RADIOLOGICAL SURVEY PLAN

FOR THE

NORTHERN MARSHALL ISLANDS

August 22, 1978

APPENDIX B

RADIOLOGICAL SURVEY PLAN

FOR

THE NORTHERN MARSHALL ISLANDS

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TAB 1

PART I

PURPOSE AND OBJECTIVES

RADIOLOGICAL SURVEY PLAN FOR THE NORTHERN MARSHALL ISLANDS

PURPOSE

THE PURPOSE OF THE NORTHERN MARSHALL ISLANDS SURVEY PROGRAM IS TO PROVIDE A DOCUMENTATION OF THE REMAINING RADIOACTIVITY FROM NUCLEAR TESTING AND TO PROVIDE SUPPORT DATA FOR AN ASSESSMENT OF THE RADIATION DOSE TO PEOPLE BEFORE THE TERMINATION OF THE UNITED NATIONS TRUST AGREEMENT.

OBJECTIVES

THE OBJECTIVES OF THE PROGRAM ARE:

1. TO OBTAIN AERIAL PHOTOS AND AERIAL RADIOLOGICAL MAPS OF THE NORTHERN MARSHALL ATOLLS, AND ISLANDS,

   A study has identified 11 atolls and 2 islands as those most likely to have received fallout from one or more nuclear tests conducted at Bikini and Enewetak during the U.S. Pacific testing program.

2. TO OBTAIN SAMPLES OF SOIL, WATER, PLANT LIFE AND FOOD, ADJACENT MARINE WATERS, AND MARINE AND TERRESTRIAL LIFE,

3. TO PROCESS, ANALYZE, AND DETERMINE THE RADIOACTIVITY CONTENT OF COLLECTED ENVIRONMENTAL SAMPLES, AND,

4. TO PREPARE A REPORT WHICH WILL PRESENT THE FINDINGS OF THE SURVEY AND AN ASSESSMENT OF THE RADIATION DOSES TO PEOPLE WHO MAY LIVE ON THE SURVEYED ATOLLS AND ISLANDS.

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TAB 2

PART II

HISTORICAL INFORMATION

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HISTORICAL INFORMATION

The U.S. nuclear weapons testing program conducted from 1946 to 1958 in the Pacific left long-term radiological contamination and health problems. Bikini and Enewetak Atolls, where the testing was conducted, were the most severely affected, but fallout from these tests has touched many islands in the Northern Marshalls. Of special concern was the heavy fallout from the March 1954 test which caused radiological injury to many of the people of Rongelap and resulted in at least one death for radiation related disease.

The Department of the Interior (DOI), Department of Defense (DOD), and the Atomic Energy Commission (AEC), later the Energy Research and Development Administration (ERDA), and now the Department of Energy (DOE), cooperated in the steps taken to date to perform radiological surveys and assessments (1967-1968) and to perform cleanup and rehabilitation of Bikini (1969 to present) and in the radiological survey and assessment of Enewetak Atoll (1972-74). This Enewetak survey utilized the most up-to-date and modern techniques, including the aerial survey of islands utilizing sensitive radiation monitoring equipment carried in helicopters. The DOD began the Enewetak cleanup in FY 1977, with the DOI rehabilitation program initiated during cleanup to take advantage of logistics and communications capabilities attendant to cleanup operations. The DOE has performed followup radiological surveys at Bikini and Enewetak Atolls. It also conducts medical observation of the exposed populations of Rongelap and Utirik Atolls at frequent intervals.

The Department of the Interior (DOI), Office of Trust Territory of the Pacific Islands (TTPI), is responsible for rehabilitation of the former test sites, Bikini and Enewetak. Phase I of the Bikini program included planting of coconut trees and building 40 homes and other community buildings on Bikini Island. The houses were built along the lagoon shore where the radiation levels were the lowest. In responding to a request from TTPI for

