977 MILITARY CONSTRUCTION PROGRAM: 1976

After Congress declined to provide funding for the project in FY 1976, LTG Johnson requested a conference with ASD(ISA) to review the program and determine a course for future action.[202] The conference took place on 5 December 1975. Participants included Mr. Amos Jordan, principal Deputy of ASD(ISA), LTG Johnson, and his Deputy for Operations and Administration, Major General William E. Shedd, III, USA. After a review of the situation, it was agreed that:

- DOD would seek FY 1977 funds in the amount of $20 million for the project.
- ASD(ISA) would assist in arranging for other agencies to testify on behalf of the project.
- DNA would advise the JCS of DOD's intention to use TDY military personnel for the project.
- DNA would look into reducing MILCON costs by having a scrap buyer remove the noncontaminated scrap and debris,[203] an option suggested by Field Command.[204]

In January 1976, the DNA Logistics Director, Mr. Earl Eagles, and his staff began work with Congressional staff members to promote understanding and approval of the $20 million MILCON fund request for FY 1977.[205] He arranged for Mr. Robert C. Nicholas, III, Staff Assistant to the House Appropriations Subcommittee on Military Construction, and Mr. Vorley M. Rexroad, Staff Assistant to the Senate Military Construction Appropriations Subcommittee, to accompany LTG Johnson on a tour of Enewetak, 8-13 February 1976. The better part of 2 days were spent inspecting the islands, including Enewetak, Medren, Japtan, and Runit.[206] The Congressional staff visit proved valuable in obtaining funds for the project. In addition, Mr. Rexroad was instrumental in developing the concept of augmenting MILCON funds with available worldwide Military Service assets on a nonreimbursable basis. During this same period, the Field Command Enewetak Planning Group began developing and pricing optional concepts to conform to the Congressional authorization of $20 million. It became obvious that the goal could not be achieved without considerable assistance from the Military Services. A February 1976 CONPLAN was developed, which resulted in a total cost of $26.016 million, with two cost-reduction alternatives: (1) assigning personnel on a PCS versus TDY basis, and (2) using cut-and-cover trenches versus crater containment of contaminated material. These alternatives lowered the cost to $19.361 million.[207]

An April 1976 CONPLAN modified the February 1976 version to provide an even greater variety of cost reduction possibilities, including PCS versus TDY personnel, cut-and-cover containment of contaminated material, and having the Services provide their own spare parts. Total cost ranged from $14.469 million to $24.331 million, depending on the option selected. The cut-and-cover alternative was rejected, as it would require lengthy efforts to revise the EIS.[208]

A 2 July 1976 CONPLAN was prepared to include crater containment and provide other cost-reduction options. It had a total cost of $24.331 million, which could be reduced by $3.111 million if personnel were PCS instead of TDY, and by $1.156 million if the Services provided spare parts for their equipment on a nonreimbursable basis, leaving a reduced cost of $20.064 million. This edition of the CONPLAN was sent for review to the JCS who in turn sent it to the Services and Commander in Chief, Pacific Command (CINCPAC) for comment.[209] This 2 July 1976 version of the CONPLAN (whose genesis can be traced back to the original April 1975 "blue" CONPLAN), became—after one more major revision—the "CONPLAN 1-76" upon which the cleanup was based.

THE LANDMARK HEARING: MARCH 1976

By the spring of 1976, three of the four cognizant Congressional committees had approved the Enewetak Atoll Cleanup Project. Only the House Committee on Appropriations, chaired by Representative Robert L. F. Sikes, remained to be convinced. The crucial hearing took place on 29 March 1976. The testimony presented by LTG Johnson and others was the most definitive and thorough explanation and justification of the project yet presented. The Committee's questions were incisive and exhaustive.

LTG Johnson's opening statement provided a general description of the project and of DNA's efforts to minimize costs and obtain necessary funding. He then presented a statement from the Honorable Samuel W. Lewis, Assistant Secretary of State for International Organizations, which emphasized the awkward U.S. position caused by the Enewetak and Bikini situations. They were of continuing concern in the Trusteeship Council and Security Council of the United Nations. The use of the atolls for nuclear testing had appeared to some as an abuse of our trusteeship in the first place. Twenty years had passed and the United States still had not been able to fulfill its obligation to return the people of Enewetak to their atoll in safety. The United States, which had introduced the idea of trusteeship to protect underdeveloped nations until they became self-sufficient, was under especially keen scrutiny since the TTPI was the only one of eleven trust territories established by the United Nations which had not achieved self-sufficiency. A timely appropriation of funds to resolve the Enewetak matter was essential to successful termination of the Trust in 1981 and to the best interests of the United States.[210]

LTG Johnson also presented a letter from Deputy Secretary of Defense William D. Clements urging favorable action on the appropriation. Mr. Clements believed it to be in the national interest, in order to avoid a host of political and legal liabilities in the posttrusteeship period, to make the dri-Enewetak less reliant on financial assistance and to promote a political environment in the Marshall Islands which would support continued use of the Kwajalein Missile Range by the United States.[211]

Rear Admiral William J. Crowe, Jr., of ASD(ISA), presented a statement supporting the project as a prerequisite to ending the Trusteeship and avoiding political and legal liabilities in the posttrusteeship period.[212]

Mr.Mitchell, the people's legal counsel, then presented a lengthy statement on their behalf. It chronicled their hardships during the war, their exile to Ujelang Atoll, and the hardships they had suffered there, including crop failures, rats, and starvation. Enewetak was not United States property. It belonged to the dri-Enewetak and had, Mr. Mitchell stated, been taken from them without their consent. The use of Enewetak for nuclear testing had been of immense value to the United States, with peacetime as well as wartime applications. The United States had spent over $10.6 billion on nuclear testing at Enewetak Atoll between 1950 and 1959. The cost of restoring the atoll would be insignificant in comparison, whether it was $20 million or $100 million. The real values to be considered were the total cost of the nuclear test program, including restoration of the atoll, and what that program had produced for the

United States in the way of nuclear weapons and security for all Americans, not what restoration would cost per individual resettled.[213] The two Iroijs, Johannes Peter and Binton Abraham, confirmed the statement's accuracy and responded to committee questions through their interpreter, Donald Capelle.

The committee discussed at length both the written agreements which committed the United States to return the atoll and the authority of the signatories to make such commitments. It was decided that Congress had provided that authority in Title 48, USC, Section 1681.[214]

The committee questioned the amount of payments which had already been made to the dri-Enewetak for use of the atoll, especially the $1,020,000 ex gratia payment made in trust in 1976. Mr. Mitchell explained that this was not a payment for use of the atoll, but an outright gift in recognition of the hardships the people had suffered at Ujelang. It was not a lease payment or a payment of damages, but a gift, intended to supplement their subsistence. Since it was a trust fund, they received only the interest, about $150 per person per year, or 43¢ per person per day, an extremely small amount, even for the Marshall Islands.[215]

The problem of subsistence was discussed further, especially the possibility of radioactivity in the food. ERDA representatives presented a report on the experimental farm on Enjebi which was producing fruit (but from which no data on uptake of radioactivity was yet available). Also, an ERDA report on radiological conditions at the atoll and protection of future residents was presented.[216] The committee was advised that the current plan did not envision soil removal from Enjebi,[217] and the island was not planned to be used for residence.[218]

The cleanup of Runit also received special attention. LTG Johnson indicated that 3 or 4 feet of soil might have to be removed from the Fig/Quince area on Runit.[219] All plutonium contamination on Runit above a specified level would be removed and encapsulated. The island would be made safe to work on and to visit.[220] In the event funding limits prevented complete cleanup of Runit, the project would have to be cancelled or the U.S. would have to retain indefinite control over the atoll; i.e., continue the quarantine of Runit. In response to a Congressional inquiry on the impact of a fund limitation, LTG Johnson stated that it was his view that, once the major effort and expense of mobilizing and initiating the cleanup had been incurred, it would be ineffective and uneconomical to quit work before the most significant radiological hazard on the atoll had been removed.[221]

Means of reducing total costs were discussed in detail, including: alternatives for disposal of contaminated material; the option to leave certain buildings standing; the use of Operations and Maintenance appropriations to finance the base camps; the use of excess equipment;

and the use of troop labor. DNA furnished detailed supporting data on their planned costs and savings.[222] The committee considered obtaining a waiver of further claims by the dri-Enewetak to hold project costs down. LTG Johnson expressed his belief that it would be extremely difficult to complete the project for the $20 million.[223]

The committee subsequently approved only $15 million of the $20 million requested by DNA and required DOD and DOI to develop additional plans to reduce project costs, including a maximum amount of effort by the dri-Enewetak in the nonradiological cleanup and rehabilitation efforts. The committee also added an amendment to the appropriations bill which prohibited spending any of the $15 million being appropriated until TTPI certified to DOD that the dri-Enewetak agreed that the $15 million constituted the total commitment of the United States Government for the cleanup of the atoll. This was to assure that the project did not become "...an endless drain..." on the United States.[224]

MILITARY CONSTRUCTION APPROPRIATION ACT OF FY 1977: JULY 1976

On 22 June 1976, The Senate Committee on Appropriations recommended approval of the full $20 million appropriation. Based on the exhaustive studies and documentation submitted by DNA, the Committee was convinced costs would be minimized through use of DOD resources already funded in other programs. Other considerations for accomplishing the project without delay were potential loss of goodwill and the long-term costs of maintaining the quarantine on Runit until it could be cleaned of radiological contamination.[225]

In the conference to resolve Senate and House differences on the MILCON appropriation bill, the conferees approved the $20 million requested with two provisions: (1) that the dri-Enewetak agree that this amount was the extent of the Government's obligation for cleanup; and (2) that maximum use be made of the Military Services resources to accomplish the cleanup.[226] The bill passed the House on 1 July 1976, the Senate on 2 July 1976, and, upon signature by the President on 16 July 1976, became Public Law 94-367. The law included the following key provisions:

"None of the funds appropriated for the cleanup may be expended for the Cleanup of Enewetak Atoll until such time as the Secretary of Defense receives certification from appropriate administering authorities of the Trust Territory of the Pacific Islands that an agreement has been reached with the owners of the land of Enewetak Atoll or their duly constituted representatives that this appropriation shall constitute the total commitment of the Government of the United States for the cleanup of Enewetak Atoll." An agreement with representatives of the TTPI certifying this stipulation was signed 16 September 1976.

"All feasible economies should be realized in the accomplishment of this project through the use of Military Services' construction and support forces, their subsistence, equipment, material, supplies and transportation, which have been funded to support ongoing operations of the Military Services and would be required for normal operations of these forces. Further, such support should be furnished without reimbursement from military construction funds."[227]

The Military Construction Program request, on which the approved version of the MILCON appropriation bill was based, provided for expenditure of the $20 million in the following manner:[228]

a. Field Construction—$1.3 million. Included in this category were the rehabilitation of existing facilities on Enewetak Island essential only for cleanup operations, construction of camp facilities on Enewetak and supporting facilities for the mobile forward camp, and the construction of boat beaching facilities.

b. Mobilization—$3.3 million. This included air and sea shipping and transportation costs needed to prepare for the start of operations at Enewetak Atoll.

c. Cleanup/Operations and Maintenance—$4.5 million. Included were costs of fuel, spare parts, supplies, mess supplies, indigenous labor wages, medical operations, communications, and equipment used for cleanup and operation of camp facilities.

d. Crater Containment—$3.7 million. This category contained those cost items specific to disposing of radioactively contaminated debris and soil by encapsulation in a crater on Runit with a soil-cement mixture and covered with a concrete cap. Cost items included a technical services contract, equipment, fuel, cement, and sea and air shipment of materials.

e. Radiological Operations—$2.6 million. This category provided for the safety monitoring and quality control evaluations for all radiological operations. Cost items included procurement and shipping of equipment and supplies and the cost of reimbursing ERDA for providing a civilian contractor-operated radiation analysis laboratory augmented with military technicians.

f. Demobilization—$2.1 million. This category included air and sea shipping and transportation costs relevant to the closing of DOD operations at Enewetak.

g. Logistics—$2.5 million. Included in this category were support necessary to the conduct of the Enewetak Atoll cleanup and air and sea transportation and shipping costs.

A summary of actual expenditures incurred during the project under the MILCON appropriation is contained in Chapter 9.

FIELD COMMAND CONCEPT PLAN 1-76: 15 SEPTEMBER 1976

The JCS and the Director, DNA had advised against having the Services furnish materiel and transportation support without reimbursement on the basis that it would detract from the Services' other missions.[229] The 2 July 1976 edition of CONPLAN 1-76 reflected this position and included funds to reimburse the Services in its estimated total cost of $24.331 million. It also included $2.9 million (ERDA's latest estimate) to reimburse ERDA for radiological support based on the 7 September 1972 conference agreement.[230] This plan was reviewed by DNA officials at Headquarters and Field Command on 2 August 1976 to identify means of reducing costs to the $20 million which had been appropriated. One obvious action was to limit the reimbursement of ERDA to the $1.5 million which had been ERDA's original estimate and which had been contained in the original DNA budget request for radiological support. Other possible reductions of MILCON costs also were discussed; however, it was agreed that no further changes to the CONPLAN would be made until JCS comments were received on the 2 July 1976 version which had been distributed by the Joint Staff to the Services and the CINCPAC.[231] The Chairman of the JCS, General George S. Brown, USAF, was briefed on the CONPLAN during a visit to Field Command that autumn.

In forwarding the 2 July 1976 CONPLAN, DNA had requested that the Military Services be assigned formal responsibility for supporting the cleanup project and that supporting Service elements be designated so that detailed planning could begin immediately, with the objective of starting cleanup operations on 1 March 1977.[232] On 10 September 1976, the Deputy Secretary of Defense requested the Chairman, JCS, to inform the Military Departments of the requirement to accomplish this project under the conditions imposed by the Congress and the need to provide support to this project, including but not limited to:

a. Full and effective troop support.
b. Maximum feasible use of PCS rather than TDY to conserve project funds in order to accomplish the project within the $20 million MILCON appropriation and to keep the total project cost down.
c. Provision of supplies, equipment, including repair parts, and transportation available Service-wide required for timely accomplishment of the project.

The Deputy Secretary of Defense also requested that the Chairman, JCS have the military departments designate, at the earliest practicable date, the military support units to be deployed for this project, in order to permit the initiation of detailed operational planning.[233] The Joint Staff decided, however, to wait until CONPLAN 1-76 had been revised to reflect all changes in the concept before formally tasking the Military Services. The Joint staff did not task the Services until 24 January 1977.[234]

After reviewing the 2 July 1976 CONPLAN, the Joint Staff recommended that it be modified to include helicopters for medical evacuation and an annex on communications support.[235] Comments also were received from CINCPAC[236] and the Air Force Surgeon General.[237] Based on these comments and on the provisions of the FY 1977 MILCON Appropriations Act, CONPLAN 1-76 was revised as of 15 September 1976.[238] Several annexes were added to conform to the JCS Operations Plan format. This CONPLAN was resubmitted to the JCS, who approved it with a few final refinements. These refinements were incorporated as Change Number 1 on 1 February 1977. The final CONPLAN 1-76 contained all the basic policy and concepts and most of the procedures required to execute the project in accordance with the will of Congress and the direction of the Secretary of Defense and the JCS.[239]

THE MISSION: SEPTEMBER 1976

The mission, as authorized by Congress[240] and approved by the JCS,[241] was to conduct a full Case 3 EIS cleanup; i.e.:

a. Physical hazards will be removed from all islands.
b. Obstructions to development of habitations and agriculture will be removed.
c. Unsalvable nonradioactive material will be disposed of in accordance with appropriate procedures.
d. Boken, Lujor, and Runit plutonium concentrations greater than 400 pCi/g will be excised, and all other concentrations between 400 and 40 pCi/g will be dealt with on an individual basis (seven islands are in this range). Concentrations of less than 40 pCi/g will not be disturbed. Cleanup of plutonium is expected to be performed iteratively until a sufficiently low concentration level is attained.
e. Plutonium will be removed from the burial crypts on Aomon.
f. Radioactive scrap will be removed from all islands in the Atoll. (Radioactive scrap has been identified on nine islands.)
g. Radioactive materials will be disposed of by crater containment on Runit.[242]

CONCEPT OF OPERATIONS: SEPTEMBER 1976

It was planned that the Enewetak Atoll Cleanup Project would be accomplished by a JTG consisting of a Commander (CJTG) who reported to Field Command, a Headquarters Element (HQ JTG), elements from the three Military Services, and ERDA (Figure 2-6).[243] Most of the changes that the Joint Staff made to the final CONPLAN were minor; however, one led to serious command and control problems during the project. DNA had recommended that the CJTG be in command of the Military Service Elements on the Atoll. At the insistence of the Navy JCS representative, the CJTG was given "supervisory authority" rather than command over the Military Service Elements of the JTG. "Supervisory authority" was uniquely defined by the Joint Staff for this one project as ". . .the detailed and local direction and control of movements or maneuvers necessary to accomplish missions or tasks assigned."[244] This ambiguous and limiting phrase caused considerable confusion and resulted in many management problems and other adverse effects on cleanup operations (described in later chapters).

D-Day was designated as the day base camp construction and radiological field surveys would begin. According to the CONPLAN schedule (Figure 2-7), construction materials and supplies for base camp construction were scheduled to be ordered at D-3 months. After D-Day, 2 months were scheduled for rehabilitation of the base camp at Enewetak Island and erection of a temporary camp at Lojwa Island (Ursula). Actual cleanup operations were to begin at D+2 months and last approximately 2 years, including cleanup of the base camps and work sites at Runit, Lojwa, and Enewetak. One month was scheduled for demobilization of personnel and materiel.[245]

The schedule was based on simultaneous efforts by a Navy Harbor Clearance Team to remove debris below the high-tide line and three Army engineer teams to remove and dispose of other debris and contaminated soil. Team A would be based at Enewetak Camp and accomplish cleanup of the noncontaminated southern islands. Team B would be based at Lojwa Camp and accomplish cleanup of the northern islands, including noncontaminated hazards and contaminated soil and hazards. Team C also would be based at Lojwa Camp and would accomplish the containment of radioactive debris and soil in the crater on Runit (Figure 2-8).[246] Before containment operations began, Team C would complete prerequisite preparations, including quarrying and crushing aggregate, constructing a dike or mole to minimize the effect of tides and seas, and setting up the batch plant and other facilities. It was anticipated that before these preparations were finished, Team B would have completed soil cleanup on all islands except Runit, thereby providing a stockpile of about 30,000 cubic yards—sufficient to begin containment operations.[247]

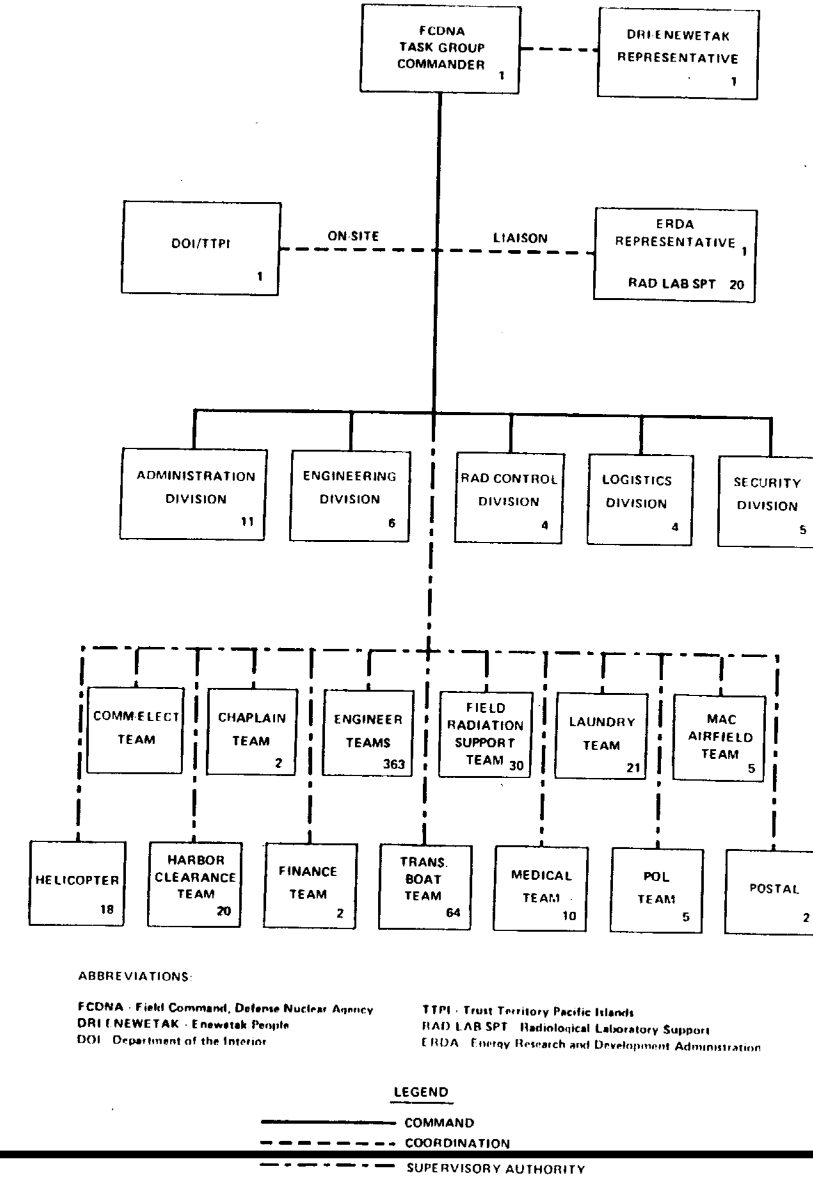


FIGURE 2-6. ENEWETAK ATOLL PROPOSED JOINT TASK GROUP.