assistance in locating the second group of houses on Bikini Island, the ERDA recommended that an aerial survey of the type flown at Enewetak be conducted for the entire Bikini Atoll. This survey would provide detailed data including contours of the total external gamma radiation, isotopic content and plutonium in the soil surface. Neither the ERDA nor the DOI had the integrated logistical support system needed for an aerial survey and DOD was requested to supply this. Since DOD would request reimbursement for its support and there was insufficient time to obtain the necessary funding, ERDA conducted a limited ground survey of external radiation levels on Bikini and Eneu Islands in June 1975. The results of this survey showed that the radiation of the interior of Bikini Island was too high for further housing settlements and that future settlements on nearby Eneu Island would minimize radiation exposures. Currently, the Bikinians are being resettled to Kili Island. A lawsuit, THE PEOPLE OF BIKINI, ET AL VS. SEAMANS, ET AL, CIVIL NO. 75-348 U.S.D.C., D. Hawaii, alleges that the U.S. Government has not assessed properly the radiological conditions at Bikini and among other things, requests the court to order an aerial survey for Bikini comparable to that conducted at Enewetak. During negotiations with the Department of Justice, the plaintiffs' legal counsel recognized that the surveys and evaluation of radiological conditions at Bikini Atoll were not as comprehensive as more recent work at Enewetak Atoll, and sought an aerial radiological survey of Bikini and the other northern Marshall Islands.

The merits of the aerial survey have been thoroughly discussed at staff levels between DOI, DOD, and DOE both before and after the initiation of the lawsuit. Briefings on the survey were provided to the Administrator of ERDA, the Assistant Secretary of Defense (Health and Environment), the Department of the Interior, Office of Trust Territories, staff members of OMB, and the Chairman of the CEQ.

After obtaining cost estimates for logistics support from the DOD and the technical program from ERDA, the Office of Management and Budget (OMB) determined that the survey would be conducted, and funds for reimbursement of DOD's logistics support were included in a DOI FY 78 supplement. DOE was directed to absorb the technical program costs.

Although the U.N. Trust Territory Agreement with the U.S. is expected to end soon, it is clear that the U.S. will continue to have a vital national interest in the northern Marshalls. Resettlement of Bikini Island has suffered a setback due to radiation exposures significantly exceeding acceptable standards, and the conditional nature under which Enewetak is being resettled, and the need to continue following the health of the Rongelapese, will require radiological monitoring of these people and their environment for the foreseeable future. The aerial survey will be a major part of a standardized data base which will provide information needed for evaluating any future claims for damage or injury. It will contribute to the future monitoring program planned for Bikini, Enewetak, and Rongelap atolls.

In addition to Enewetak, Bikini, and Rongelap Atolls, there are eleven other atolls or single islands that received intermediate range fallout from one or more of the megaton range tests. A number of these atolls are presently inhabited while others are used for food collection. During nuclear test operations, there was a limited monitoring program that did not provide anywhere near the coverage that can be obtained with the current aerial survey technology and instrumentation. In addition, there is little or no data on possible plutonium contamination outside of Bikini and Enewetak Atolls.

The proposed aerial survey uses the same equipment and procedures which were successfully employed at Enewetak Atoll in 1972-1973. The people of

[redacted]

Bikini feel they have been short-changed because the U.S. conducted a highly visible exhaustive radiological survey of Enewetak. The Bikini portion of the aerial survey, coupled with the previous and planned ground surveys, will go a long way toward making the Bikini data base comparable to that of Enewetak.

If the aerial survey of the northern Marshalls, including Bikini, is not conducted, the U.S. Government would be terminating the Trust Territory agreement without taking all prudent steps to evaluate the residual radiological contamination on the islands affected by the U.S. nuclear tests.

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TAB 3

PART III

SCOPE OF SURVEY

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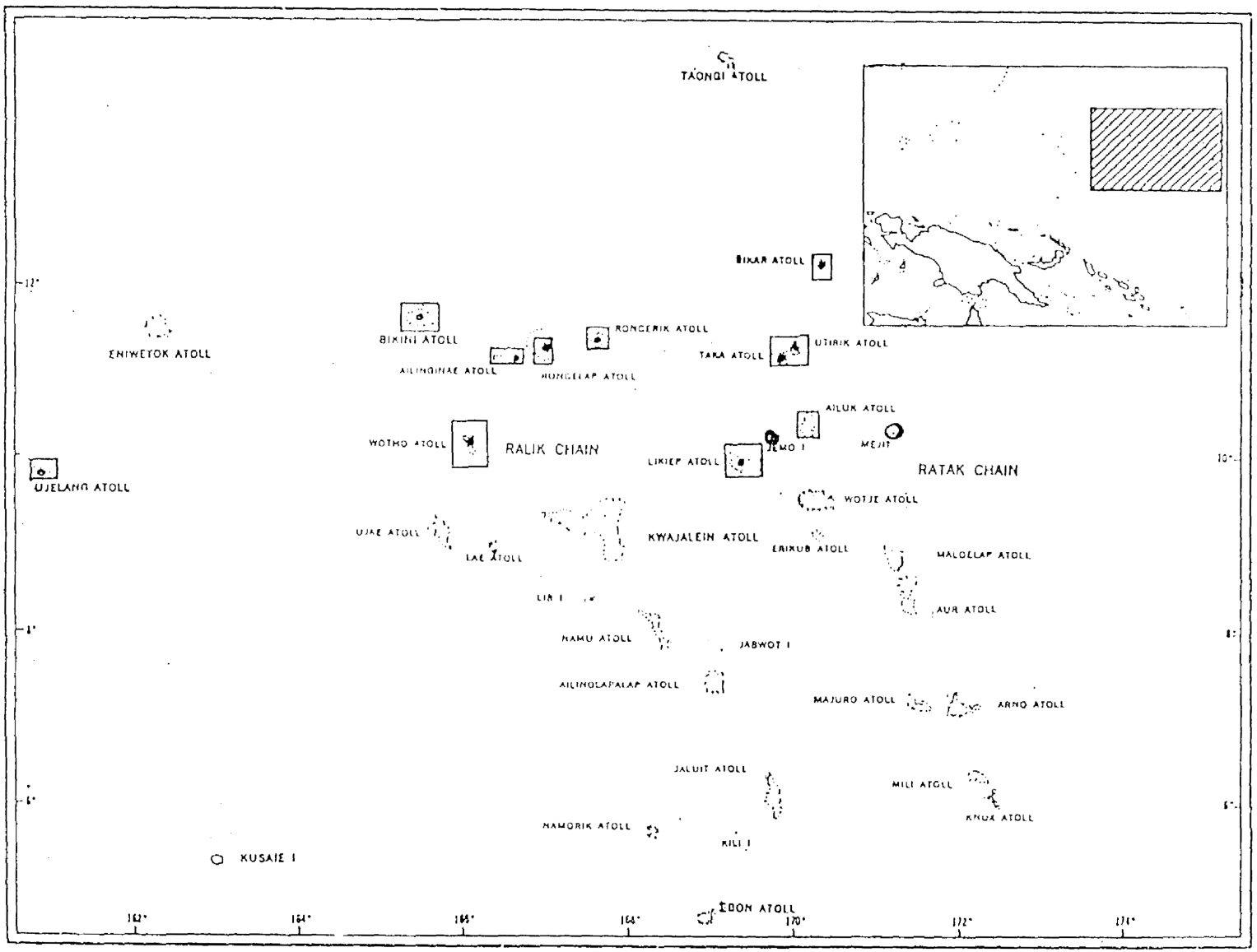
RADIOLOGICAL SURVEY PLAN FOR THE NORTHERN MARSHALL ISLANDS

III A. SCOPE OF SURVEY PROGRAM

The Radiological Survey Plan for the Northern Marshall Islands will cover the following atolls and islands within the time frame of July 1978 through December 1978.

Atolls	No. of Islands To Be Surveyed	Total Area ($mi.^2$)
1. Ailinginae	13	.93
2. Ailuk	12	1.72
3. Bikar	3	.19
4. Bikini	15	3.00
5. Likiep	13	3.02
6. Rongelap	16	.52
7. Rongerik	8	.81
8. Taka	3	.18
9. Ujelang	9	.60
10. Utirik	3	1.27
11. Wotho	4	1.38
12. Jemo Island*	1	Unknown
13. Mejit Island*	1	Unknown

*The term "Island" is used in this case to denote an isolated island that is not part of an atoll and does not have a lagoon.



MARSHALL ISLANDS

III-1 MAP

ORGANIZATION AND MANAGEMENT CONCEPT

The Department of Energy (DOE) is responsible for the conduct of the program. The Division of Operational and Environmental Safety (OES) Headquarters, is responsible for coordination with the Department of the Interior and all Washington-level Federal agencies and officials and to provide the overall technical program guidance to the Nevada Operations Office.