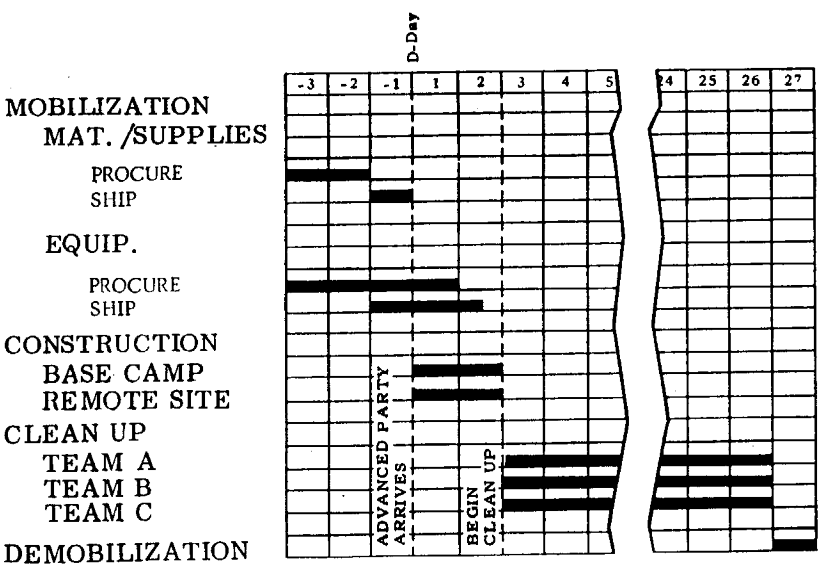


FIGURE 2-7. OPERATION SCHEDULE (MONTHS).

Containment would be accomplished by mixing contaminated soil, cement, and salt water into a slurry and pumping the mixture through pipes to a tremie barge, then to the bottom of the crater. By keeping the discharge end of the tremie pipe at least 1 foot beneath the top surface of the previously placed slurry, a monolithic mass would be accumulated, gradually displacing the water from the crater. All contaminated debris was to be removed from the islands and encapsulated in the slurry during this phase. When the water became too shallow to float the barge, the tremie operation would stop and the slurry line would be held by a crane moving slowly around to form a mound. During the inactive periods in the containment operation, Team C personnel would assist Team B in their cleanup of Runit, the last and largest soil cleanup operation. After all contaminated debris and soil had been contained, a cleanup of the containment site would be conducted to assure that all contaminated material was in the container before the concrete cap was begun. The container would be covered with an 18-inch-thick concrete cap. Once the cap was complete, the stone mole would be grouted with noncontaminated material to provide a structure more resistant to the effects of the sea.[248]

The CONPLAN cleanup schedule was based on man-hour estimates taken from the Enewetak Engineering Study and adjusted for such factors as weather, radiological safety, and emergencies.[249] The concept planners estimated that cleanup of all plutonium contamination over 40 pCi/g on 11

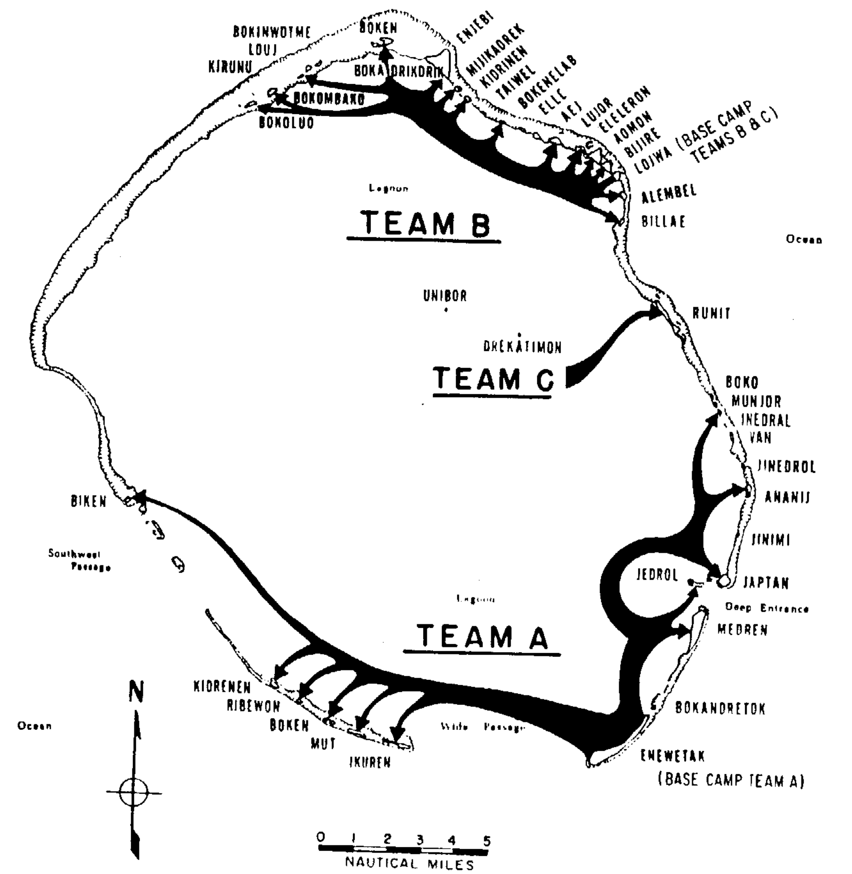


FIGURE 2-8. ARMY ENGINEER TEAM ASSIGNMENTS.

islands would require removal of 125,000 cubic yards of soil.[250] They recognized the many uncertainties in their estimates and the many unknowns in the mission, especially the radiological cleanup. Consequently, they set no fixed dates but provided only a general estimate for project completion. CONPLAN estimates ranged from 21 to 25 months for cleanup operations, including demobilization of base camps.[251,252]

SUPPORT ELEMENTS

The Joint Staff planners attempted to distribute the Enewetak project tasks among the Services as equally as possible while retaining unit mission integrity. Actual cleanup work was assigned to the Army Engineer Units and the Navy Harbor Clearance Units (later known as Water-Beach Cleanup Teams). Intra-atoll transportation was assigned to the Navy, with one exception. The Army would provide amphibious lighters (LARCs), Army amphibious vehicles with a unique capability for crossing the several hundred yards of shallow reefs which surrounded many of the islands and prevented access by the Navy landing craft. Other support teams, designated by the JCS[253,254] and identified in the CONPLAN,[255] included:

a. The Field Radiation Support Team, to be provided by the Air Force to oversee on-site radiological safety, conduct field radiological sampling of debris, and carry out explosive ordnance disposal.
b. The Medical Team, to be furnished by the Air Force to provide medical and dental care to all authorized personnel on Enewetak Atoll. The physician also would serve as staff physician to the CJTG.
c. The Chaplain Team, to be furnished by the Army to provide religious services and associated support to all personnel. The Chaplain also would serve on the staff of the CJTG.
d. The Communications-Electronics Team, to be furnished by the Air Force to provide all common-user communications support.
e. The Helicopter Team, to be furnished by the Army for intra-atoll medical evacuation, and search and rescue.
f. The Finance Team, consisting of one Army noncommissioned officer to provide military pay assistance.
g. The Laundry Team, to be furnished by the Army, since they were the only service which operated portable tactical laundry units, to operate a general laundry at Enewetak Camp and a decontamination laundry at Lojwa Camp.
h. The Petroleum-Oil-Lubricants (POL) Team, to be furnished by the Air Force to resupply forward-area POL stores and provide limited quality surveillance of POL products such as helicopter fuel.
i. The Airfield Team, to be furnished by the Air Force to operate the aerial port, including marshalling, loading, and offloading of aircraft.
j. The Postal Team, to be furnished by the Air Force to operate the military post office.

In addition to these teams, the Navy and Air Force were tasked to furnish technicians to work with the radiological support contractors, thus reducing the cost of radiological survey and laboratory operations.[256] The radiological support contractors, engaged and supervised by ERDA, were to provide soil surveys and laboratory analyses necessary to establish cleanup requirements, to evaluate the effectiveness of cleanup work, to support radiological health and safety programs, and to certify the results of radiological cleanup. The base support contractor, Holmes & Narver-

Pacific Test Division (H&N-PTD), was to operate and maintain the Enewetak base camp and furnish other contract services.[257]

Logistics support policy was based on maximum utilization of Military Services' equipment, supplies, subsistence, and transportation which had been funded by the services for normal operations. Existing Government logistics sources and systems would be used for supply, maintenance, and transportation when possible. Military Ocean Terminals at Oakland, California, and Honolulu, Hawaii, would serve as the primary surface shipping points, while Travis AFB, California, and Hickam AFB, Hawaii, would be the primary air terminals. H&N maintained logistics support offices at or near those locations to expedite acquisition, packing, and shipment of material.[258]

The Army member of the Joint Staff proposed that the CONPLAN provide for the use of MILCON funds to cover FY 1977-1978 costs fully, if necessary, to minimize impact on Service programs in the early years. The CONPLAN could then allow the Services to reprogram for the remaining costs in FY 1979. LTG Johnson pointed out that this would violate the language and intent of Congress, both by reimbursing the Services for costs which they already had programmed for troop support and by programming additional Service funds in FY 1979 solely for the Enewetak project.[259] The Joint Staff persisted in adding this provision; however, it was never implemented because the Services were able to support the project in the early years from programmed funds. The Army member of the Joint Staff also proposed that the final Operations Plan (OPLAN) be forwarded to the JCS for approval. DNA objected that this would infringe on the Director's authority as DOD Project Manager for the cleanup project and would unnecessarily involve the JCS in operational details in the execution of concepts approved by the JCS in its review of the CONPLAN. The JCS concurred with DNA and concentrated on review and approval of the CONPLAN.[260,261]

Now, all that was needed to produce a complete OPLAN were the technical and operational details which only the Military Services and the other federal agencies could provide. Until formal JCS tasking was received, Army activities could only coordinate informally with DNA officials to determine the status of planning efforts. Meanwhile, the other agencies, including the Air Force, the Navy, and the dri-Enewetak themselves, were conducting surveys and refining plans for the cleanup project.

SEPTEMBER 1976 SURVEYS AND CEREMONIES

In September 1976, the dri-Enewetak Planning Council, iroijs, and respected elders returned to the atoll to participate in field surveys and in ceremonies marking the formal, legal return of Enewetak Atoll to the people. The ceremonies took place on 16 September 1976 on the lawn in front of the Battle of Enewetak Memorial. BG Lacy represented the United States Government in the signing of agreements by the Honorable Peter T. Coleman, Acting High Commissioner of the TTPI; the dri-Enewetak Iroij, Johannes Peter, and the dri-Enjebi Iroij, Binton Abraham (Figure 2-9). The District Administrator of the Marshall Islands, Mr. Oscar DeBrum also was present, while Mr. Earl Eagles represented HQ DNA.[262]

Originally, it had been expected that this transfer could take place in 1973; however, resolution of numerous difficult issues regarding residual rights of the United States and use of the TTPI as an intermediary—as well as the higher-priority cleanup and rehabilitation planning—had required 3 years. The people's attorney did not want the TTPI involved in use agreements for the DNA cleanup forces, the Coast Guard LORAN Station, or ERDA's marine biological laboratory. However, DNA and DOI attorneys contended that the trust agreement precluded their signing agreements directly with the people.[263] The matter was resolved by preparation of agreements involving the TTPI but signed concurrently by the dri-Enewetak. Documents signed on 16 September 1976 included:

a. The agreement terminating rights, title, and interest of the United States to Enewetak Atoll under the 1944 agreement with the TTPI.[264]

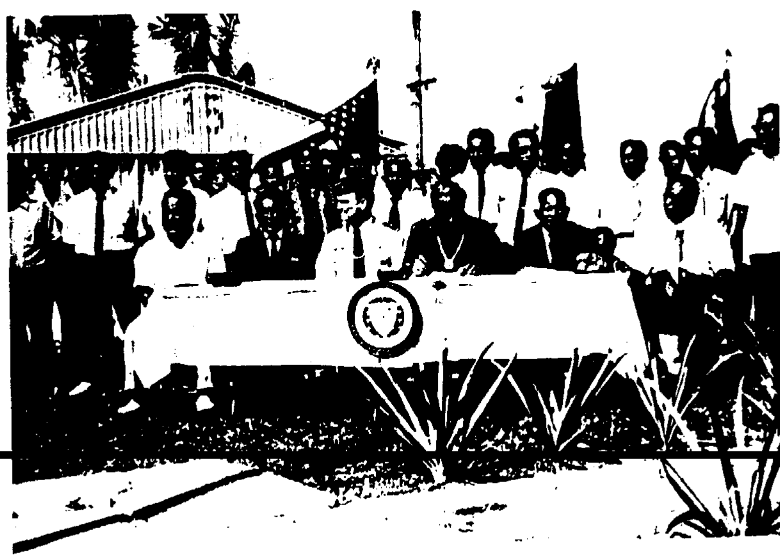


FIGURE 2-9. ENEWETAK ATOLL TRANSFER CEREMONY.

b. The TTPI's release and return of use and occupancy rights at Enewetak Atoll to the dri-Enewetak.[265]

c. The TTPI's joint disclaimer of right, title, or interest in or to Enewetak Atoll.[266]

d. The TTPI's quitclaim deed to Ujelang Atoll.[267]

e. The agreement granting use and occupancy rights at Enewetak Atoll to the TTPI by the dri-Enewetak.[268]

f. The agreement granting use and occupancy rights at Enewetak Atoll (for the cleanup) to the United States by the TTPI.[269]

g. The dri-Enewetak agreement that the $20 million appropriated by the Military Construction Appropriation Act of 1977 constituted the total commitment of the United States for the cleanup of Enewetak Atoll.[270]

h. The TTPI certification to the Secretary of Defense that the dri-Enewetak had agreed that the $20 million constituted the total obligation of the United States for the cleanup of Enewetak Atoll.[271]

Following the signing ceremonies, the dri-Enewetak Planning Council, Field Command, and TTPI representatives conducted a joint survey of the islands. Results of this survey, which were confirmed in Planning Council resolutions, significantly reduced the scope of nonradiological cleanup.[272,273]

NONRADIOLOGICAL CLEANUP PLANNING: 1974 - 1976

All of the cleanup work in the southern islands, and much of the work in the northern islands, involved removal of nonradiological hazards and obstructions to use of the islands. This nonradiological cleanup included buildings and their contents, utility systems, bunkers, towers, scrap piles, derelict watercraft, and World War II armaments and debris. Some bunkers could be made safe by removing doors and protruding hazards, while others would have to be sealed with concrete. Much of the work on the southern islands involved dismantling base camp buildings and facilities to make room for the houses, gardens, and coconut plantations of the people.

The Enewetak Engineering Study described each hazard and each obstruction which had been identified for removal during the 1972 engineering survey. However, the study itself was too voluminous to be used in the field or as a ready reference. Lieutenant Colonel Charles Focht, USA, of the Field Command's Pacific Support Office, originated a Master Index to the study which satisfied those needs. The Master Index was developed jointly by Field Command and H&N to identify each task by index number, location, description of work to be accomplished, and whether the task would be accomplished by DOD as part of the cleanup project or by TTPI as part of the rehabilitation program. The Master Index was revised periodically, based on resurveys and planning changes.

The most productive resurvey effort was that conducted in September 1976 during the visit to the atoll by the Enewetak Planning Council after the signing ceremonies. It had two objectives: (1) to comply with the direction of Congress that practical measures be taken to reduce nonradiological cleanup costs; and (2) to refine nonradiological cleanup plans.

Before the main party arrived, engineers from Field Command and H&N made a detailed survey of each island. This survey revealed that some of the work identified in the first field survey in 1972 had been modified or eliminated by natural forces, such as the complete corrosion of metal. In a significant modification of previous plans, Lieutenant David Gebert, USN, of Field Command, and Mr. Charles P. Nelson, of H&N (for TTPI), arranged an exchange of TTPI work in the northern islands for DOD work in the southern islands. Before this agreement, DOD had the responsibility for cleanup of radiological debris and hazardous nonradiological debris, and TTPI had the responsibility for cleanup of nonhazardous, nonradiological debris. Since both types of nonradiological debris were present on both the northern islands and the southern islands, work crews from DOD and TTPI would be engaged in parallel efforts on virtually every island. This had an added disadvantage in the north, for it meant that TTPI crews would have to be integrated into the radiological safety program. By exchanging jobs totalling an equal number of man-hours, DOD took over all of TTPI's responsibilities for nonhazardous, nonradiological debris in the north, and TTPI took over an equal amount of DOD's responsibilities for hazardous, nonradiological debris in the south. Thus, TTPI's site restoration work was restricted to the residence islands, and all cleanup and restoration work on the contaminated northern islands would be accomplished by DOD. This exchange also eliminated such inefficiencies as having DOD remove hazardous pipe stubs from a nonhazardous concrete slab before TTPI removed the whole slab.

Upon their arrival, the Planning Council reviewed the survey and suggested additional work reductions such as leaving asphalt runways in areas designated for tree planting and cutting holes in them to permit planting, and leaving flat concrete foundation slabs for use as copra drying locations. The Planning Council passed a resolution approving the resurvey results, and the Master Index was revised accordingly. This resurvey eliminated approximately 80,000 man-hours of work from the southern islands cleanup effort.[274] The Planning Council also agreed to the following criteria for nonradiological cleanup of islands, according to use-categories defined in the March 1975 Master Plan:[275]

Major Inhabited Islands: Remove all hazards and all obstructions to reasonable use of the land, out to the Mean Low Water Line.

Intensive Agriculture Islands: Remove all hazards out to the Mean Low Water Line. Remove all obstructions to reasonable use of the land out to the periphery of the vegetation area.

Food Gathering Islands: Remove all hazards out to the Mean Low Water Line. Leave in place objects which do not significantly interfere with food gathering.

NONCONTAMINATED MATERIAL DISPOSAL: 1974 - 1976

Disposition of noncontaminated material did not have the many problems connected with the disposal of radiologically contaminated materials. The EIS provided three basic methods for disposal of noncontaminated material:

a. Combustibles would be burned in a pit, the ashes gathered and stockpiled for future use as a soil conditioner, and the pit backfilled and restored to its original contour.
b. Materials that could be used by the Enewetak people would be salvaged and stockpiled. Presumably, this included wood which the people could burn for cooking. The dri-Enewetak requested that usable material be stockpiled for them and not sent to other areas of the TTPI.
c. Unusable material would be dumped in the lagoon at selected locations.[276]

The question of lagoon-dumping of uncontaminated scrap had been settled at the meeting held at the EPA on 8 August 1974. After some discussion as to whether shallow dumping would create artificial reef habitats for marine life or cause reef damage leading to ciguatoxic contamination of marine life, deep-water lagoon-dumping had been decided upon. All present had agreed that the practice would have no substantial adverse effect, especially since depths of 200 feet were to be used as dumping sites.[277]

DISPOSAL BY SALE: 1975 - 1976

Most of the uncontaminated material to be removed during cleanup was on three islands designated for residence (Japtan, Medren, and Enewetak). Much of it had commercial value as scrap. On 5 December 1975, DOD had requested DNA to examine the possibility of reducing MILCON costs by having a Japanese scrap buyer remove the noncontaminated scrap.[278] There was some question, however, as to the ownership of the scrap and the eligibility of a foreign buyer. Under the existing agreement between the United States and the TTPI for the use of Enewetak Atoll, the scrap material would have been abandoned in place. According to the Engineering Study and the EIS, it would be dismantled and stockpiled for use or sale by the people. The TTPI-Marshall Islands District Early Return Program anticipated some employment and revenue for the dri-Enewetak from the sale of scrap. The Marshall Islands District Administrator, Mr. Oscar DeBrum, expressed an interest in contracting for the sale and removal of the material. Initially, this appeared to provide an excellent means of accomplishing much of the southern islands cleanup and reducing the effort and cost of the DOD project. Accordingly, in December 1975[279] and in January 1976,[280] Field Command recommended that the facilities and material required for the cleanup operations be identified and that the remaining facilities and material revert to TTPI under the use agreement so that TTPI could contract for its sale and removal by commercial contract. At the same time, LTC Hente, of Field Command's Pacific Support Office, was coordinating with Defense Property Disposal Office (DPDO) officials in Hawaii regarding another alternative—that of having DPDO contract for the sale and removal of the scrap.

On 13 January 1976, the HQ DNA Logistics Directorate advised Field Command that a recent change in Public Law 40-USC 472 and Federal Property Disposal Regulations prohibited transfer of the material to TTPI or the dri-Enewetak without prior determination by DPDO that the material was "uneconomically salvageable."[281] This guidance did not apply to buildings left standing by cleanup forces. Thus, in planning the disposition of Lojwa Camp, it was determined that cleanup forces would remove the installed equipment and facilities for which DOD had other requirements, and that the remaining buildings which had been erected for the project would revert to TTPI for use by the dri-Enewetak or disassembly by TTPI forces.

The HQ DNA Logistics Directorate also advised that it would be extremely costly to conduct a special radiological survey at that time to assure the material was noncontaminated. Therefore, the survey and sale, if any, could not take place until cleanup operations had begun.[282] Mr. Oscar DeBrum was so advised on 3 February 1976.

The advantages of accomplishing some cleanup by scrap sale continued to be explored. Since most of the facilities and material had been acquired under the Enewetak base support contract, it was suggested that the current base support contractor, H&N-PTD, remove and sell the material as a plant closure action, with net proceeds being credited to the base support contract. However, in view of the 13 January 1976 decision, this

suggestion was rejected. Field Command continued to pursue the matter. LTC Hente escorted Mr. Dean Easton, Chief, DPDO, Hawaii, and Mr. R. Rupert, DPDO, to Enewetak for a physical survey of scrap materials and excess/surplus equipment on 22-30 June 1976. Both men were impressed by the quantity and quality of available material and were confident that a number of companies would be interested and submit bids. It was estimated that 80 percent (24,000 gross tons) of the material was, in effect, base support contractor inventory and that any proceeds of its sale, less DPDO's expenses, would be returned to H&N-PTD for credit against the base support contract. This was confirmed in a DNA-Defense Supply Agency conference on 2 September 1976.[283]

At Enewetak, following the 16 September 1976 signing ceremonies marking formal return of the atoll to the dri-Enewetak, their iroijs and Planning Council were informed that, due to the change in the law, the usable material could not be left for them. They were, however, given permission to dismantle buildings 190 and 544 and take the material to Ujelang. Their removal of these buildings saved an estimated 400 man-hours of cleanup work for DOD forces.[284]

In November 1976 a team from Field Command led by Lieutenant Colonel Manuel Sanches, USA, monitored all of the material for radioactive contamination and, together with a team from DPDO, Hawaii, marked it for inspection by potential buyers.[285] The scrap sale and removal operations are described in Chapter 4.

OTHER PLANNING ACTIONS: NOVEMBER-DECEMBER 1976

BG Lacy and a few key staff officials embarked on a series of coordinating conferences in November 1976. The first, at Headquarters DNA on 11 November, was to brief the Director on the current planning status and to establish a new D-Day. When the 2 July 1976 version of the CONPLAN was forwarded to the JCS, a tentative D-Day of 1 March 1977 had been set forth. However, by November, the CONPLAN still was not approved by the JCS, the Military Services still had not been tasked to support the cleanup, and a radiological support plan had not been prepared. Planning was behind to the extent that BG Lacy felt that the 1 March 1977 D-Day could not be met. He recommended that D-Day be established at least 6 months after the date that the JCS tasked the Services.[286] Instead, LTG Johnson chose to fix a new target D-Day of 15 June 1977 and challenged the planners to meet it.

The next conference was called by the District Administrator of the Marshall Islands, at Majuro, on 15-19 November 1976. Organizations represented included Field Command, TTPI, ERDA, H&N, and MLSC.

The conferees prepared a new schedule for developing an OPLAN and for mobilizing personnel and equipment based on a 15 June 1977 D-Day. They also developed plans for support of the rehabilitation program. Plans for the early return of 50 dri-Enewetak to Japtan in March 1977 were completed, as well as plans for employing some of the dri-Enewetak in the cleanup and rehabilitation work. Logistics policy and plans for support of the activities at Enewetak were also developed.[287]

BG Lacy's team next met in Saipan with the Acting High Commissioner of the TTPI, Mr. Coleman, and the dri-Enewetak legal counsel, Mr. Mitchell, on 20 November 1976 to coordinate plans for the early return and for interface of the cleanup and rehabilitation efforts. The Field Command team then conferred with Hawaiian area officials on 22-23 November 1976 on preparations for the cleanup project, including establishment of a branch exchange at Enewetak and a forthcoming survey by a Navy team.[288]

This Navy survey team, assisted by Field Command personnel, conducted a thorough investigation of Enewetak Atoll waters and beaches from 30 November through 15 December 1976. They produced a definitive report of harbor clearance requirements, beach access and trafficability, and personnel and equipment requirements.[289] The report was incorporated in the Field Command OPLAN with only minor changes. In December 1976, a team from the Pacific Air Forces Surgeon's Office also conducted a survey at Enewetak Atoll in preparation for establishing a Medical Clinic at Enewetak Camp and a Medical Aid Station at Lojwa Camp.[290]

CRATER CONTAINMENT DESIGN: 1975 - 1977

On 29 November 1976, POD completed the initial "Design Analysis for Crater Containment of Contaminated Material at Enewetak." It concluded that use of Lacrosse Crater would be unduly expensive and provided procedures for use of Cactus Crater, as the preliminary DEIS had proposed. At Field Command's request, the design analysis provided for a capacity of up to 200,000 cubic yards of soil, the worst case anticipated,[291,292] with the capability of containing even larger quantities if necessary. POD recommended that the tremie method of placing soil-cement slurry be used below the water level only and that placement above the water level be accomplished by windrowing the dry soil and cement, then spraying it with water to initiate the cement's bonding action.[293] The POD design called for containing contaminated debris in the contaminated slurry mix and using dikes to contain slurry and debris placed after soil cement operations had begun.[294] Further details on crater containment design and construction are in Chapter 8.

RADIOLOGICAL SUPPORT AND CLEANUP PLANNING: 1975 - 1977

On 16 June 1975, the Director, DNA requested ERDA assistance in developing a plan for radiological monitoring and support. This plan was considered to be one of the most important elements in planning for accomplishment of the project. A draft DNA-ERDA agreement for radiological support was forwarded with the request.[295]

While the agreement was being negotiated at the Washington level, Field Command and ERDA-NV began developing a proposed radiological support plan. It was immediately apparent that some radiological control and survey tasks could be accomplished by troops but that other radiological support would have to be provided by ERDA contractors. A target date of 31 August 1975 was established for completing the draft radiological cleanup plan.[296]

The DNA-ERDA agreement, commonly referred to as the "Shedd-Liverman" agreement, for radiological support of the cleanup project was signed on 28 August (DNA) and 10 September (ERDA) 1975. It proclaimed the intent of both agencies to ensure that radiological hazards were disposed of in such a manner that safe resettlement could be accomplished. Further, it specified compliance with the guidelines which had been recommended for the cleanup by the AEC Task Group.[297] These guidelines were more stringent than those in general use in the United States, and they had received endorsement by the Congress as a precondition for resettlement.[298] The agreement obligated ERDA to provide certification when the radiological cleanup had complied with the guidelines.

In October 1975, representatives of Field Command and ERDA-NV met to review the DNA-ERDA agreement and discuss development of the radiological cleanup plan.[299] A draft plan was completed on 13 November 1975, based on results of this conference.[300] The two parties met again in May 1976, at which time ERDA-NV proposed to develop a field survey system for measuring plutonium concentrations in the soil using a gamma detector mounted on a boom extending from a van. (The van was a small tracked vehicle with the trade name "IMP." This trade name and its derivatives and variations as used herein are or were derived from a trademark which is the property of the De Lorean Manufacturing Company. Hereafter, throughout the documentary, the process of conducting an in situ survey using this van is referred to as "IMPing," and the vehicles are referred to as "IMPs.") It was anticipated that this in situ system—in comparison with conventional soil sampling techniques—would significantly reduce the effort and increase the speed of measuring plutonium concentrations. It also was expected to expedite soil cleanup and minimize the volume of soil excised. Possible disadvantages were the limited soil depth which the system would survey and the possibility that this new approach might not be acceptable to EPA and other concerned agencies. A prototype in situ detector was undergoing tests at the site of the Hamilton event on the Nevada Test Site, and it was anticipated that ERDA would approve the system for use at Enewetak.[301]

The Radiological Cleanup Plan was revised again on 16 July 1976, but it left some basic questions relative to radiological cleanup criteria still unanswered. Field Command asked for HQ DNA assistance in obtaining definitive answers from ERDA as soon as possible.[302,303] Detailed criteria and guidance were required to complete a Radiological Cleanup Appendix to the CONPLAN[304] and to develop estimates of work requirements upon which to base resource needs. The situation was complicated by two factors: (1) ERDA Headquarters in Washington had not formally assigned ERDA-NV the responsibility for furnishing radiological support; and (2) MILCON funds were limited.

The DNA-ERDA agreement stipulated that ERDA would provide technical and scientific advice and assistance on radiological activities associated with cleanup, including, but not limited to:

a. Advice and assistance on the preparation of the radiological cleanup plan and the radiological safety program.
b. Interface with other Federal agencies concerning radiological matters.
c. Provision of on-atoll ERDA representation.
d. Performance of radiological support, to include: (1) Day-to-day field monitoring, dosimetry, and record keeping for health and safety. (2) Radiological classification of material for removal, disposal, or reuse. (3) Certification, on an island-by-island basis. (4) Establishment, operation, and maintenance of a field laboratory.

Item d of these ERDA commitments was contingent on reimbursement from DNA. In view of the $20 million ceiling which had been set by Congress and its charge to use all available economy measures, DNA's reimbursement to ERDA would of necessity be limited to the $1.5 million which had been estimated earlier. A compromise was reached whereby the military services would provide for radiological safety and the classification of debris and ERDA would only provide for classification of soil and management of the radiological laboratory.

Field Command and ERDA-NV representatives conferred on 28-29 October 1976 to define the responsibilities of ERDA contractors and military personnel. To reduce project costs further, it was agreed that military technicians would assist in the ERDA contractor laboratory, in driving the in situ vans, and in maintaining and repairing radiation detectors and other equipment. ERDA-NV representatives advised that their radiological support would not be available in April 1977, as was

required to meet the then-planned 1 March 1977 D-Day. They estimated it would require 6 to 9 months; i.e., until 1 October 1977, before the radiological laboratory would be operational.[305]

The major technical problem in completing the radiological cleanup plan concerned criteria for evaluating debris and soil against radiological cleanup requirements. Without adequate criteria, the type of equipment needed for field and laboratory measurements was uncertain, necessary survey procedures could not be developed, and there was no measure for determining and certifying the quality of cleanup. The need for precise criteria for the cleanup project was made even more critical by the planned periodic rotation of personnel throughout the life of the project.

The AEC Task Group had made recommendations on cleanup of both debris and soil, but these recommendations were too general and open to too many interpretations to serve as criteria for those in the field. With respect to debris, the AEC Task Group had recommended that "all radioactive scrap metal and contaminated debris. . .should be removed."[306] This recommendation was modified in the EIS Case 3 cleanup actions to the requirement that "radioactive scrap be removed from all islands in the atoll." Although this guidance might seem clear-cut at first glance, that was not the case. No material is totally devoid of radioactivity; and clearly not every level of radioactivity is sufficient to warrant disposal of the material containing it.

The ERDA radiological advisors to DNA on the Enewetak Cleanup were reluctant to recommend criteria for use in deciding which debris was radioactive and deserving of disposal and which was not. ERDA had criteria in existence governing the release of materials for uncontrolled use following use in contaminated areas, but these criteria were not suitable for the Enewetak debris situation. One reason was that much of the Enewetak debris was situated in areas with considerable background radiation, so that definitive measurements could not be made unless the debris were relocated to a low background area. Such a practice would have led to costly, unnecessary debris movement merely to make measurements. Numerous attempts were made to define "background" and situations when debris might qualify for disposal, but none were acceptable. A second reason why ERDA criteria were not suitable was that they only addressed surface contamination. Normally, activated contamination such as that found in much of the Enewetak debris was not encountered in ERDA operations. During one planning meeting on debris criteria, Mr. Tommy F. McCraw, of ERDA Headquarters, pointed out that ERDA's reluctance to provide advice stemmed in part from the fact that they had not been successful in negotiating a contamination threshold level with EPA. He also felt that, if criteria were more stringent than had been used at Bikini, the Bikinians would not understand. (Likewise, the dri-Enewetak would not appreciate any criteria which were less stringent than had been used at Bikini.) He further expressed concern that if any specific numbers were announced as criteria, they would be rejected by EPA.[307] Thus, the ERDA advice was that Field Command should develop radiological criteria, with whatever assumptions deemed suitable, and present it to ERDA for approval.

A concept was then formulated at Field Command for monitoring debris. The monitoring included definitive measurements for alpha, beta, and gamma radiation under various conditions. The criteria were specific, and they were forwarded to Headquarters DOE for review. A decision was reached that the criteria were acceptable, and that they should be set forth explicitly in Standing Operating Procedures for use on the atoll by cleanup forces.

With respect to contaminated soil, the AEC Task Group had recommended that it be removed if plutonium concentrations exceeded 400 pCi/g; removed on a case-by-case basis, considering all radiological conditions, if plutonium concentrations were in the range of 40 to 400 pCi/g; and not be removed if plutonium concentrations were less than 40 pCi/g.

Despite the specificity of the Task Group criteria for soil removal, there still were uncertainties concerning the area/volume of soil to which the plutonium concentrations were to apply. At one extreme, an "island average" could be used. At the other (impractical, but illustrative) extreme, a gram-by-gram decision could be made. Thus, the soil cleanup criteria also needed clarification so that techniques could be defined for assaying and removing soil.

The initial Field Command concept for evaluating soil was to gather and analyze samples in a manner similar to that which had been used for the Radiological Survey, but on a more closely spaced grid, and only in those portions of islands which appeared likely to have average concentrations exceeding 40 pCi/g based on survey data. The question Field Command sought to have answered by ERDA in meetings on developing a Radiological Cleanup Plan was how many samples would be required from any area to achieve a characterization which would satisfy certification expectations. Once ERDA chose an in situ method in lieu of the survey-type soil sampling method, the question changed in nature.

Another conference was held at Field Command on 28-29 December 1976.[308] It produced a Radiological Cleanup Plan which was modified slightly by Headquarters, DNA,[309,310] and used as an Appendix to the final CONPLAN 1-76.

In summary, radiological cleanup planning had required extensive effort over many months by Field Command and ERDA planners to resolve the many questions concerning concept and method of execution. The final

CONPLAN 1-76 was based on the EIS Case 3 radiological cleanup as approved by Congress and the JCS.[311] That plan still had to be modified somewhat in subsequent planning actions, however.

FIELD COMMAND OPLAN 600-77: 1977

Field Command OPLAN 600-77 was essentially an expansion of the 15 September 1976 Field Command CONPLAN 1-76; however, it could not be developed until MILCON funds had been appropriated and the Military Services had been formally tasked to support the project. Beginning in August 1976, Field Command began preparations to develop the OPLAN. The Plans and Operations Director, Colonel John V. Hemler, Jr., USA, assumed responsibility for preparing the plan. In actual practice, COL Schaefer, and COL Thompson, (both of the Logistics Directorate), who had finalized the CONPLANs, served with COL Hemler as tri-chairmen in presiding over the OPLAN development conferences. To develop the individual annexes of the OPLAN, functional working groups were established, each chaired by a Field Command staff official, including:[312]

Operations Group - LCDR R. F. Walters, USN
Radiological Subgroup - LTC M. L. Sanches, USA
Logistics Group - Mr. D. L. Wilson
Comptroller Group - LTC M. J. Worrick, USAF
Manpower Group - CPT L. C. Dudley, USAF
Communications Group - LTC R. H. Ludwig, USAF

On 10 September 1976, the Secretary of Defense had requested the JCS to task the Services for project support. It had been hoped that the first OPLAN development conference could be held later that month. However, it was 24 January 1977 before the JCS provided formal tasking.[313] Therefore, the first conference had to be postponed several times and finally began on 3 February 1977 in Albuquerque. The Army representatives still had not received their tasking when the first conference began.