Field Operations

The Nevada Operations Office Program Manager will be responsible for operational control and management of the field operations and for direction of support activities. These support activities include Medical, and Photo Documentation. Overall technical direction of the scientific program is assigned to Dr. William L. Robison, Lawrence Livermore Laboratory, or his designated representatives who will provide the technical direction for the aerial, terrestrial and marine field operations. All participants in the terrestrial and marine field operations will be assigned as individual members of the program.

Analysis and Dose Assessment

The Technical Director will also provide the direction and coordination of the terrestrial and marine sample analysis, dose assessment, and for the preparation of the final report. During this part of the program, he will report to the OES Project Director.

Scientific Participation

Invited scientific parties and requests for participation by other groups will be administered by the NV Project Manager. Interaction of these parties with the field operations technical program will be coordinated by the Technical Director or his designee.

The overall aerial, terrestrial and marine program is expected to include representatives of:

1. Division of Operational and Environmental Safety (OES, DOE/HQ,)
2. Nevada Operations Office (NV).
3. EG&G, Las Vegas, Nevada.
4. Lawrence Livermore Laboratory (LLL), Livermore, California.

5. Environmental Protection Agency (EPA), Las Vegas, Nevada.
6. Brookhaven National Laboratory (BNL) New York.
7. University of Washington (UW), Washington.

A limited number of other scientific parties may be invited to participate on a non-interference basis. Likely candidates are University of Hawaii Mid-Pacific Marine Laboratory (MPML) and Bowling Green University. No funds will be allocated to these additional parties.

Due to the number of islands being surveyed, the field operations which are conducted from the ship, will be divided into three distinct operational series. Technical and support personnel will be rotated through these 3 series to maintain maximum efficiency and dedication of effort.

Limited medical support will be provided for DOE and contractor staff throughout the field operations.

The organization chart for the Northern Marshall Islands Radiological Survey program is presented on the next two pages.

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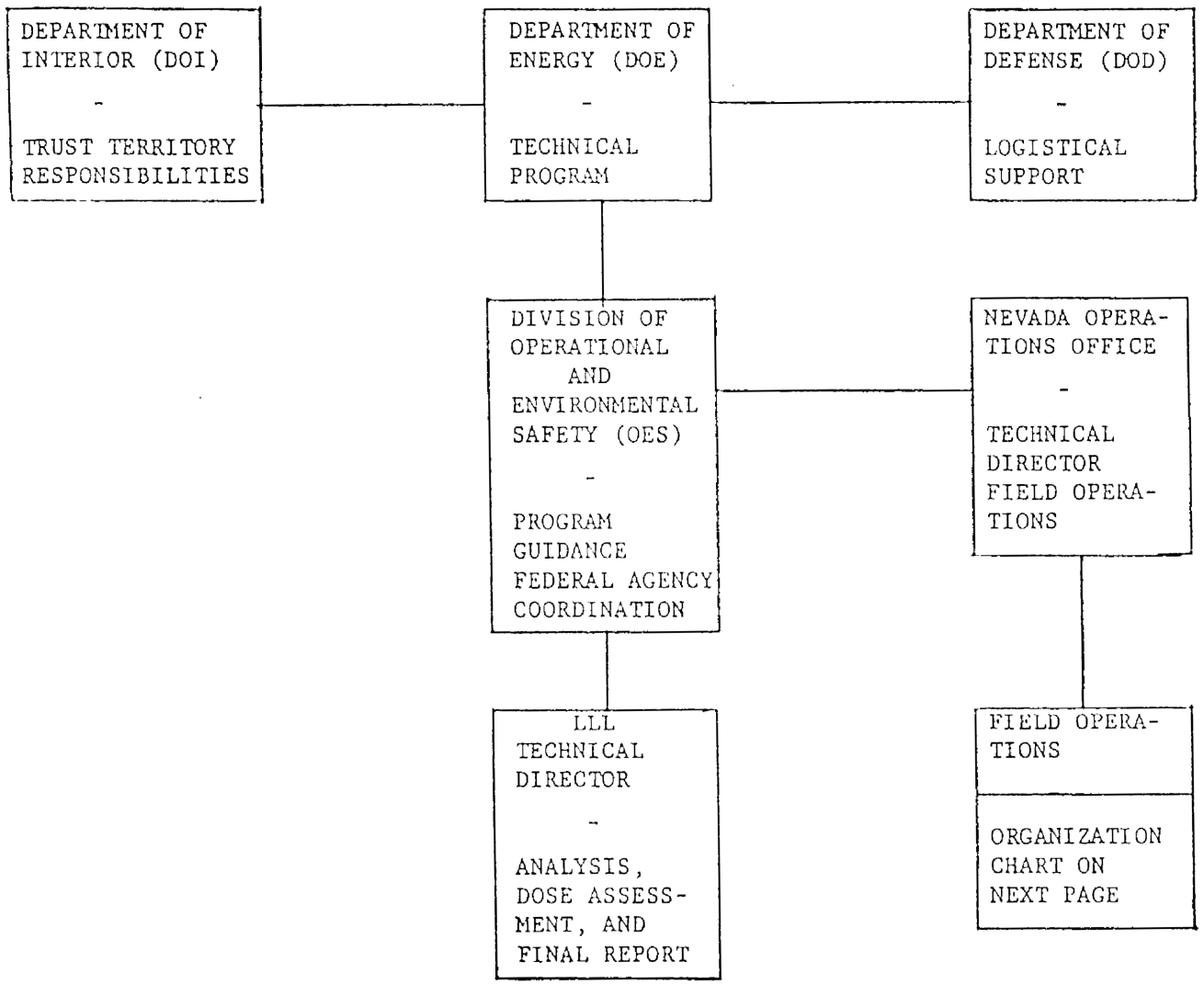
NORTHERN MARSHALL ISLANDS RADIOLOGICAL SURVEY