FIRST OPLAN CONFERENCE: 3-4 FEBRUARY 1977

At the first OPLAN development conference, conferees came from the Service headquarters in Washington and their action-level commands; i.e., Army Forces Command, Commander Naval Surface Forces, Pacific (COMNAVSURFPAC), and Pacific Air Forces (PACAF). ERDA representatives came from their Washington headquarters and the Nevada

Operations Office. HQ DNA sent four representatives. Holmes & Narver's home office and its Pacific Test Division were both represented. The conference considered overall concepts and policies and identified potential problem areas which were resolved or assigned to specific representatives for action. While this conference was primarily an orientation and introduction for the second OPLAN conference, there were several significant results:[314]

a. ERDA-NV stated that the in situ vans would not be available for shipment until August 1977, and the Radiological Laboratory would not be available until October 1977. They agreed, however, to review their schedule since it was not responsive to the planned D-Day of 15 June 1977.
b. Navy representatives identified a source of nonreimbursable sealift for mobilization and resupply—COMNAVSURFPAC ships traversing the Pacific on semiannual deployments which could provide space for heavy equipment and other cargo.
c. Navy representatives advised that the Boat Transportation Team could support other on-atoll tenant requirements for inter-island transportation, within reason.
d. Although CONPLAN 1-76 encouraged a 1-year, unaccompanied tour, the Services planned to use 4- to 6-month TDY tours, which they would fund, in order to avert the costs of moving families.

SECOND OPLAN CONFERENCE: 21 FEBRUARY-9 MARCH 1977

The second OPLAN development conference was held at Enewetak Atoll from 21 February 1977 through 9 March 1977. The location had two advantages. It permitted conferees to become familiar with the field of operations, and it isolated them from distractions so that a great amount of work was accomplished in a short time. The conference had three principal objectives:

a. Development of a draft OPLAN.
b. Identification of personnel and materiel requirements for mobilization, so that these could be requisitioned on a priority basis.
c. Development of an operational schedule, to include firmly establishing D-Day (the beginning of camp construction and radiological surveys).

Under the direction of BG Lacy, the same Field Command triumvirate chairmen and working group organization employed in Albuquerque were used at Enewetak. A total of 120 representatives from the Services, other government agencies, and various contractors participated in the conference and the concurrent surveys.

Personnel from the 20th Engineer Brigade, Fort Bragg, North Carolina, working in three teams, surveyed cleanup worksites and provided detailed input for the operations annex of the OPLAN. Their surveys were organized according to the work assignments in CONPLAN 1-76: Team A surveyed the southern islands; Team B, the northern islands; and Team C, the crater containment worksite on Runit. Personnel from the 84th Engineer Battalion, U.S. Army Support Command, Hawaii (USASCH), surveyed Lojwa and prepared a detailed plan for construction of the forward camp to be located there. Personnel from the 485th Medical Detachment, Fort Sam Houston, Texas, conducted extensive entomological surveys to provide insect and rodent control data.[315] Navy and Air Force planners conducted surveys of the support facilities they would be utilizing.

The general tone of planning at this second OPLAN conference was more practical, less theoretical than previously, since the individuals involved were, in many cases, either those who would actually supervise the work or those to whom they would report. Recognizing that major surprises in actual contamination measurements would occur over the next 3 years, and to provide the cleanup project leadership with maximum flexibility in decision making once the situation became clearer, the planners translated the CONPLAN cleanup guidance for soil excision into:[316] "In general, the ERDA guidelines provide for removal of concentrations of plutonium soil exceeding 400 pCi/g, and for selective removal in the range of 40 to 400 pCi/g."[317]

For some reason not specified, the planners omitted reference to removal of the crypts on Aomon where contaminated material had been buried.[318] This omission later led to suggestions from some that the largest crypt need not be removed, suggestions which were not accepted by the Director, DNA. The CONPLAN text requiring containment of contaminated debris in contaminated soil-cement slurry[319] was expanded and revised into three OPLAN provisions.

The ERDA-NV input to the OPLAN clarified the conflicting guidance on soil cleanup in earlier planning documents. The AEC Task Group Report had, in one location, recommended that, once soil cleanup action was initiated, "the concentrations would be reduced to the lowest practical level."[320] In another location, and in the EIS, this suggested guidance was inappropriately worded to the effect that, where initiated, soil cleanup "would be to well below 40 pCi/g."[321] Now, ERDA planners interpreted this objective anew, providing guidance that the reduction should be "to some lower number which shall be determined by cost-benefit considerations but will usually not be below local background."[322] This interpretation permitted intelligent focusing of effort, made optimum use of precious cleanup resources, preserved the ecology of some islands, and made possible the cleanup work that the dri-Enewetak urgently needed.

With the selection of the in situ method, the radiological planning issue shifted from the number of soil samples per unit area to how many in situ measurements were needed and what size the in situ field of view should be. In developing the OPLAN, the issue was resolved by specific ERDA decisions. Measurements would be made at a specific height and on a specific grid spacing. Raw data would be converted to plutonium concentrations using a consistent set of reasonable assumptions, and the resulting numbers would be related to the revised soil cleanup criteria. (See expanded discussions in later chapters.)

OPLAN development indicated that the cleanup would require more people, more time, and more money than previously estimated.[323] While the CONPLAN estimated 600 military personnel, the OPLAN called for 866. In the CONPLAN, it was estimated that the project would take 28 months from D-Day, while the OPLAN developers estimated 34 months. Time estimates for camp construction and demobilization in both plans were furnished by 84th Engineer Battalion personnel; however, planning factors had changed considerably since the time the CONPLAN had been developed; i.e., tents and prefabricated buildings were eliminated in favor of more permanent facilities. Some of the additional time was required to construct additional billeting and recreation facilities required to support a population of 443 at Lojwa Camp, 122 more than estimated in the CONPLAN.[324] Additional construction time also was required because the many prefabricated units anticipated in the CONPLAN were not available. All but a few facilities would have to be constructed using standard building materials.[325,326] Too, some activities which were previously considered as part of the cleanup were redefined as demobilization functions.

There was an anticipated 3-month delay in availability of ERDA radiological support (15 September 1977 rather than 15 June 1977). In order to accommodate this delay and the delay in availability of the Lojwa Camp, the planners rescheduled mobilization and cleanup activities. Northern islands debris survey and removal were rescheduled to begin prior to, instead of concurrent with, contaminated soil operations and southern islands cleanup.[327]

Three alternatives for determining D-Day were considered:

a. D-Day of 15 June 1977, with mobilization actions as scheduled in the JCS-approved CONPLAN.
b. D-Day of 15 June 1977, with modifications to the CONPLAN schedule of mobilization actions to accommodate the delay in ERDA radiological support and Lojwa Camp availability.
c. Deferral of D-Day to accommodate the delay in ERDA radiological support and Lojwa Camp availability while maintaining the CONPLAN schedule for mobilization actions.

The critical factor in the selection of D-Day was the time required for mobilization of manpower and material. For a major project, a minimum of 180 days normally is required from the time personnel and supplies are requisitioned until they arrive at the work site. The Logistics and Manpower Working Groups insisted that even with Force Activity Designator (FAD) II, a relatively high military priority, and expedited action at all levels, an absolute minimum of 90 days was required. Even so, to meet a 15 June 1977 D-Day, the absolute latest date the mobilization effort could begin was 15 March 1977.

The first alternative, which required that base camps using tents be erected in 60 days, was clearly impractical for the more permanent type camp being proposed for Lojwa. The third alternative was strongly favored by ERDA and Army planners. Navy and Air Force planners were prepared to support either the second or third alternative although they, too, preferred the latter. The Manpower and Logistics Working Groups also preferred the third alternative, but believed that they could support the second if certain conditions were met: (1) the project must be designated as FAD II; and (2) mobilization must begin by 15 March 1977. Manpower and material for base camp construction must be requisitioned a minimum of 90 days before construction forces were due to arrive on D-Day. Since actual cleanup operations would not begin until after the mobilization phase was completed at D+5 months, manpower and equipment for cleanup could be ordered later; however, the manpower and material required for camp construction would have to be identified and requisitioned as soon as possible. This meant that mobilization could not be delayed until the OPLAN had been finalized and approved, but must begin immediately (March) if D-Day were to be 15 June 1977.

Based upon these considerations, BG Lacy selected the second alternative and approved starting mobilization on 15 March 1977. The deciding factor in establishing 15 June 1977 as D-Day was general agreement that the momentum established at the conference should be maintained. Other factors were avoidance of cost escalations and the need to demonstrate to the dri-Enewetak, and to the world, that the United States was about to fulfill its promises.[328,329]

To accommodate both the lengthened schedules and the 15 June 1977 D-Day, the operations schedule of the CONPLAN (Figure 2-7) had to be revised in the OPLAN. The determining factor in the CONPLAN schedule was contaminated soil removal and containment, which was estimated to require approximately 2 years. Since the actual extent of soil contamination, especially subsurface contamination, was unknown, the planners could only make a rough estimate of its magnitude. The OPLAN acknowledged this in several places:

"The cleanup guidelines for transuranic contaminated soil removal will continue to change and be amplified during the course of the operation."

"The general scope of work as defined by the Enewetak Radiological Study and the Engineering Study for a Cleanup of Enewetak has been changed and will continue to be adjusted to meet changing cleanup guidelines and circumstances."

"This operation will be constrained by the uncertainty of the scope of work. Should the scope of work increase as a result of conducting operations, it may impede accomplishment of the mission."[330]

Due to this uncertainty in the scope of work, the OPLAN developers, like the CONPLAN developers, did not include in the text any scheduled dates for milestones other than D-Day.

The new OPLAN operations schedules had to be hastily prepared and coordinated, with the result that minor errors in scheduling appeared in the timetable for mission accomplishment.[331] After the OPLAN was published, the schedules were refined and two new schedule formats were adopted, one for general briefing and the other for detailed planning and briefing. The general cleanup project schedule as of 15 March 1977 is shown in Figure 2-10. On some schedules; e.g., Figure 2-10, the mobilization phase is shown as extending from 15 March to 15 November 1977, a period

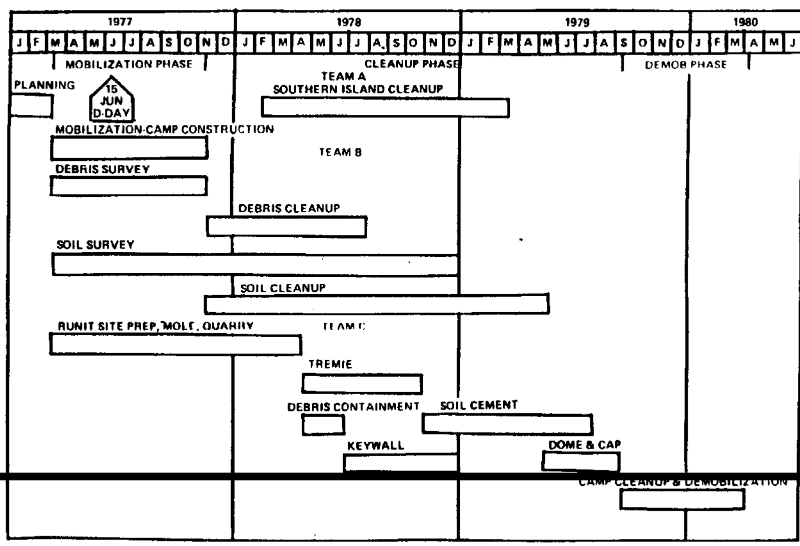


FIGURE 2-10. ENEWETAK CLEANUP PROJECT SCHEDULE - 15 MAR 77.

of 8 months. For the purposes of this documentary, this period may be viewed as a 3-month preparatory phase ending on D-Day (during which time personnel and material for the cleanup were identified, ordered, and transported to Enewetak), and a 5-month mobilization phase following D-Day (during which time the base camps were built or rehabilitated and all on-atoll preparations for the cleanup were made).

Comparison of the CONPLAN and OPLAN schedules reveals that the OPLAN allowed more time to prepare the more permanent type base camps (5 months versus 2) and more time to demobilize them (7 months versus 1). Although the 20th Brigade engineers generally confirmed the accuracy of the Engineering Study and CONPLAN workload estimates by conducting their own survey, they allowed only 22 months in the OPLAN for actual radiological cleanup and containment versus 24 months in the CONPLAN. However, the CONPLAN cleanup estimates included demobilization of the base camps while the engineers' estimates allocated time separately for that function. The OPLAN was based on excision and containment of about 79,000 cubic yards of contaminated soil (the estimate which appeared in the EIS). The planners believed that, if it became necessary to expand the scope of work to the possible totals of 125,000 to 200,000 cubic yards mentioned in the CONPLAN, additional money, manpower, resources and time would be required.

OPERATIONS PLAN ISSUES: MARCH-APRIL 1977

Several controversial issues arose during development of OPLAN 600-77. In reviewing the CONPLAN, the JCS planners had reduced the Force Activity Designator priority to FAD V, which is normally assigned to routine administrative missions. The Service logisticians at the OPLAN conference confirmed DNA's belief that supplies ordered with a FAD V would not be delivered in time to support a 15 June 1977 D-Day. At their request, DNA appealed the Joint Staff decision, and the project was authorized higher priorities for both mobilization (FAD II) and resupply (FAD III).[332]

OPLAN conferees also requested that DNA determine if special transportation rates for the project could be obtained from Military Airlift Command (MAC) and Military Sealift Command (MSC), based on the MILCON Appropriation Act which indicated that transportation would be furnished without reimbursement. The Assistant Secretary of Defense, Comptroller, advised DNA that the law did not apply to industrially funded DOD components such as MAC and MSC; therefore, no special transportation rates would be provided for the project.[333]

Air Force planners proposed to continue contracting out the airfield operation to H&N under a Field Command-MAC agreement as had been done since early 1976. The Air Force also planned to contract out the communications support operation to H&N. However, the Air Force General Counsel determined that this would be contrary to the MILCON Appropriation Act, which he interpreted to require use of military personnel for the specific cleanup functions the Air Force had been tasked to provide.[334] This interpretation, in its strictest sense, was upheld by the DOD Assistant General Counsel.[335] DNA and the other Services, however, did not construe the Act as precluding the Services from contracting for support for their specific cleanup functions, since the Act only specified that troops would be used to accomplish the cleanup. Support for those cleanup troops could be provided by whatever means the Services might choose, based on Service policy.[336,337] The latter interpretation was applied by DNA, the Army, and the Navy in providing support for the project. This interpretation was also concurred in by the DOD Assistant General Counsel; i.e., the Air Force could not contract with H&N for the communications function because that specific operational function was assigned to the Air Force, but the Army could contract with H&N to operate the messhall for its troops on Lojwa because the Army's specific operational function was cleanup, which they were doing, not operating messhalls.

Only four major issues remained unresolved at the end of the second OPLAN conference:[338]

a. The Army believed that at least three landing craft, utility (LCUs) would be required. The Navy representatives did not believe they could man more than two LCUs. A strict limitation had been imposed by the Chief of Naval Operations on the number of Navy personnel to be provided for the project.
b. The Army believed that two doctors would be required, one for Enewetak Base Camp and the other to be stationed at Lojwa Base Camp. The Air Force, which was to provide medical services, contended that only one doctor would be necessary, as the medical evacuation (MEDEVAC) helicopters could transport patients from Lojwa to Enewetak where the facilities would be more complete. The Army was not so much concerned about emergency medical treatment as about the day-to-day supervision of all health and safety aspects that a doctor could provide at the primitive and hard-working Lojwa Camp.
c. The Army, which was to provide four helicopters, wanted them to be used for MEDEVAC and search and rescue (SAR) missions only, while Field Command believed they should be available to the CJTG for command and control purposes also.

d. DNA and ERDA had not agreed on the details of certification by ERDA.

Requirements for personnel and materiel were not complete by the end of the conference, but they had progressed well enough that most requisition actions could be initiated. On his return trip, BG Lacy briefed the CINCPAC staff on results of the conference and plans for the cleanup project.[339]

EARLY RETURN TO JAPTAN: MARCH 1977

During the second OPLAN conference, BG Lacy and Mr. Oscar DeBrum completed an agreement for the early return of approximately 50 dri-Enewetak to Japtan Island. These officials visited Ujelang Atoll on 25 February 1977 to coordinate with the people on plans for early return.[340]

On 15 March 1977, the two iroijs, Johannes and Binton, with over 50 dri-Enewetak, returned to Enewetak Atoll to live on Japtan during the cleanup project and to consult and advise on the cleanup and rehabilitation effort (Figure 2-11). Existing Quonset buildings on Japtan had been renovated to provide suitable temporary housing. Ceremonies and a banquet marked the event which was recorded by an American

FIGURE 2-11. EARLY RETURN OF THE PEOPLE TO JAPTAN.

Broadcasting Company television crew as well as other media representatives.

FINALIZING THE OPERATIONS PLAN 600-77

On 31 March 1977, LTG Johnson was relieved as Director, DNA, by Vice Admiral Robert R. Monroe, USN. Shortly after the change of command, the last OPLAN development conference was conducted in Albuquerque on 25-29 April 1977 to resolve outstanding issues and produce a version of the OPLAN which, while not having final approval, could be used for planning purposes. A number of comments had been received by Field Command on the items approved at the previous conference, and these and the four open items from that meeting were considered. Some of the suggestions were accepted or modified and some were rejected. The four outstanding issues were resolved as follows:[341]

a. The LCU issue had been coordinated informally by Field Command, Army, and Navy representatives between conferences and was easily resolved. The Army would provide three LCUs, instead of two, from its reserve at Okinawa, and the Navy would provide the additional crew.
b. The medical doctor issue also had been resolved informally before the conference by discussions among Field Command, PACAF, and USASCH. It was agreed that the Air Force would furnish two doctors, one for Enewetak Camp and one for Lojwa Camp.
c. The helicopter issue was resolved by the Army agreeing that, while the primary helicopter missions were MEDEVAC and SAR, the Army Element Commander could use them for command, control, and logistical purposes. The Army further agreed that, on a case-by-case basis, the helicopters could be made available to other elements, including the CJTG, for related missions.
d. The ERDA certification issue had been resolved at a DNA-DOE headquarters-level conference early in April 1977, at which the question of how DOE would certify radiological aspects of the cleanup was discussed. It was agreed that certification would be island-by-island, instead of for the atoll as a whole. Although the format for certification was left for future decision, the basic issue of DOE certification was agreed upon and an appropriate text for the OPLAN was established.

A number of other points were raised at the final OPLAN conference; e.g., law enforcement, administration, military justice, and civil affairs. These were resolved satisfactorily, and the OPLAN was officially approved for planning purposes by the Service, DOE and Field Command

representatives. It was printed by Field Command as rapidly as possible and distributed in May 1977. On 15 Jun 1977 (D-Day), VADM Monroe approved the OPLAN for execution and the Enewetak Cleanup Project was officially begun.

CHAPTER 3

MOBILIZATION: 1974 - 1978

ENEWETAK CAMP REHABILITATION: 1974 - 1976

Before cleanup operations could begin it was necessary to prepare base camps for the cleanup forces and to mobilize the required manpower and materiel. The military base at Enewetak Atoll had been placed in caretaker status in 1968 by the USAF Space and Missile Test Center (SAMTEC). By 1 January 1974, when the atoll was transferred to the Defense Nuclear Agency (DNA), the facilities at the main base camp on Enewetak Island required extensive rehabilitation before they could be used to support a significant work force.

Operation and maintenance of the Enewetak Camp had been accomplished for SAMTEC by a contractor, Management and Technical Services Company, Inc. (MATSCO). The contract covered only minimum essential life-support systems for a small contractor force which maintained a nominal presence on the atoll. The contract was transferred to Field Command, DNA, which continued it in effect until a more dynamic base support system could be developed and financed. The Fiscal Year (FY) 1974 operating funds transferred to DNA by the Air Force barely covered the caretaker contract costs. The Air Force had agreed to accomplish essential repairs to the runway but had not budgeted for repair or replacement of other facilities, such as the water distillation and electrical power systems, which were on the verge of collapse.[1] Field Command promptly initiated several actions to rehabilitate these essential facilities (Figure 3-1 and 3-2).

In June 1974, four excess 800-kilowatt diesel generators were obtained from Kwajalein Missile Range to replace the turbine generators the Atomic Energy Commission had installed at Enewetak following Typhoon Olga. These were installed by the Corps of Engineers, Pacific Ocean Division (POD), and their contractor, American Electric Co. The replacement generators provided far more reliable power than the turbines though they used half as much fuel. The first of several new water distillation units was procured and installed to replace obsolete and unserviceable units. Since the communications system was a mixture of U.S. Navy and commercial equipment, Field Command obtained both U.S. Navy and factory assistance in repairing and replacing components. These actions were financed by FY 1974 DNA Operations and Maintenance (O&M) funds. FY 1975 O&M funds were requested for additional projects, including repair of the electrical distribution system

FIGURE 3-1. DELAPIDATED BUILDING.

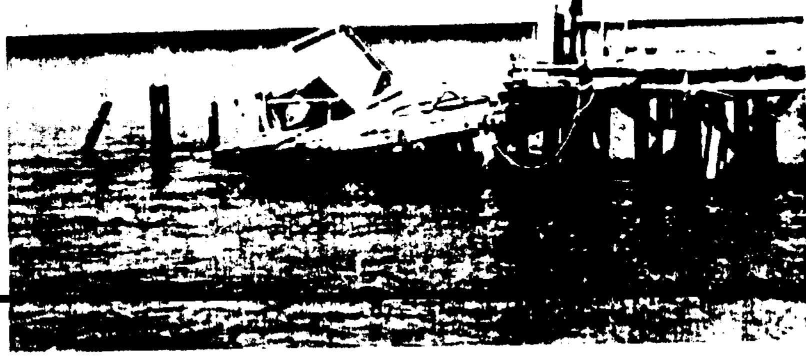


FIGURE 3-2. DELAPIDATED BOAT DOCK.

($10K); replacement of an elevated water storage tank with a hydropneumatic system ($40K); replacement of several 5-ton air conditioning units ($15K); replacement of a dormitory water supply system ($40K); interim repair of piers ($20K); and repair of fuel fill lines and buoys ($2K).[2]

Rehabilitation of the mooring buoys and navigational aids in the lagoon was accomplished by the U.S. Coast Guard. The Coast Guard cutter BASSWOOD called at Enewetak on 30 July 1975 for the initial rehabilitation effort and returned periodically throughout the project.[3] Until December 1977, there was a Coast Guard LORAN (long-range aid to navigation) station at Enewetak which rendered invaluable assistance in several emergencies and which was a valued member of the Enewetak community.

The runway repair work accomplished by Air Force Systems Command in May 1974 was limited to patching potholes and applying a fog seal coat to the central 75 feet. These repairs began to fail in less than a month.[4] Field Command arranged to have an Air Force engineer inspect the runway on 4 September 1974[5] and to have POD inspect it on 18-25 September 1974 and recommend corrective action. There were potholes, loose asphalt, cracks, and severe raveling in the first 3,000 feet of the runway, plus depressions, cracks, and potholes over the entire airfield complex.[6] These conditions caused Saturn Airways, the Military Airlift Command (MAC) contract carrier which served Enewetak, to refuse to land at Enewetak after 9 October 1974 until the runway was repaired.[7] Emergency repairs were made by the base support contractor,[8] and air service was resumed on 6 November 1974;[9] however, the urgency of need for extensive runway repair had been made obvious. The POD report estimated repair costs at $500,000 for temporary repairs and $2,961,000 for major rehabilitation.[10] DNA could justify only temporary repairs since it was not certain then that the Enewetak Atoll Cleanup Project would be authorized by Congress.

In transferring the atoll to DNA, the Air Force had agreed to finance runway repairs necessary to give a full year of service. As the year ended, DNA was faced with a $500,000 minimum repair cost. The Air Force agreed to furnish $60,000. DNA obtained $300,000 in O&M funds from DOD and $140,000 by deferring an approved Johnston Atoll project to pay for Enewetak runway repairs.[11] Arrangements were made with POD to have the runway repaired by one of their contractors, Martin Zachary, who were then working at Kwajalein Missile Range. POD also prepared the necessary environmental assessment and permit to use the old quarry at Medren (Elmer) Island as a source of aggregate for the project.[12] When the project was delayed several months by paperwork and nonavailability of ships to move paving equipment to Enewetak, the runway was kept open by removing loose asphalt and patching potholes. In August 1975, the repair project began. The center section of the 3,000 feet of runway was replaced, depressed areas were filled, a seal coat was applied, and airfield markings were painted on the new surfaces. The repairs were highly satisfactory with the exception of the markings. Within 4 months, the paint was peeling in large flakes. This condition caused growing concern until DNA, in October 1976, had the markings repainted by its base support contractor.[13,14] After these rehabilitation and repair efforts, the runway handled heavy traffic, including C-5 cargo aircraft, for the duration of the cleanup project.

Other Enewetak Camp rehabilitation work which was accomplished by POD contractors in 1975 and 1976 included: rehabilitation of the electrical distribution system; repair of water storage tanks; and repair of the salt water pump station.[15] These projects were beyond the capability of the MATSCO base support work force. It appeared that, although POD charged an overhead fee for its services, it would cost less to use POD's contractors to design and execute the work than to augment MATSCO's capability. These projects took more time and money than the Commander, Field Command had anticipated; however, they vastly improved the essential support systems that would be needed throughout the entire project, and they provided Field Command valuable experience regarding the engineering problems, the logistical difficulties, and the high cost of working on the remote atoll of Enewetak.

CHANGE OF CONCEPTS AND CONTRACTORS: 1975 - 1977

The original concept was for the Corps of Engineers to include base camp rehabilitation, maintenance and operation in the contract for cleanup of the atoll. This concept had to be changed, however, based upon the Congressional decision to make maximum use of military manpower to accomplish and support the cleanup project. While much of the rehabilitation, operations, and maintenance work could be performed by military personnel, a number of jobs remained for which the military services were not manned, since they were normally performed by civil service or contract labor. These would have to be performed by a base support contractor at Enewetak Atoll. The existing MATSCO contract was suitable only for caretaker operations. A new contract was required to upgrade the Enewetak Camp from caretaker status and to provide base support during the cleanup project. Field Command attempted to develop a new contract with sufficiently detailed specifications for competitive bid, but which also was broad enough to allow for the unidentifiable exigencies which were sure to occur during the project.[16] It was a very difficult task, and there was considerable doubt that a satisfactory contract could be developed and awarded in time to support the project.

A more effective and less expensive means of providing contractor support—by extending the Johnston Atoll support system to include Enewetak Atoll—was proposed by Mr. David L. Wilson, of Field Command. At Johnston Atoll, the Energy Research and Development Administration's Nevada Operations Office (ERDA-NV), under the Economy Act of 1932,[17] furnished Field Command the services of its contractor, Holmes & Narver, Pacific Test Division (H&N-PTD) to operate and maintain the Field Command base there. Field Command's atoll commander exercised operational control over H&N-PTD's engineering, repair, maintenance, and operations services, and established work requirements by issuing base regulations, annual work orders, and special work orders as required. Extension of this system to Enewetak Atoll would provide effective, flexible contractor support for the cleanup project. When the proposal was discussed with the Director of ERDA's Pacific Area Support Office (PASO), Mr. William J. Stanley, in September 1975, it was learned that he too had considered and supported the concept.[18] A formal evaluation and economic analysis was conducted which indicated that a savings of $200,000 per year could be realized by not entering into a separate Enewetak Atoll contract for the cleanup. One civilian and two military man-years previously devoted to administering the caretaker contract were to be saved. Also, adoption of the proposal permitted reallocation of resources between the atolls to accomplish priority tasks and facilitated maximum utilization of DNA resources to accomplish DNA missions in the Pacific.[19,20] Use of H&N-PTD to design, engineer, and accomplish major repair and rehabilitation projects at Enewetak also resulted in significant savings over the use of POD contractors for such projects. After several months of negotiation, the proposal was approved for H&N-PTD to replace MATSCO as the Enewetak Atoll support contractor effective 1 April 1976.[21]

Preparations to upgrade Enewetak Camp from caretaker to standby status began in February 1976, when teams from Field Command and H&N conducted a survey of equipment and facilities. During his 10 February 1975 visit to the atoll, Director, DNA, Lieutenant General Warren D. Johnson, USAF, had ordered a general cleanup of the camp, including storage areas where unserviceable and serviceable excess material from the test period had been commingled and abandoned in great disarray. This cleanup was accomplished by the two-man Field Command team, Mr. John Armstrong and Staff Sergeant Clyde Rittenberry, USAF, in conjunction with their equipment survey. In a period of 24 days, they cleaned out and put in order 42 buildings, removing 170 dump truck loads of salvage and trash.[22,23]

The transition from MATSCO to H&N-PTD began in mid-March 1976 and, on 1 April 1976, H&N-PTD became the base support contractor for the duration of the project. Major (later Lieutenant Colonel) William L. Spicuzza, USA, was assigned as Commander, Enewetak Atoll by Field Command, effective 1 April 1976, to manage base operations and to exercise operational control over H&N-PTD activities at the atoll. During the following year, over $600,000 worth of rehabilitation work was accomplished by H&N-PTD including: repair of dormitories, shops, and warehouses; repair of petroleum storage and dispensing facilities; repair of the cargo pier; and activation of maintenance and supply facilities.[24]

While Enewetak Atoll was being reactivated in 1976, Johnston Atoll was being phased down to a lesser state of readiness due to President Ford's deletion of the "prompt" requirement from the mission of Johnston Atoll to maintain "readiness for resumption of atmospheric nuclear testing." A bargeload of supplies and equipment which had become excess to Johnston Atoll's reduced requirements was delivered to Enewetak in April 1976. In addition to much needed building materials, it included an aluminum-hulled landing craft to augment Enewetak's rusting fleet.[25] "Tiger teams" of H&N employees from Johnston Atoll were used to augment the Enewetak Atoll work force for Enewetak Camp rehabilitation projects.

The Air Force acknowledged its responsibility for programming and managing Enewetak Atoll communications facilities in February 1976. On 15 June 1976, seven Air Force enlisted personnel from the 1961st Communications Group, Clark AFB, Philippine Islands, arrived at Enewetak and spent the next 6 weeks rehabilitating the antenna system.[26] This was followed by an Air Force Communications Service survey of communications requirements and resources in September 1976.

Another reactivation project was establishment of the Enewetak Camp exchange by the Hawaiian Regional Exchange. This organization conducted a survey in October 1976 to determine requirements and resources for establishing outlets at the Enewetak and Lojwa Camps. The Enewetak exchange began operating on 8 February 1977 and was officially opened by the Commander, Field Command, DNA, Brigadier General Thomas E. Lacy, USAF, and the Regional Exchange Commander, Colonel Robert M. Sullivan, Jr., USAF, on 1 March 1977, during the second Enewetak Planning Conference (Figure 3-3).

CONSTRUCTION PROGRESSES: 1977

BG Lacy promised the Services that Enewetak Camp would be ready to support their mobilization forces by the planned D-Day, 15 June 1977. This required an accelerated construction effort by H&N-PTD. H&N also had been tasked to assist in design and construction of the Lojwa Camp.

FIGURE 3-3. ENEWETAK EXCHANGE.

Engineers and draftsmen were sent from their corporate headquarters to assist in these efforts.

Normally, the Army Corps of Engineers or the Naval Facilities Engineering Command is the design and construction agent for projects funded by the Military Construction Appropriation. Authorization was obtained for the Director, DNA to be the design and construction agent for the Enewetak Cleanup Project.[27] The Commander, Field Command was authorized to act for the Director, DNA in obtaining H&N-PTD's services for design and construction of the Enewetak Atoll facilities.[28,29]

H&N-PTD again brought employees from Johnston Atoll to augment its Enewetak work force to complete rehabilitation of the Enewetak Camp. The work involved over 70 facilities including the dining hall, billets, laundry, power and water plants, recreation, supply, and maintenance buildings.[30] The total cost was almost $2,000,000 and was financed by a combination of Military Construction (MILCON) funds and Army and DNA O&M funds.[31] H&N had the essential elements of the Enewetak Camp ready by 15 June 1977. Two other projects were to be completed by the Army Element: (1) construction of billet spaces for the helicopter crew in one wing of the hangar; and (2) partitioning a portion of Building 24 for Army Element headquarters offices.

MOBILIZATION BEGINS: 15 MARCH 1977

Mobilization of military forces and material for the radiological cleanup of Enewetak Atoll began on 15 March 1977 with the requisitioning of personnel and supplies identified in the draft operations plan (Field Command's OPLAN 600-77), which had been developed in the preceding 2 weeks at the second Enewetak Planning Conference. However, U.S. Army Support Command, Hawaii (USASCH) did not receive supply requisitioning authority until 28 March 1977. The logisticians had concurred in establishing D-Day as 15 June 1977 only if they could begin requisitioning materiel immediately, in order to provide a minimum of 90 days' order and delivery time. To make matters worse, in the closing minutes of the second planning conference, the start of Lojwa Camp site preparation was advanced from D-Day to D minus 28 days. This left less than 9 weeks to mobilize men and materiel for that work.

First priority in ordering materiel went to building supplies for camp construction and to life support equipment to be installed in the camps. To minimize lead time, most of the items were to be ordered by H&N from commercial sources rather than through DOD supply channels. H&N-PTD established a logistics center at its offices on Hickam AFB, Hawaii. H&N-PTD moved in two office trailers to provide additional office space for the engineers, supply, and procurement personnel who were involved in designing facilities and ordering construction material. These personnel came from USASCH, from PTD's staff, and from H&N headquarters. It was found that so much time had elapsed since the Army bills of material for base camps were drawn up that they were outdated. Considerable research and interpretation were required before they could be used for requisitioning supplies.

Meanwhile, on 31 March 1977, 2 weeks into the mobilization effort, Field Command changed its office of primary responsibility for Enewetak matters from the Director of Logistics to the Director of Plans and Operations.[32] With this shift, the Enewetak Planning Group, which had been established under the chairmanship of the Director of Logistics to provide staff management continuity and coordination for the project, ceased to meet.

AIR FORCE COMMUNICATIONS ARRIVE: 16 MARCH 1977

To coordinate mobilization efforts, reliable radio communications were urgently needed at the atoll. The Air Force responded promptly and, on 16 March 1977, an installation team with replacement equipment arrived on a C-5 aircraft, the first of these giants to land at the atoll (Figure 3-4). The

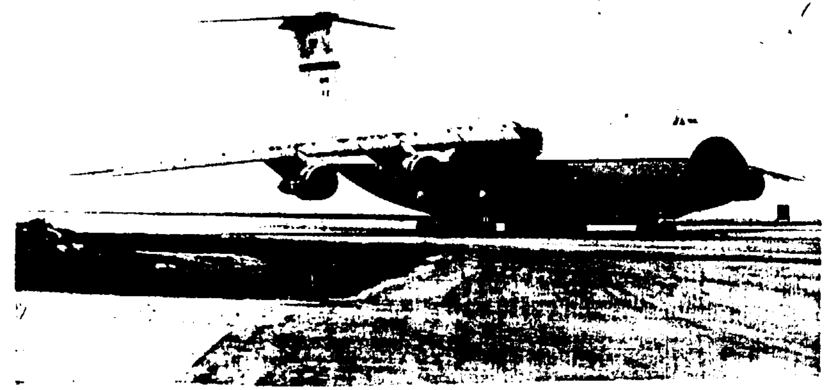


FIGURE 3-4. USAF C-5 ON ENEWETAK.

Defense Communications Service terminal was relocated and rehabilitated to provide three voice circuits and one automated data circuit using 10-kilowatt, high-frequency transmitters. The Air Force communications team began operating the new system on 16 May 1977.[33]

HONOLULU SUPPORT: MARCH 1977

The nearest sources for most logistics support were in the Honolulu area. Logistics action officials of the agencies in Hawaii made an all-out effort to locate materiel required to begin base camp construction and operation, such as building materials, billeting, office, and shop equipment. They investigated every possible local source, including the Defense Property Disposal Region (Pacific), to assure maximum use of available resources at minimum additional cost. The success of the initial preparatory phase was due in large part to the personal efforts and cooperation of Honolulu-area action officials.

To coordinate mobilization actions at Enewetak Atoll, the first members of the Joint Task Group (JTG) Commander's staff deployed to the atoll on 5 April 1977. They were the JTG Logistics Officer, Lieutenant Colonel John R. Sitten, Jr., USA, who became the interim Atoll Commander, and

Master Sergeant J. S. Loggins, Engineer Construction NCO. Accompanying them was Captain Charles E. Day, USA, from the Field Command Hawaii Office, assigned on a 2-week temporary duty (TDY) basis to provide radiological safety support for the first joint effort of the project.[34]

FIRST ARMY-NAVY TEAM: 5 APRIL-17 MAY 1977

The first joint Army-Navy effort of the project was removal of aggregate from a stockpile on Enjebi (Janet) Island to Lojwa (Ursula) Island for use in construction of the forward base camp. It was accomplished by four Army equipment operators and five Navy boat operators assigned TDY to the atoll for the aggregate operation. Procedures for accomplishing and supporting the operation were developed by the atoll commander, the H&N site manager, and Field Command's chief logistician.[35,36] The team used base support equipment—scooploaders, dump trucks, and landing craft, mechanized (LCM-8)—to move the aggregate. The bulk-haul system, which had previously been used to deliver soil for ERDA's experimental tree farm on Enjebi, was used to transport the aggregate to Lojwa. With the bulk-haul system, the landing craft well deck was loaded directly with approximately 40 cubic yards of aggregate for each trip, instead of with one truck carrying only about 8 cubic yards of aggregate. This was the first use of bulk haul by a military team at the atoll. A year later, after extensive radiological safety testing, the procedure would be employed to improve capabilities for moving radiologically contaminated soil.

Work began on 8 April 1977 under the supervision of Chief Boatswain's Mate Roger Black. During the week, the team camped on Enjebi in trailer facilities originally established for the Lawrence Livermore Laboratory's experimental tree farm. The Enjebi trailer camp was operated and maintained by two H&N-PTD employees. On weekends, the team returned to the main base camp on Enewetak Island. CPT Day implemented the radiological safety program. Air samplers obtained from the Nevada Test Site were set up downwind of aggregate loading and offloading operations, and dust filter masks were worn by personnel in the area. When the operation was completed on 9 May 1977, a total of 1,300 cubic yards of aggregate was stockpiled on Lojwa for use by the construction forces.[37]

FIRST NAVY SEALIFT: 14 APRIL 1977

Much of the sealift for the Enewetak Atoll Radiological Cleanup Project was furnished by Commander, Naval Surface Forces, Pacific (COMNAVSURFPAC) and subordinate elements, including Commander, Amphibious Group Eastern Pacific, and Commander, Amphibious Group ONE. Their deployments of amphibious ships to the Western Pacific several times a year called at Enewetak Atoll throughout the project, bringing equipment and supplies. Without this extraordinary effort by COMNAVSURFPAC—and the total cooperation of all Navy echelons from the Office of the Chief of Naval Operations down to individual ships' crews—the project would have been in serious financial straits from the start.

The first such task group arrived from San Diego on 14 April 1977 (Figure 3-5). It included the USS ANCHORAGE, USS ST. LOUIS, USS ALAMO, and USS SCHENECTADY.[38] They delivered 2,588 measurement tons (M/T = 40 cu. ft.) of cargo, including a 90-ton crane, generators, trucks, causeway sections, and distillation units from the West Coast, and busses, shop vans, trucks, construction equipment, and building supplies from Pearl Harbor. All this materiel had been acquired and delivered to the ports of embarkation in less than 3 weeks by Field Command, H&N-PTD, USASCH, and Pacific Air Forces in order to take advantage of the no-cost sealift offered by COMNAVSURFPAC.