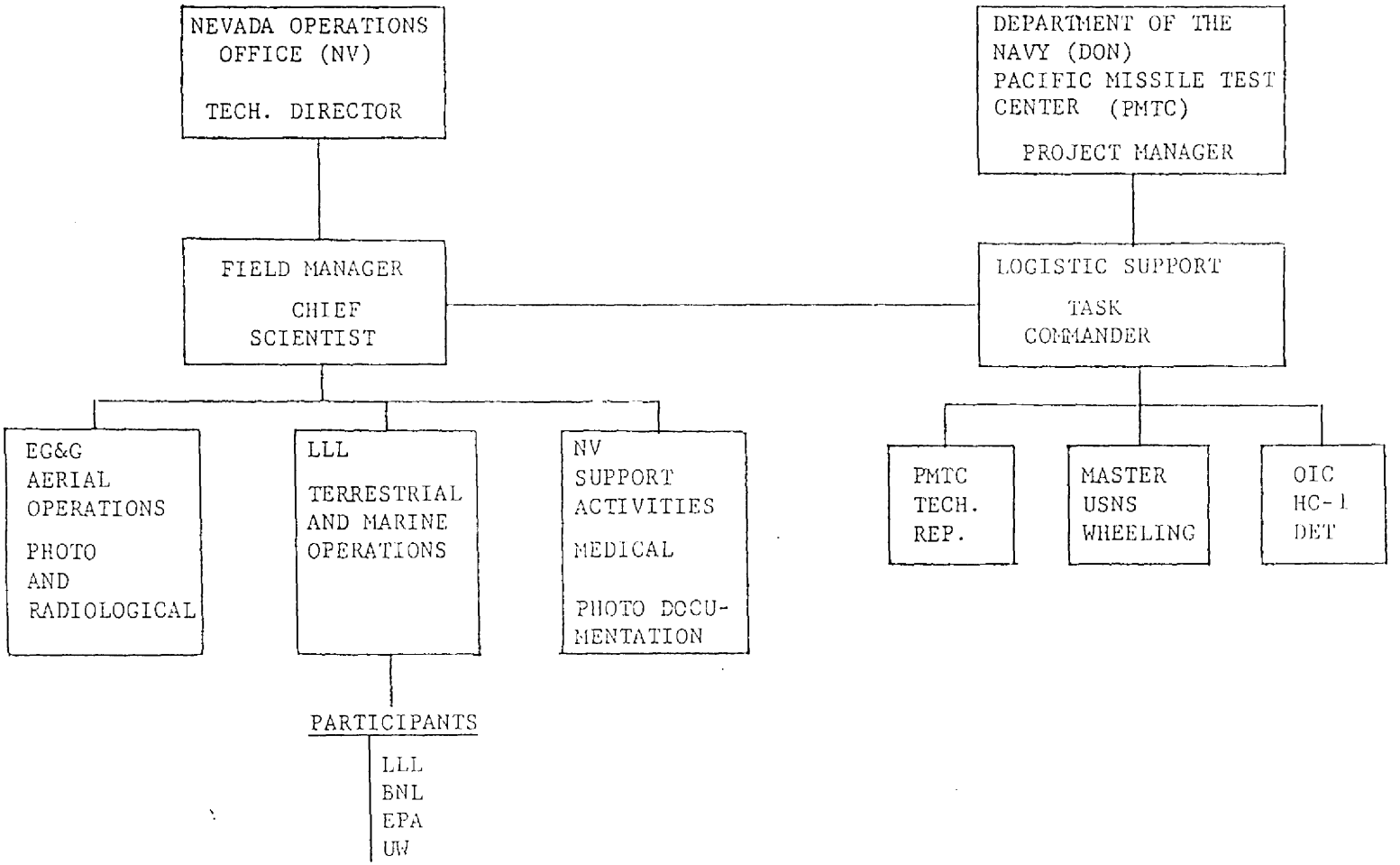
ORGANIZATION CHART



NORTHERN MARSHALL ISLANDS RADIOLOGICAL SURVEY

FIELD OPERATIONS

ORGANIZATION CHART



PART IIIC

LOGISTIC SUPPORT - DEPARTMENT OF THE NAVY

The field portion of the Northern Marshall Island Radiological Survey Program will be conducted in two separate operations, the photographic survey and the radiological survey. The Department of the Navy (DON) Project Manager for coordination and execution of DOD responsibilities for rendering logistics support to this survey is Commander, Pacific Missile Test Center, Pt. Mugu, California.

The photographic survey of the 11 atolls and 2 islands will be accomplished utilizing a DON fixed-wing aircraft. The platform has been specifically configured to receive the EG&G high resolution and infrared-capable cameras, plus additional peripheral support equipment.

The aircraft will be based at Kwajalein and will be required to fly 10 to 12 hours a day for approximately 24 days. This period includes contingencies for weather and aircraft down time.

Utilizing the data gathered from the photographic operation, an aerial radiological survey will be conducted of the atolls, and islands by means of two helicopters equipped with EG&G radiation detection and recording instrumentation. The helicopters will normally operate from the USNS Wheeling, the base support ship. The terrestrial and marine radiological survey operations will require the services of a support vessel and will therefore also use the USNS Wheeling as a base support ship.