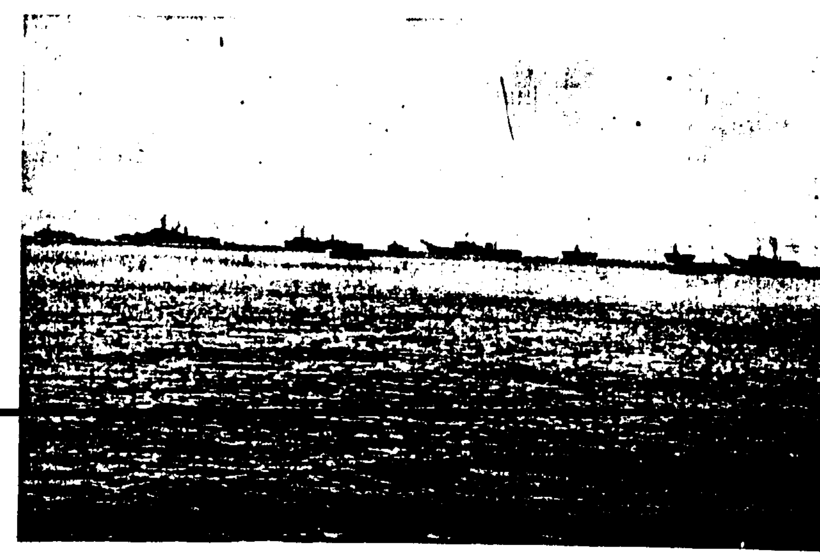


FIGURE 3-5. CONVOY ARRIVAL.

FIRST LOGISTICS CONFERENCE: 18-19 APRIL 1977

Field Command was responsible for coordinating mobilization efforts by the Defense Agencies, the Military Services, and other government agencies and contractors. On 18-19 April 1977, their representatives met at Headquarters, Military Traffic Management Command, Western Area (MTMCWA) in Oakland, California, to coordinate supply and transportation actions. The conference was called and chaired by Field Command's chief logistician and was hosted by the Commander, MTMCWA. The goal of the conference was to identify what cargo was available, when it was needed, and the most effective, economical means of getting it to Enewetak.

Primary concerns were acquisition and delivery of equipment and supplies for the U.S. Army Element (USAE) to begin Lojwa Camp site preparation on 17 May 1977 and Lojwa Camp construction on 15 June 1977. The Military Sealift Command (MSC) ship American Racer, which was due to call at Enewetak on 31 May 1977, could deliver most of the material. Almost 5,000 measurement tons of cargo were identified which would be available to ship on the American Racer. This ship was one of the deep-draft vessels which MSC used to deliver cargo between ports in the Pacific. It could not be offloaded directly at the Enewetak cargo pier, where the water was only 8 feet deep, but would have to be anchored in the lagoon and offloaded into lighters which could, in turn, be offloaded on the piers or beaches. The COMNAVSURFPAC representative agreed to expedite deployment of crews for the landing craft which were scheduled to arrive at Enewetak on 8 May 1977 so that they could be used to offload the American Racer. Field Command, U.S. Army Forces Command, and H&N-PTD representatives began developing plans for stevedores to offload the ship and for shallow-draft barge service for future resupply of the atoll.[39]

It was determined that items required prior to the ship's arrival could be provided by loan of some base support contractor equipment and by airlift of other critical items via scheduled MAC flights. Field Command also agreed to finance a special C-5 airlift to deliver four helicopters and other critical items from Hickam AFB in time to meet 17 May 1977 materiel requirements. The conferees also identified four landing craft, three Army LARCs (amphibious lighters), two other boats, explosives, and a variety of general cargo which would be available for a special Navy sealift in June 1977. The conference not only solved many mobilization problems but reinforced the momentum and positive working relationships generated in developing the OPLAN, and extended them to the supply and transportation agencies which would be supporting the project from the West Coast.

The Logistics Working Group used the 29 April 1977 OPLAN Resolution Conference to further refine plans for offload of the American Racer and implementation of shallow-draft barge service to Enewetak Atoll. It was agreed that H&N-PTD would offload Navy-operated landing craft at the beach, that the Racer's crew would operate its winches, and that the Army would provide one officer and 19 enlisted men from Fort Eustis, Virginia, to offload the ship.[40] The conferees also formally requested the Commander, MSC to provide shallow-draft barge service between Pearl Harbor, Johnston Atoll, and Enewetak Atoll.[41]

TRANSPORTATION UNITS ARRIVE: 3-16 MAY 1977

On 3 May 1977, six enlisted personnel from U.S. Navy Assault Craft Unit ONE (ACU-ONE) arrived at Enewetak Atoll to receive and put in service the first increment of landing craft which were to be delivered on 7 May 1977 by a Navy task group returning to the U.S. from Naha, Okinawa. The convoy consisted of the USS MONTICELLO, the USS VANCOUVER, and the USS SAN BERNARDINO. They delivered one landing craft, utility (LCU), three LCM-8s, one warping tug, three 90-foot causeway sections, and other equipment[42] totaling 4,493 measurement tons. The craft were promptly inspected and serviced by the ACU-ONE team. Sea trials of the LCM-8s were conducted during the next week, and they were put into service for lightering and support of Lojwa Camp construction.

Another early arrival was the Air Force airfield team, which landed on 10 May 1977. It was operational by 15 May 1977 when the next C-5 aircraft arrived at Enewetak and offloaded four UH-1 helicopters and other critical Army equipment. Maintenance and flight crew members accompanied the helicopters to prepare them for use. The Air Force communications installation team and their equipment redeployed to Yokota, Japan, on the same aircraft.[43] On the same day, the petroleum supply ship, USNS RINCON, delivered fuel to top off the diesel, gasoline, and aviation fuel (JP-4) storage tanks.[44]

ADVANCE PARTY ARRIVES: 17 MAY 1977

On 17 May 1977, an advance party consisting of the Commander, JTG (CJTG), the base camp construction forces, and the support teams arrived. By the original CONPLAN, their arrival was to be the event signalling D-Day—the first deployment of camp construction forces. Under the OPLAN, D-Day was established as 15 June 1977.

Originally, the first CJTG was to have been Colonel Howard B. Thompson, USA, who had been in charge of Field Command's planning office in Hawaii for the previous 2-1/2 years. However, because his 3-year assignment to Field Command was almost completed before the project was funded and mobilized, the assignment fell to Colonel Edgar J. Mixan, USA. He assumed command on 17 May 1977 and activated the JTG. Lieutenant Colonel Charles W. Focht, USA, and CPT Day, from the Field Command Hawaii Office, arrived in the advance party to serve as Chief, Engineering Division (J-3), and Chief, Radiation Control Division (J-2), respectively. Other JTG headquarters staff members in the advance party included Major Gerald G. Garner, USA, Chief, Administration Division (J-1) and Captain Randolph A. Flint, USA, Morale and Welfare Officer.[45]

The advance party included members of the Air Force Medical, Postal, and Petroleum, Oil, and Lubricants (POL) Teams. The H&N first aid station in Barracks 462 was used as a dispensary until a larger facility was completed. The POL Team remodeled an abandoned facility into an office and fuels laboratory and serviced the fuel trucks and trailers which had been delivered on the first sealift (Figure 3-6). APO 96333 was opened by the Air Force Postal Team on 6 June 1977.

The largest contingent of the advance party was the USAE of one general construction platoon, supported by a skeleton staff and

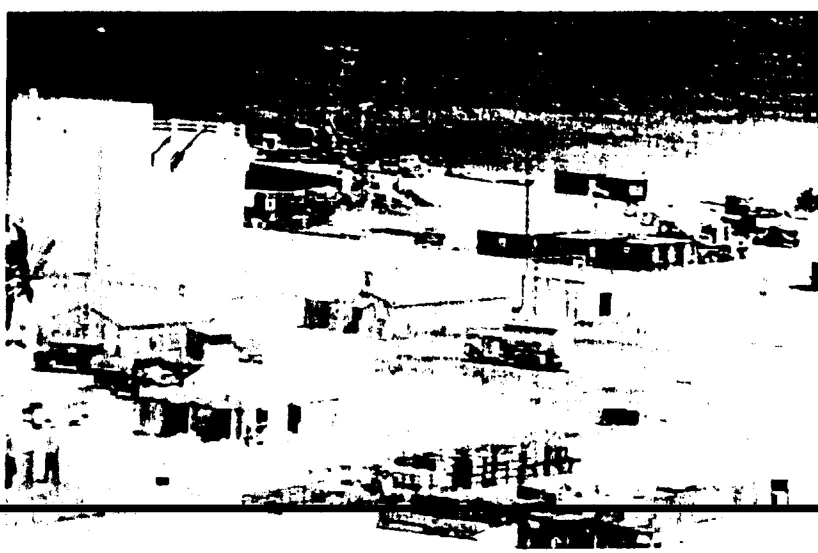


FIGURE 3-6. POL & LABORATORY AREA.

commanded by Captain James T. Scullary, USA. Their mission was to construct concrete slabs for the buildings at Lojwa Base Camp.[46]

The date, 17 May 1977, marked another arrival at Enewetak Atoll. On Japtan Island, a baby boy was born, the greatgrandson of Iroij Johannes Peter. He was the first dri-Enewetak to be born on the atoll since the people were removed in 1947.

These events and the status of mobilization efforts were reported in weekly situation reports (SITREPs) from the CJTG to Field Command. Field Command extracted the items of general interest and issued its own weekly SITREP to all activities concerned with the Enewetak Cleanup Project and Rehabilitation Program.[47,48]

LOJWA CAMP CONSTRUCTION: MAY-NOVEMBER 1977

During Congressional hearings, a Senate staff member had advised DNA that a recent study by the Army indicated that the military depots had on hand a number of tents and prefabricated base camp components that could be used in the cleanup project to minimize costs of camp construction. Under the original concept in CONPLAN 1-76, the base camp at Lojwa was to employ these tents, prefabricated buildings, field kitchens, and latrines for approximately 400 troops. CONPLAN 1-76 projected that it would take 2 months for construction of this prefab camp.[49]

After the CONPLAN was finalized in September 1976, the Services were contacted to determine actual availability of the base camp components, such as the Air Force special purpose portable kitchen and mess hall. The Air Force advised Field Command that there were not enough complete, serviceable units on hand for the cleanup project. During the second Enewetak Planning Conference, it was learned that the prefabricated base camp components were not in depot stocks, but consisted of drawings and bills of material. Additionally, the Army planners determined that tents would not be satisfactory for a 3-year project and that more comfortable and durable facilities would be required. They developed preliminary plans for a camp which would take a minimum of 7 months to construct, at an estimated cost of about $3.4 million. This was reduced by $500,000 when the Army was able to provide a power plant from their Nontactical Power Generation Program.

The design and construction of the camp was a joint effort by 84th Engineer Battalion personnel in Hawaii and H&N, based on a Field Command-USASCH memorandum of agreement dated 7 March 1977. At the first design conference on 19 March 1977, it was agreed that the battalion would construct all general purpose buildings on Lojwa, provide the power plant, and identify requirements for water distillation, laundry, and food service. H&N-PTD would design, procure and install the distillation, laundry, food service, and cold storage equipment.[50]

Design efforts in Hawaii were well coordinated until the battalion deployed to Enewetak, and the H&N design effort was transferred to their Anaheim, California, office. After that separation, coordination was somewhat impaired and some supply and construction problems arose.[51]

On 19 May 1977, the USAE began clearing brush and surveying sites for construction of Lojwa Camp. ERDA-NV had declared the island radiologically safe for construction operations, including earth moving. Air samplers were placed downwind of all earthmoving activities as recommended by ERDA-NV.[52] On 23 May 1977, personnel from Company B moved to Lojwa, established a temporary camp using tents, and began constructing slabs. Until the American Racer arrived, they made the most of available assets, borrowing a bulldozer, concrete mixer, and other equipment from Field Command. H&N set up a temporary mess hall using the only building on the island, refrigerator vans on loan from MSC, portable distillation units on loan from the Marine Corps, and water storage bladders on loan from an Army depot. Company B built a field shower system and established field latrines. The troops slept in tents and on beds obtained as excess from Kwajalein Missile Range. These facilities were expanded from time to time to satisfy an ever-growing population at Lojwa Camp. Use of the Lojwa Camp during its construction saved 4 hours a day which would have been used commuting by boat from Enewetak Camp (Figures 3-7, 3-8, 3-9).[53]

Construction of Lojwa Camp was hampered by unforeseen supply and construction problems. There were no Army supply personnel on the atoll when the first loads of building materials arrived, and the Army supply officer did not arrive until after construction had started. Numerous delays and work stoppages occurred, caused by a lack of critically needed items. In some cases, these were on the atoll, but no record of their arrival or location existed. Sometimes a search of Lojwa, Runit, and Enewetak Islands permitted identification and location of critical items. Sometimes a method was found to continue without them. For example, the troops fabricated window hinges from beer cans until the real articles could be found. Most hardware and lumber were plentiful, but plumbing and some electrical items were in extremely short supply due to demands in the Eastern United States following an unusually cold winter. The pipe shortage delayed placing of some concrete slabs which were to contain sewer pipes, until the troops devised a means of working around the problem. These shortages also delayed completion of water, sewage, and electrical systems to service critical facilities, such as the mess hall and latrines.

FIGURE 3-7. LOJWA CAMP.

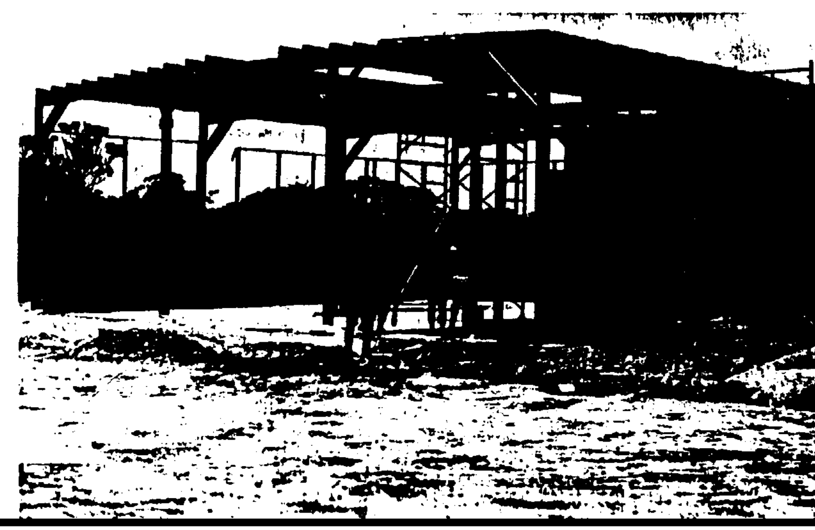


FIGURE 3-8. LOJWA BUILDING CONSTRUCTION.

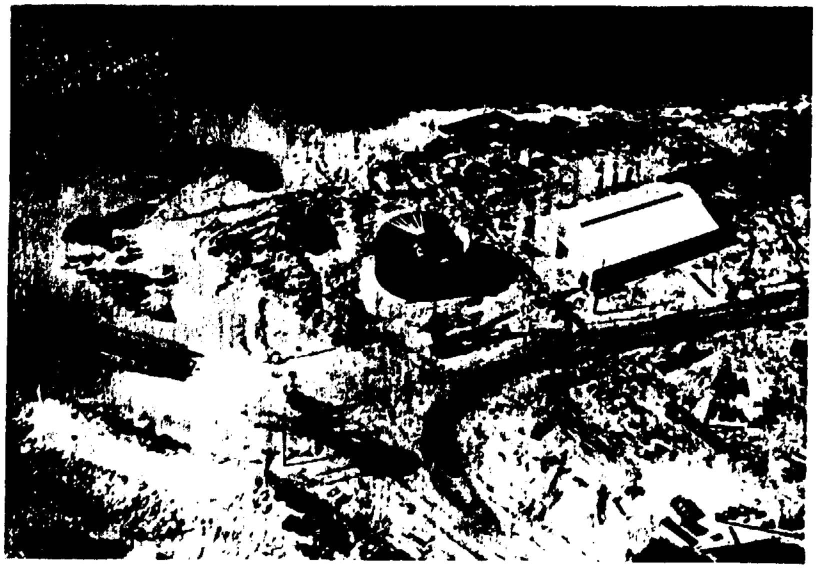


FIGURE 3-9. LOJWA INDUSTRIAL AREA.

The coral rock, high humidity, and heat at Enewetak caused construction problems which had to be overcome. For example, the first concrete placed at Lojwa set up so quickly that the crew could not work it out to a smooth surface. They learned that a vapor barrier was required to reduce the loss of water into the crushed coral surface which, when combined with the temperature of the mix (80° F), caused it to set too quickly.

To expedite Lojwa Camp construction, all common framing and trusses were prefabricated at Enewetak Camp. Despite difficulties in transporting the larger sections to Lojwa, the procedure was generally successful. As construction continued toward completion, the troops gained valuable on-the-job training and experience.[54]

MILITARY SEALIFT COMMAND SUPPORT BEGINS: 31 MAY 1977

MSC support of the Enewetak Radiological Cleanup Project began with the sailing of the American Racer from the Military Ocean Terminal, Bay Area, Oakland, California, on 14 May 1977. The ship was delayed for repairs at Pearl Harbor and arrived at Enewetak on 4 June 1977.[55] It carried 7,423 measurement tons of supplies and equipment, including

1,578 measurement tons of Army rolling stock (vehicles, vans, and construction equipment).

There was concern that expertise was not available on Enewetak to offload the American Racer; therefore, an Army stevedore team from Fort Eustis was provided to assist offloading the ship into landing craft. However, since the team's previous experience was limited to offloading ships alongside cargo piers, its value to the Enewetak operation was limited. Fortunately, H&N-PTD's riggers and stevedores were well experienced. They operated the ship's winches when it developed that the ship's crews could not, and they took charge of the more hazardous and complex tasks. Because of this experience, the Fort Eustis team was not requested for subsequent offloading operations.

Lightering was accomplished with landing craft operated by the U.S. Navy Element (USNE), whose Officer-in-Charge, Lieutenant Commander J. E. Hopkins, USN, arrived on 7 June 1977 with 18 additional maintenance and operations personnel.[56] Everyone on atoll who could be spared from other duties, including 40 men of the USAE, was employed in offloading and storing the cargo. It still required 8 days to complete offloading the ship.[57] It took even longer to put some of the cargo into operation. Most of the new vehicles arrived in mothballed condition. Although many critical items still had not arrived, enough equipment and supplies had been received that the USAE could increase its camp construction force on Lojwa from two to four platoons.[58]

D-DAY, 15 JUNE 1977

The day prior to D-Day was marked by the arrival of the USAE Commander, Lieutenant Colonel Lee W. Tucker, USA; the interim U.S. Air Force Element Commander, Major H. Rumzrek, USAF; 50 more construction troops; and nine more Air Force support personnel. They were welcomed by Director, DNA, Vice Admiral Robert R. Monroe, USN, and Commander, Field Command, BG Lacy, who had arrived the previous day accompanied by Mr. Roger Ray, of ERDA-NV, and Mr. Earl Gilmore and Mr. Frank Drake, of H&N, (Figure 3-10).

D-Day arrivals increased the atoll population from 336 to 394. Following the D-Day ceremony, the Director and his party departed for Johnston Atoll for an inspection visit. The following day, seven members of the news media arrived to cover mobilization activities. Additional troop arrivals by 17 June 1977 increased the atoll population to 536.[59]

Among the D-Day arrivals were Staff Sergeant Charles H. Freeman, USA, and his laundry team from the 613th Field Service Company at Fort McClellan, Alabama. They used the washers and dryers ordered for self-

FIGURE 3-10. D-DAY ARRIVALS.

service laundromats until the industrial laundry equipment arrived. Under a sign reading "Freeman's Inc. Free Laundry," they began providing laundry service on 17 June 1977. The initial team not only did the organizational clothing and linens for which they were responsible but provided individual laundry service for other cleanup project personnel, washing, drying, and folding some 800 bundles of laundry per month (Figure 3-11).

ORGANIZING THE JOINT TASK GROUP: JUNE 1977

Upon the arrival of the Military Service Element commanders, COL Mixan began organizing the JTG to accomplish its mission (Figure 3-12). His efforts were greatly complicated by the Joint Staff decision (in the CONPLAN) to give Commander, JTG "supervisory authority" rather than command authority over the Military Service Elements.[60] The effect of this decision was to exclude the CJTG from the chain of command of the three Military Service Elements assigned to accomplish and support the cleanup project. He assigned missions and tasks, but had only limited ability to control the timing or manner of their execution. Most of the Service Element commanders, as well as the JTG commanders, found supervisory authority to be a poor substitute for command authority.[61,62,63,64,65]

FIGURE 3-11. FREEMAN'S, INC. FREE LAUNDRY.

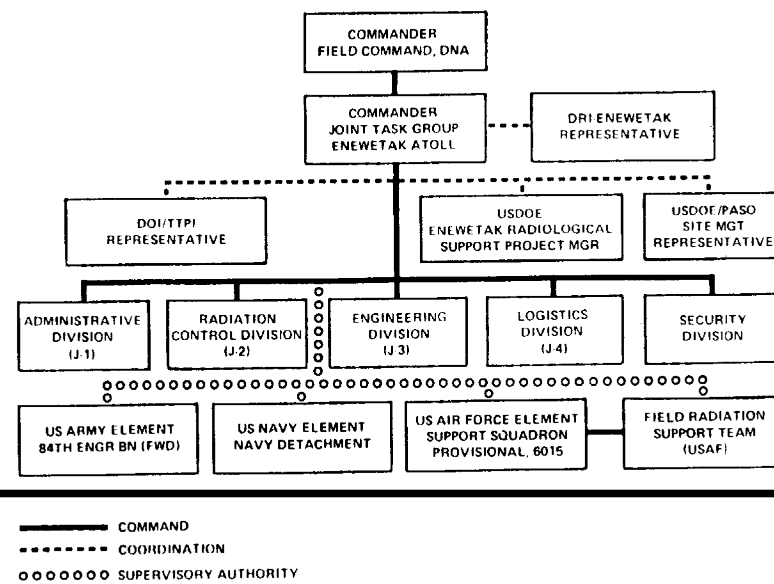


FIGURE 3-12. JOINT TASK GROUP ORGANIZATION.

The absence of a clear line of command authority was partially overcome by the professionalism and common sense of most of the key officers assigned during the project. One of the principal points of friction regarding command authority was the relationship between the JTG staff officers and the officers of the Service Elements. Often the responsibilities for planning the cleanup operations overlapped. Priorities for accomplishing tasks were subject to differing interpretations. Differences included resource utilization and availability, logistics support, time lags for off-atoll procurement, resupply means and scheduling, weather, emergency situations, and other considerations which were perceived differently in terms of their potential impact on mission accomplishment. In actuality, to complete the project successfully the Director, DNA, the Commander, Field Command, and the CJTG assumed command authority they did not have, and the Service Elements acquiesced in this assumption of authority in a cooperative spirit, recognizing that it was essential to effective operation.[66,67,68]

One area of particular concern to Field Command and all three JTG commanders was the lack of a senior Army Element command echelon at Lojwa. The majority of the Army cleanup forces were located on Lojwa, yet the Army Element command base was on Enewetak Island. The USAE commanders shared this concern to some degree, and studied numerous alternatives to alleviate the situation. Solutions considered included moving the majority of the USAE headquarters and the commander to Lojwa, moving the S3 operations office there (except for an Operations Liaison Officer to coordinate with the JTG staff), putting the USAE Executive Officer at Lojwa, and developing another command cell utilizing additional personnel from higher headquarters. At one point, the USAE Commander proposed to the CJTG that he move virtually the entire USAE headquarters to Lojwa, but after full consideration of the impact on the daily coordination requirements among the USAE, the JTG staff, and the other Service Elements and agencies, this option was not implemented. After detailed consideration of the advantages and disadvantages of each alternative, the USAE commander believed mission accomplishment would be best served by the senior Army Company Commander on Lojwa also serving as the Lojwa base commander.

The organization problem was aggravated by the manner in which the JTG staff was mobilized over a period of months. It was activated too late to work together as a team to formulate policies, procedures, and instructions prior to the arrival of the Service Elements and other agencies reporting for duty on the atoll. There was a need for rapid development and publication of local policies. Had this been accomplished prior to deployment to the atoll, the Service Elements and personnel would have entered an environment which was well organized relative to specific

guidelines and procedures, and control would have been established more readily.[69]

A significant organizational shortcoming during the first year was the lack of a JTG deputy commander/chief of staff to relieve the commander of administrative burdens. With much of the work either incomplete in definition or in an experimental phase, the CJTG had to devote his time and efforts to the operational mission. Eventually, this need was recognized, and a lieutenant colonel position was established, although too late for the initial year of the project.[70]

Despite these and other organizational shortcomings and command and control problems, the on-atoll organizational structure for the cleanup forces proved to be workable and effective. It resulted in highly successful accomplishment of the complex mission, on time and within budget.

FIELD RADIATION SUPPORT TEAM DEPLOYMENT: 28 JUNE 1977

The Field Radiation Support Team (FRST) was formed on 19 June 1977 at Hickam AFB. FRST personnel were given a 4-day basic radiological indoctrination course at the 25th Infantry Chemical-Biological-Radiological School, Schofield Barracks, Hawaii. Initial FRST personnel deployed to the atoll on 28 June 1977, where they began a 3-week specialized training course in local radiological hazards, the method of cleanup operations, and the instrumentation peculiar to their Enewetak mission. Experience showed that the 4-day basic indoctrination course in Hawaii was unnecessary and, after January 1978, all Enewetak-related training for replacement FRST personnel was accomplished on atoll.

The on-atoll specialized FRST training for the first increment was interrupted for an urgent on-site investigation of a suspected radiological burial site near the Erie shot ground zero on south Runit. This investigation, described in Chapter 4, diverted some FRST members from training classes to on-site work. By the time the investigation was completed, other operations had progressed to the point where the initial FRST increment received most of its specialized training by field testing the equipment and procedures the radiological planners had devised for the cleanup project, rather than by classroom training.[71]

Most of the radiation safety and detection equipment obtained for the cleanup was state-of-the-art commercial equipment. The radiation detection equipment was chosen because the one electronics package could be used to measure alpha, beta, or gamma simply by attaching the appropriate probe and adjusting the high voltage setting. The commercial protective masks were chosen to comply with Occupational Safety and Health Administration's requirements for field of view for heavy equipment operators, and because the face plates were set out from the face to provide more air circulation within the mask and hence greater wearer comfort, an important factor in the tropical climate. M17 standard military masks were not used because of possible plutonium migration through the filter cartridges and the tight facial contact. The anti-contamination suits chosen were light-weight and cotton, thus providing protection with minimal discomfort. None of these items had been used by troops in a tropical atoll environment, but they were well tested and proved excellent choices at Enewetak.[72]

ENEWETAK RADIOLOGICAL SUPPORT PROJECT DEPLOYMENT: 28 JUNE 1977

ERDA-NV office provided two distinctly different types of support to the Enewetak Radiological Cleanup Project:

a. Base operations and maintenance support were furnished through ERDA-PASO, directed by Mr. Stanley, and through H&N-PTD, whose General Manager was Mr. Donald J. Brush. The ERDA-PASO Site Representative position at Enewetak was manned by personnel from their Hickam AFB office on a rotational, temporary-duty basis.
b. Radiological support for the cleanup project was managed by ERDA-NV as a project; i.e., the Enewetak Radiological Support Project (ERSP). The ERSP Project Manager was Mr. Roger Ray, then Assistant Manager for Environment and Safety, ERDA-NV. ERSP was organized as shown in Figure 3-13. Staff support was furnished by ERDA-NV and ERDA-PASO as required. On-site operations were directed by the Project Manager or, in his absence, one of the Deputy Project Managers serving on rotational assignments. They were assisted from time to time by technical representatives from the ERDA-NV office.

Three ERDA-NV contractors were assigned to the ERSP project:

a. EG&G, Inc. equipped, maintained, and operated van-mounted radiation detection measurement and data recording systems. EG&G also performed the reduction, analysis, and interpretation of data from these systems.
b. Eberline Instrument Corporation (EIC) equipped, maintained, and operated field analytical and instrument calibration laboratories.
c. Desert Research Institute (DRI) assisted in the on-site interpretation and mapping of data collected by EG&G. DRI also provided advice as to sampling areas and arrays as requested by the Project Manager.[73]

To comply with Congressional direction, enlisted specialists from the Navy and Air Force were assigned to maintain radiological equipment and to assist in the laboratory and in field survey work.

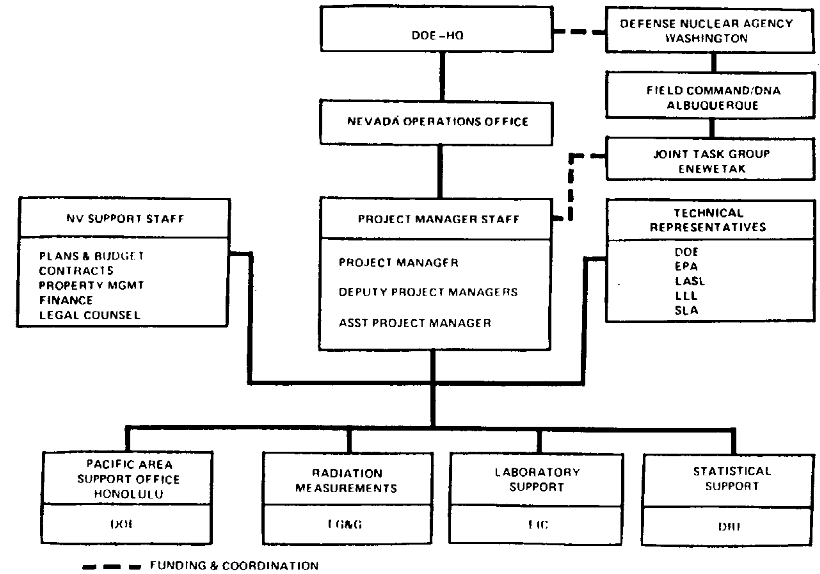


FIGURE 3-13. DOE-ERSP ORGANIZATION.

On 21 June 1977, Mr. Albert E. Doles, of EIC, and two Navy and two Air Force enlisted men deployed to the atoll and began establishing a temporary laboratory facility at Enewetak Camp. Its initial capability was limited to counting alpha, beta, and gamma radiation in soil and air sampler filters, pending delivery of the laboratory's trailers (Figure 3-14). On 27 June 1977, three Air Force Precision Measurement Equipment Laboratory maintenance technicians arrived, established their shop, and began calibrating the instruments.[74]

On 1 July 1977, the first in situ van (IMP) (Figure 3-15) arrived by air. Inspection revealed a leak in the container of liquid nitrogen required to cool the van's germanium detector. The liquid nitrogen plants which Field Command had obtained from the Air Force had not yet arrived. A Dewar flask of liquid nitrogen was flown from Hawaii and, on 15 July 1977, the IMP was in operation on Enjebi.[75]

The first DRI statistician, Ms. Madaline Barnes, arrived at the atoll on 12 July 1977. The laboratory trailers arrived on 25 July 1977. Two more EIC employees and the rest of the Navy and Air Force personnel arrived the following week and began putting the trailers in order. The Radiation Laboratory was operational on 24 August 1977, although construction on some of its major facilities continued until 18 October 1977.[76]

FIGURE 3-14. TEMPORARY RADIOLOGICAL LABORATORY.

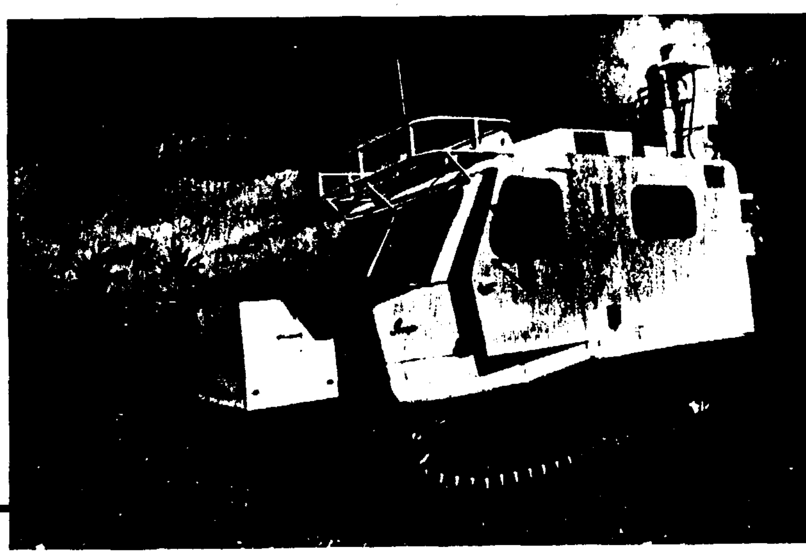


FIGURE 3-15. IN SITU VAN (IMP).

SOUTH RUNIT MOBILIZATION: JUNE-JULY 1977

Since containment of contaminated soil and debris was to be accomplished on northern Runit, certain basic facilities were to be established on the uncontaminated southern end of the island to support that operation. Preliminary design concepts for construction of crater containment support facilities at the Runit work site were developed by personnel of an Army Engineer Brigade at the Second Enewetak Planning Conference. The equipment specifications assumed that new commercial equipment would be procured with MILCON funds, despite Congressional and DOD direction to make use of existing DOD equipment. Identification and location of suitable substitutes in DOD equipment pools required an exhaustive effort by Field Command engineers and logisticians and by Headquarters DNA supply personnel. Much of the needed equipment was found in Navy inventories. Not all of the substitutes were fully satisfactory when put into operation; however, most of the Runit crater containment operation was performed with existing DOD equipment, despite significant maintenance and operational problems, described in Chapter 8.

Construction of facilities on south Runit was severely constrained until it could be determined if there was a contaminated burial site near the Erie ground zero, and until the south end of the island could be declared radiologically clean. Until this was accomplished, troops erecting the administrative building were required to wear full-face masks, suits, gloves, and rubber boots. Despite the 90-degree heat and the discomfort of wearing anticontamination gear, the crew had completely framed and roofed the structure before the area was declared safe and the restrictions were lifted on 15 July 1977 (Figure 3-16).[77,78] Meanwhile, a decontamination building, latrine, and concrete slabs for a boat ramp had been prefabricated at Enewetak Camp for installation on south Runit.[79] Much of the aggregate for Runit site construction was hauled from the stockpile at Enjebi. As in the case of Lojwa, Runit construction was significantly slowed by lack of certain critical building materials.

MOBILIZATION CONTINUES: JULY-NOVEMBER 1977

Building materials which arrived at the ports of embarkation after the American Racer sailed were delivered by a special COMNAVSURFPAC sealift consisting of the USS POINT DEFIANCE and USS FREDERICK. The ships called at Oakland, California, for that cargo, after loading landing craft and other Navy cargo at San Diego and demolition material at Seal Beach, California. More equipment and supplies were loaded at Pearl

FIGURE 3-16. RUNIT FACILITIES.

Harbor, Hawaii. The two ships arrived at Enewetak on 25 July 1977 to deliver 7,650 measurement tons of cargo which included four landing craft (two LCM-3s and two LCM-6s), one personnel boat (landing craft, vehicle, personnel-LCVP), the radiation laboratory trailers, two liquid nitrogen plants, vehicles, construction equipment, and other equipment and supplies.[80] The major role played by these no-cost sealifts, and the full cooperation of the Navy in providing them, bears mention again.

The MSC awarded Dillingham Tug and Barge Corporation the contract for bimonthly shallow-draft barge service between Pearl Harbor, Johnston Atoll, and Enewetak Atoll. The first shallow-draft barge, which arrived on 23 August 1977 (Figure 3-17), carried 3,448 measurement tons of Army, exchange, and Field Command cargo from Oakland, and 647 measurement tons of Field Command cargo from Pearl Harbor. The only deck space left was that required for access to the reefer vans.[81] Even so, many critical items had not been received in time for shipment on the barge or the special Navy sealift. It was time to review the status of undelivered orders and the cargo available for the next Navy sealift.[82]

Supply and transportation representatives of the agencies involved in the cleanup project met at Headquarters MTMCWA in Oakland, California, on 27-28 July 1977 to identify and resolve problems associated with marshalling the remaining undelivered Army equipment and shipping it to Enewetak. Approximately 9,000 measurement tons of rolling

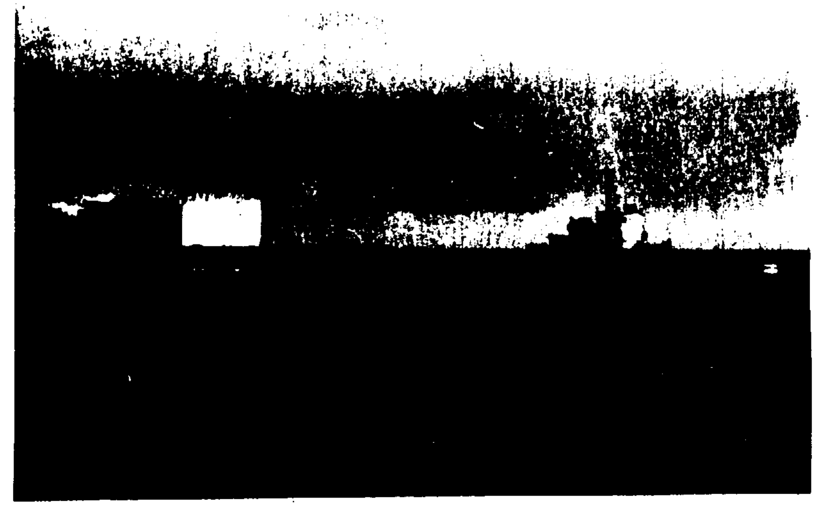


FIGURE 3-17. SHALLOW-DRAFT BARGE.

stock and outsize cargo were ready for release by the depots. The U.S. Army Material Development and Readiness Command Logistics Control Activity took action to have it shipped to San Diego in a roll-on/roll-off configuration to facilitate loading and offloading. Also, Army and Field Command cargo in Oakland was to be transshipped to San Diego to be loaded on the September 1977 Navy sealift. Unresolved was a required delivery date on atoll for the four Army LARCs waiting at Rough and Ready Depot, California, for movement down the Sacramento River and onward to Enewetak. Field Command agreed to resolve the matter before the next major conference in mid-August 1977.[83]

The Armed Forces Radio and Television Service stations at Enewetak Camp and Lojwa Camp were installed in late July and early August 1977 by technicians from the Television-Audio Support Activity of the U.S. Army Electronics Command, Sacramento Army Depot, California. The system provided for broadcast of video tapes and FM radio (Figure 3-18). The Enewetak Camp video station began broadcasting on 11 August 1977, and the Lojwa Camp station went on the air a few days later.

On 29 July 1977, Brigadier General Grayson D. Tate, USA, replaced BG Lacy as Commander, Field Command, DNA. Later that week, Colonel Charles J. Treat, USA, reported for duty with Field Command's Logistics Directorate, and became the Special Assistant for Enewetak Operations. His addition to the management staff was to prove of inestimable value.