It is estimated that 556 total flight hours will be required for the helicopters which will include flight hours for predeployment training, transporting personnel and equipment ashore, and for other administrative purposes as required.

LOGISTIC SUPPORT

The requirement for berthing support personnel on the USNS Wheeling during the survey is as follows:

Military Sealift Command	65
PACMISTESTCEN	23
Helicopter HC-1	24
Department of Energy and Contractors	37
Total	149

AERIAL PHOTO AND RADIOLOGICAL SURVEY PROGRAM

1 PHOTO MISSION

Photographic coverage of all islands of interest in the Northern Marshalls is required for three purposes: (1) provide detailed color flight maps of each island at specific scales for use by the radiation survey team, (2) specific data analysis to provide a variety of information about the islands, and (3) provide the underlays for the aerial radiation data.

Coverage will be obtained using present photographic equipment operated for the DOE by EG&G. This equipment is calibrated and adjusted for optimum performance to obtain imagery suitable for analysis purposes as well as the production of photographic prints.

The photo mission will be flown, using an EC-121 provided by the Pacific Missile Test Center based out of Kwajelein. Some film processing will be accomplished while at Kwajelein utilizing the photo lab operated by KENTRON. The film processing of imagery obtained for scientific purposes will be processed under controlled conditions by EG&G in Las Vegas, Nevada.

Seven EG&G personnel are required to support the mission which is expected to take 24 days. This time includes weather and down-time contingencies.

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2. RADIOLOGICAL SURVEY

The Aerial Radiation Surveys will be carried out by means of two Navy helicopters which will fly multiple missions from the USNS WHEELING station near the atoll or in the lagoons when possible. EG&G will supply the scientific flight crews and technical support personnel to operate and maintain the radiation measuring and position measuring equipment.

The aerial radiation survey will employ an array of forty 12.7 cm diameter by 5 cm thick NaI(Tl) scintillation detectors mounted within two pads which are hung externally on the helicopter. Signals from the detectors are fed into a multichannel data acquisition system mounted inside the helicopter. Gamma radiation data is accumulated continuously and recorded on magnetic tape once each second. In addition to the radiation data, position information provided by a microwave ranging system and a radar altimeter are also recorded on magnetic tape each second. Flight lines on each atoll island spaced 45 meters apart will be flown at an altitude of 30 meters and a speed of 30 meters per second. A steering indicator, using signals from the microwave ranging system, will be used to aid the helicopter pilot in maintaining uniform flight line spacing.

A large portion of the data reduction will be performed in the field using two NOVA 840 minicomputer based data reduction systems. Radiation and position data are correlated on a second-by-second basis and processed in the form of radiation contours overlayed on aerial photographs.

Specifically, the data will be processed to provide total gamma ray exposure rate (extrapolated to the 1 meter level) and selected isotope (e.g. ^{241}Am, ^{137}Cs, and ^{60}Co) concentration contours. Minimum detectability on the order of 5 pCi/g for ^{241}Am and less than 1 pCi/g for ^{137}Cs and ^{60}Co can be obtained with this system.

TERRESTRIAL AND MARINE PROGRAM

The purpose of this part of the radiological survey program is to document and evaluate in the form of radiological dose assessments the probable consequences of living on the 13 atolls and islands being studied.

The goals are to collect appropriate and sufficient representative samples and to analyze and obtain quality data from which these assessments can be accurately predicted.

TERRESTRIAL PROGRAM

To provide a meaningful dose assessment at the conclusion of the overall survey program, soil and vegetation sampling will be required. These samples will be analyzed for ^{90}Sr, one of the major contributors to the potential dose, ^{137}Cs, and the transuranics (the transuranics primarily include ^{238}, $^{239-240}Pu$ and ^{241}Am). Soil sampling is required to determine the depth distribution of gamma emitters to help quantify and verify the aerial radiological survey data. It has been found that 90 percent of the total predicted doses to populations at Bikini and Enewetak Atolls are due to ^{90}Sr and ^{137}Cs ingested via the terrestrial foodchains. To properly assess this pathway, soil profile and surface soil samples and vegetation samples must be collected to determine the potential radionuclide uptake in subsistence crops. The transuranics are determined to evaluate the long-term potential effects from the gradual buildup of these isotopes.

The terrestrial program will include collection of the following types of samples:

1. Surface soils.
2. Soil profiles.
3. Subsistence crops and associated soil profiles (i.e. coconut, Pandanus fruit, breadfruit, papaya, squash, etc.). These crops may not be available on many of the atolls. However, wherever they are available, it is of primary importance to sample the edible products and determine the associated soil profiles.

4. Indicator species - where subsistence crops are unavailable, indicator plants such as Scavevola and Messerschmidia will be collected.
5. Fauna-coconut crabs, birds, bird eggs, and rats will be collected if available. These are not as high priority as the soils and vegetations, but should be collected when readily available.
6. Domestic animals and fowl (e.g., pigs and chickens)- on some of the atolls domestic animals and fowl may be available. If so, they should be obtained to evaluate the radionuclide uptake in animals that are grazing and integrating large areas of the island and to help evaluate the radionuclide intake of the people via the diet.

Sample processing will be performed at LLL. Gamma spectroscopy and wet chemistry analysis will be performed at LLL and on special subcontract to other laboratories.