FIGURE 3-18. ARMED FORCES RADIO & TELEVISION STATION.

On 12 August 1977, representatives to the logistics-comptroller conference from the JTG and the 84th Engineer Battalion arrived early to brief BG Tate and the Field Command staff on the current status of mobilization, critical problem areas, and conceptual plans for cleanup operations. After these briefings, BG Tate and COL Treat attended a 2-day conference in Las Vegas, Nevada, on radiological cleanup criteria. They returned to Albuquerque in time to participate in most of the Logistics-Comptroller conference on 17-18 August 1977.[84]

The August 1977 conference at Field Command was called to review mobilization progress to date, and to coordinate actions to complete mobilization and to support the beginning of cleanup operations. The engineer battalion representative estimated that, due to shortages of material to complete life-support systems, the Lojwa Camp construction was 60 days behind schedule for the planned beneficial occupancy on 15 November 1977—the date scheduled for transition from the Mobilization Phase to the Cleanup Phase of the Enewetak Project. A similar problem was developing in the construction of the south Runit site. The engineer predicted that, if the critical supplies were airlifted and if additional construction troops were provided, beneficial occupancy could be achieved by 1-15 January 1978. DNA initiated action during the conference to airlift almost 50,000 pounds of critical material from Travis AFB, California.

Plans for brush clearing, soil and debris cleanup, and crater containment were reviewed, and equipment requirements were adjusted based on recent operations experience. Requirements were cancelled for 49 items, some of which had already arrived on atoll and had to be shipped back to the United States, and 14 new items were added by the engineers.

It appeared that manpower would have to be adjusted also. The construction engineers were due to be replaced by combat engineer cleanup forces on 15 November 1977. The construction engineers could be retained until their 179-day TDY limitation expired in December 1977; however, if the combat engineers' arrival was delayed an equal time, that would have delayed the start of cleanup. It was decided to retain some individuals in the construction forces having critical skills and to change the mix of the replacement forces arriving 15 November 1977. In addition to the four combat platoons scheduled to begin soil and debris cleanup and the two platoons scheduled for Runit site construction and operations, one extra construction platoon would be deployed. Some of the combat platoons would be used to assist in completing construction, while the others would begin cleanup operations. The engineers predicted that, if the additional construction platoons were not provided, beneficial occupancy would be delayed until mid-February 1978.[85]

Based on arrangements made at the logistics conference, COMNAVSURFPAC ships picked up cargo from the Military Ocean Terminal, Bay Area and delivered it to San Diego for later shipment by Navy amphibious ships to Enewetak Atoll. Two LARCs, which had been towed down the Sacramento River from Rough and Ready Depot, and several thousand measurement tons of other cargo were moved by the USS OGDEN on 18 August 1977.[86] Two weeks later, two more LARCs and additional cargo were delivered to San Diego by the USS MOUNT VERNON (Figure 3-19).

On Enewetak Island, the first fatality of the cleanup project occurred on 19 August 1977. Hull Technician Victor J. Priest, USN, was welding on the bow ramp of a landing craft when preservative in the void area inside the ramp exploded, ripping a 6-foot hole in the ramp and killing him. The accident was investigated by Commander, Amphibious Group Eastern Pacific. Memorial services at the base chapel the following Sunday were attended by over 200 military and civilian personnel, including Iroij Johannes Peter and many of the dri-Enewetak.[87,88]

On 29 August 1977, the USS BOLSTER delivered a YC barge and two smaller barges from Pearl Harbor for use in intra-atoll transportation. The JTG Logistics Officer took advantage of the ocean transport by having the YC barge loaded with over 100 measurement tons of cargo from Kwajalein Missile Range.[89]

FIGURE 3-19. ARMY AMPHIBIOUS LIGHTER (LARC).

On 13 September 1977, a detachment from Underwater Demolition Team Eleven, commanded by Lieutenant Commander J. F. Sandoz, USN, arrived to begin channel clearance and underwater demolition work (described in the next chapter). In addition, this team supervised the storage, in an explosives bunker on Medren, of 181 measurement tons of explosives delivered by the Navy ammunition ship, USS HALEAKOS, on 22 September 1977.[90,91]

On 28 September 1977, a Navy task group consisting of the USS MOUNT VERNON, USS MOBILE, and USS DENVER arrived at Enewetak to deliver 6,617 measurement tons of cargo, including two LARCs. Despite heavy afternoon rains, they were offloaded in 14 hours.

The second shallow-draft barge arrived on 2 October 1977 with subsistence, cement, attapulgite, and other supplies.[92] The USS MOLALA arrived on 3 October 1977 and delivered another YC barge.[93]

On 12 October 1977, the Navy Water-Beach Cleanup Team arrived at the atoll and set up a base of operations in Building 4 near the other Navy activities. The team consisted of one officer and 15 enlisted personnel from Harbor Clearance Units One and Two; and one officer and three enlisted personnel from Team 21, Explosive Ordnance Disposal Mobile Unit One.[94]

On 21 October 1977, the USS FORT FISHER delivered 3,161 measurement tons of cargo, including two more Army LARCs. The last

Navy task group during the Mobilization Phase arrived on 3 November 1977. The USS JUNEAU and USS ALAMO arrived from Okinawa and offloaded two LCUs, and three LCM-8s.[95] During the Mobilization Phase, these Navy opportune sealifts delivered over 29,600 measurement tons of cargo at no cost to the project, a savings in sealift costs of well over $1,600,000.

The delivery of on-atoll critical building supplies, and the use of H&N-PTD journeymen to complete some utility systems and other critical facilities significantly improved the status of Lojwa Camp construction. By mid-October, USASCH was able to report that they were slightly ahead of the original construction schedule. The camp's 420,000-gallon steel water tank was on hand and was being assembled. In the process, Private First Class Kelvin W. Tea, USA, placed over 15,000 bolts, one of the more formidable tasks in Lojwa Camp construction. Completion of the fresh water and salt water distribution systems was still being delayed by a nationwide shortage of pipe. Consequently, food service, shower, latrine, and sewer facilities would not be completed by the scheduled 15 November 1977 mobilization completion date.[96]

PERMITS: 1975 - 1977

In addition to delays in camp construction, extended delays were encountered in obtaining three Corps of Engineers' permits for the project. There was some doubt that permits were necessary, since the Environmental Impact Statement documented the concurrence of those concerned with the cleanup project actions to be covered by the three proposed permits. Nevertheless, DNA decided to obtain them and, in October 1975, POD agreed to expedite action to provide permits for: (1) disposal of noncontaminated debris in the lagoon; (2) clearance (by coral demolition) of channels into certain islands; and (3) crater containment of contaminated soil and debris. POD's costs in providing permits would be financed from cleanup design funds already allocated.[97] It turned out to be more than a simple paper transaction.

The U.S. Fish and Wildlife Service, in their action on the permits, requested that DNA meet several conditions, including revegetation of cleared areas; replacement of soil removed in excising plutonium concentrations on Runit, avoidance of seabird nesting grounds during the nesting season; periodic radiation sampling in terrestrial and aquatic resources; and semiannual reports to the Fish and Wildlife Service on radiation found within fish and wildlife.[98] Field Command advised that the Environmental Impact Statement covered all of the conditions except the semiannual sampling and reporting of radiation in fish and wildlife, and Field Command objected to this condition on numerous grounds.[99]

In formulating the crater containment permit, a standard provision was included by the Corps of Engineers which would have required DNA to maintain the structure in good condition indefinitely. (The general rationale for this position was: Cactus Crater presently exists on the northern end of Runit Island; Cactus Crater extends below the water table, thus it is filled with water; since Cactus Crater is filled with water, even though it is located partially on the reef, the probability exists for migration of its water to and from the lagoon due to tidal action, thereby making it subject to the laws governing the introduction of materials into navigable waterways; a plan to fill Cactus Crater with a concrete slurry mixture equates to building a structure on a navigable waterway; the standard provision requires that anyone building a structure on a navigable waterway must commit themselves in writing to perpetual maintenance of the structure.) DNA objected to this provision as being inappropriate and pointed out that it was directly contrary to all U.S. commitments, directly contrary to the national-level decisions made after 3 years of debate, and in violation of Congressional guidance. Agreement was reached eventually that DNA would maintain the structure until the project was complete, and thereafter would assure that periodic monitoring of the site was accomplished by some Federal agency until the United States terminated its trusteeship responsibilities.[100]

Resolution of all these issues took an inordinate amount of time, and it began to appear that either the permits would have to be ignored or the absence of permits was going to halt work on the project. The channel clearance permit was finally issued on 31 August 1977, 2 weeks before blasting began.[101] The lagoon disposal permit was issued on 3 November 1977.[102] The crater containment permit was not issued until 9 November 1977, the week before the Mobilization Phase officially ended and the Cleanup Phase began.[103]

OPERATION SWITCH I: NOVEMBER 1977

Most military personnel were replaced after serving 4-6 months TDY at Enewetak. Replacement of the personnel who arrived in May and June 1977 began in October 1977, and the turnover in November was near-total. Over 400 personnel were replaced in that month in an exchange termed Operation Switch. It required extensive planning and close coordination by the JTG, the Service Elements, and Field Command's Pacific Support Office, which scheduled the airlift and coordinated Operation Switch actions in Honolulu.

Operation Switch also created increased demands for billeting at Enewetak Atoll. Building 686 on Enewetak was pressed into service as overflow billets, and incoming personnel who were scheduled to work in the north were sent promptly to Lojwa Camp. There were some problems in retaining necessary skills to assure continuous operational capability during the exchange—and, as was obvious, the loss of experience, continuity, and working relationships was staggering. In general, however, Operation Switch I was very successfully executed.[104]

MOBILIZATION/CLEANUP OVERLAP

Although 15 November 1977 was identified, for scheduling and record purposes, as the end of the Mobilization Phase and the beginning of the Cleanup Phase, in practice, mobilization and cleanup efforts overlapped by several months. Some cleanup operations began long before 15 November 1977, and some mobilization efforts were not completed until much later.

During the first week of December 1977, seven navigational aids were installed by personnel of the U.S. Coast Guard Enewetak LORAN Station, with technical guidance by Mr. Steve Guishikuma of the 14th Coast Guard District, and with boat support by the USNE. Navigational lights were installed at the Enewetak personnel pier, on the derelict concrete ship off Japtan, on the Point Oscar survey platform, on the east end of Biken (Leroy) Island, and on the landing ramps at Runit, Lojwa, and Enjebi.[105,106] These aids significantly increased the safety of boat operations at dawn and dusk, and for any emergency boat operations required during the hours of darkness.

As was previously noted, Lojwa camp construction was seriously behind schedule, and CJTG was urging that work be accelerated to provide beneficial occupancy as scheduled by 15 November 1977. Through many well-conceived and well-directed actions, this was achieved, although some facilities were incomplete. The power plant, distillation plant, billets, and most other major facilities were complete; however, the dining hall was not used until 25 December 1977, when the first meal served was Christmas dinner. Burnout latrines and water trailers were used until planned facilities were finished.[107] Temporary water lines and other makeshift facilities were gradually replaced, some as late as February 1978, as camp construction phased into camp maintenance (Figure 3-20).

Through superb teamwork as well as many outstanding individual efforts, mobilization for the Enewetak Radiological Cleanup Project was a success. By 15 November 1977, the base camps were ready to support the cleanup forces. The equipment to locate, remove, and dispose of contaminated material was on hand, and the forces were deployed and ready to begin cleanup operations.

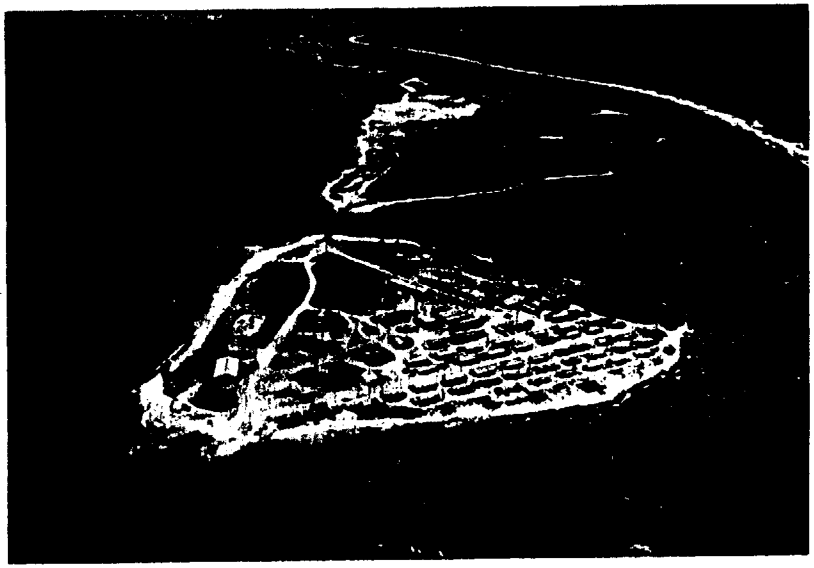


FIGURE 3-20. COMPLETED LOJWA BASE CAMP.

CHAPTER 4

RADIATION SAFETY AND CLEANUP PREPARATIONS

NONCONTAMINATED SCRAP REMOVAL BY CONTRACTOR

Most of the noncontaminated material to be removed during the cleanup project was located on the three islands designated for residence: Japtan (David), Medren (Elmer), and Enewetak (Fred). This material consisted primarily of buildings and equipment acquired by the base support contractor during the nuclear test period. The Defense Logistics Agency agreed to have its Defense Property Disposal Service (DPDS) conduct a sale of this material and return a proportionate amount of any proceeds to the base support contract.[1] The scrap was monitored by Field Command, DNA to assure that it was free of radioactive contamination, marked for identification to bidders, and then transferred to DPDS. The invitation for bid was issued in November 1976[2] and, on 11 January 1977, 24 prospective bidders were flown to Enewetak for on-site inspections.[3] Sixteen bids were received, the successful one being $544,000. To minimize interference with the early returnees' settlement of Japtan, scrap removal was to be complete on that island by 4 May 1977. Scrap removal on the remaining islands was to be complete by 30 November 1977 to minimize interference with Joint Task Group (JTG) cleanup operations.[4]

The contractor began work in March 1977 and, after several extensions due to unforeseen circumstances, completed his operations on 11 September 1978. Within 18 months, with a work force of approximately 20 people working 10 hours per day, 7 days per week, and with government logistics and intra-atoll transportation support, the contractor removed most of the excess buildings, salvage material, and scrap from the three residential islands. The material removed amounted to well over 55,000 cubic yards, weighing in excess of 38,000 long tons.[5] It was estimated that the scrap removal operation reduced the noncontaminated cleanup effort for the JTG by 117,971 man-hours.[6] While the salvage contractor was starting cleanup operations on the southern islands and the base camps on Enewetak Island and Lojwa (Ursula) were being readied, radiological survey work began in the northern islands.

GROSS AERIAL SURVEY

OPLAN 600-77 called for the use of an Army helicopter to carry an Energy Research and Development Administration (ERDA) contractor's

(EG&G) Radiation and Environmental Data Acquisition and Recorder (REDAR) system over the islands to perform a gross radiological survey before field surveys with the in situ vans began. The system was designed to detect and record surface radiation from americium-241 (Am-241). It was believed that a REDAR survey might facilitate the in situ survey and possibly reduce the areas to be surveyed by the vans. The REDAR was installed on a UH-1 helicopter during the week of 20 June 1977. Transponders were set up on Enewetak and Biken (Leroy) Islands, and the system was checked out.[7]

Survey flights were conducted during the next 2 weeks. Several passes were required to survey the larger islands. A total of 35.6 hours were flown for the survey before it was completed on 8 July 1977.[8] The survey was largely unsuccessful as REDAR did not have the sensitivity necessary to refine areas for in situ soil surveys. It was also thwarted by heavy vegetation covering large parts of many islands. Consequently, it was of little benefit in improving the 1973 radiological survey data.

ERIE SITE SURVEY

Runit (Yvonne) was the last island scheduled for contaminated soil survey and cleanup. The northern end of the island, which had been contaminated by many nuclear detonations, was to be used for contaminated soil and debris stockpiles and crater containment operations. The southern end of the island, which was to be used for the quarry, rock crusher, and other support activities, was radiologically nonhazardous, with one possible exception.

In May 1956, a nuclear device, Erie, had been detonated from a 300-foot tower near the ocean beach just north of the runway on the southern end of Runit. Experimental specimens had been scattered west of the tower at distances of 120 to 300 feet. In order to find the specimens, the soil in that area had been removed to depths up to 5 feet and deposited to the north in thin layers. The depression was later backfilled but pertinent reports did not indicate what had happened to the debris produced by the detonation. A 1958 drawing showed an area of contaminated rubble some 200 feet wide from the Erie ground zero (GZ) to the ocean beach. By 1977, much of this land area had eroded away and contaminated debris was scattered on the beach. The 1973 radiological survey by the Atomic Energy Commission (AEC) listed a suspected contaminated debris burial site in the vicinity of the Erie GZ. This suspicion had to be resolved before work could begin to locate the rock crushing facility in the area.[9]

A special team was deployed on 30 June 1977 to investigate the Erie Site. It consisted of two radiological specialists from Field Command, two

men from U.S. Army Armaments Research and Development Command with magnetometers to help locate buried debris, a U.S. Army Element (USAE) survey team and backhoe operators, plus 16 members of the newly arrived Field Radiation Support Team (FRST). The survey team located the GZ and established five radials from it with stakes placed at 50-foot intervals. A backhoe was used to dig a trench beside each stake to obtain soil samples and locate any buried debris. Trenches were dug as deep as 6 feet depending on levels of coral rock and ground water. Each trench was checked with an SPA-2 micro-R meter for evidence of contaminated debris. Soil samples were taken from the sides of the trenches at 1-foot intervals (Figure 4-1) and were analyzed by Eberline Instrument Corporation (EIC) in their laboratory at Enewetak Camp.

Stringent radiological safety measures were established for the survey. A hot line was established near the personnel pier. Air samplers were positioned downwind of all earth-moving operations. During the engineer survey phase, all personnel crossing the hot line wore rubber boots and double surgical masks. During the trenching/soil sampling phase, all personnel in the area wore boots, anti-contamination (anti-C) coveralls, gloves, full-face respirators and hoods, with tape over all openings where dust might enter. Due to heat stress and discomfort produced primarily by the respirator, personnel were able to work only approximately 2 hours in the morning and 2 hours in the afternoon. After a few days' operations, it was noted that personnel were not fully recovering from the previous day's fatigue. Thereafter, workers in full anti-C suits were given hourly breaks. Temperature readings of over 90°F were commonplace as early as 1000 hours. Because of the heat, two FRST members were removed from the survey before it was completed on 11 July 1977.

The survey effort disclosed that there was no contaminated burial site at Erie GZ. The average surface and 1-foot depth activity was 24 picocuries per gram (pCi/g), well below the 40 pCi/g guideline for any surface soil cleanup action. Some subsurface hot spots of 150 to 282 pCi/g, well below the then current 400 pCi/g guidelines for required cleanup, were found. These were roped off during Runit site construction. Concurrent with the survey, contaminated debris found south of the permanent hot line was collected and stockpiled north of that line by USAE personnel working in full anti-C suits.[10,11]

The Erie site survey provided a valuable field test of radiological control and safety measures and equipment. By participating in the survey, Field Command's radiological planners, Dr. Edward T. Bramlitt and Lieutenant Colonel Manuel L. Sanches, USA, and the JTG Radiological Control Division staff, were able to observe and experience directly the application of their plans. This permitted further refinement of the radiological control and safety procedures which were to be used for the project.