Marine Program

A variety of the marine organisms commonly consumed at the atolls will be collected to estimate dose from consumption of marine food products. A number of lagoon water samples and near shore sediments will also be collected to compute and compare concentration factors of the different radionuclides detected in the marine organisms and to assess the radionuclide levels in the abiotic components of the lagoon environment. As a minimum at least two representative reef species and invertebrates, commonly consumed, will be collected from several locations at each atoll. The fish will be disected into muscle, bone, skin, gut contents, gills and internal organs. These tissues will be pooled for analysis, while the tissues of the pelagic species, providing that large enough samples are available, will be separately analyzed. Since the dietary habits of the Marshallese may be different on the various atolls, this processing procedure will allow us to reconstruct the radionuclide concentrations in any assembly of tissues and organs commonly consumed. All

on these numbers of samples.

Data Bank

The data bank designed at LLL for organizing the Enewetak 1972-1973 data, the 1975 Bikini Survey and all of the LLL followup terrestrial research programs will be used for storage and retrieval of all data collected during this program. The data will be readily accessible by atoll, island, type of sample, radionuclide, etc. This will be the source of the information to prepare dose assessments.

Dose Assessment and Reporting

The dose assessment and reporting will be conducted at LLL and represents the final product of the program. The dose assessment will include the evaluation of the following pathways:

1. External Gamma
2. Terrestrial Food Chain
   a. Food products
   b. Drinking water
3. Marine Food Chain

The results will be published in a series of reports issued in accordance with the time period required for completion of the analysis of the samples and interpretation of the resulting radiological data. The reports are expected to be completed and issued in the following approximate time periods after the survey.

1. External Gamma Doses - 6 months.
2. Drinking Water Doses - 6 months.
3. Marine Food Chain Doses - 1.3 years.
4. Terrestrial Food Chain Doses - 1.8 years.
5. Dose Summary of all pathways - 2 years.

Although the above reports will include the assessment of all 13 atolls, there may be interim reports on dose evaluations of specific atolls.

samples will be analyzed for ^{90}Sr, ^{137}Cs, and the transuranics by wet chemical methods. These are the principal dose contributing radionuclides in the marine pathway at Enewetak and Bikini.

On inhabited islands, available freshwater supplies (cisterns of ground water) will be sampled for radionuclide analysis. Conductivity measurements will be made to assess the freshness of the water supply, and coliform analysis will be performed in the field and health officials will be advised if any water is found with high concentrations of bacteria.

Analytical processing and analysis

All terrestrial and marine samples will be processed at LLL for analysis. Radionuclide concentrations will be assessed using appropriate methods of detections which will include alpha, beta and gamma counting systems. A large fraction of the radioanalytical work will be conducted at LLL; but because the large number of samples requiring analysis will overload the LLL laboratories facilities, it will be necessary to send some samples to off-site laboratories on DOE contract for analysis. A rigorous quality control program will be integrated into the radionalytical effort. The quality control program will be managed by LLL and a sufficient number of blanks, standards and duplicates, will be prepared and distributed to all participating laboratories to assess and maintain the quality of the data generated by the participants. As a minimum, data will be generated to assess the levels of ^{90}Sr, ^{137}Cs, and the transuranics. These radionuclides are the principal dose contributing radionuclides expected in all food products collected from the atolls.

Approximately 7000 soil, vegetation, and terrestrial organisms and 1800 fish organs and tissues, marine invertebrates, sediments, and water samples will be processed and analyzed for the above listed radionuclides during the program. The analytical program costs are based

RADIOLOGICAL SURVEY PLAN

FOR THE

NORTHERN MARSHALL ISLANDS

SURVEY SCHEDULE

All equipment will be loaded at Port Hueneme, California or Honolulu, Hawaii. Equipment checks will be performed while the U.S.N. Wheeling is enroute to Kwajalein from Honolulu. Remaining technical support will board the ship at Kwajalein either at port or utilizing the SH-3 Helos that are aboard the ship. For logistics reasons, the survey of the atolls was divided into three series as shown below:

1ST SERIES - 22 DAYS
(includes travel time)

APPROX. DATE	ACTION	DAYS
Sept. 17	Travel from Kwajalein to Rongelap	
	Survey Rongelap Atoll	7
	Pack and depart for Rongerik	
	Survey Rongerik Atoll	5
	Pack and depart for Taka Atoll	
	Survey Taka Atoll	2
	Pack and depart for Utirik Atoll	
	Survey Utirik Atoll	4
	Travel to Kwajalein Atoll Base	

2ND SERIES - 22 DAYS
(includes travel time)

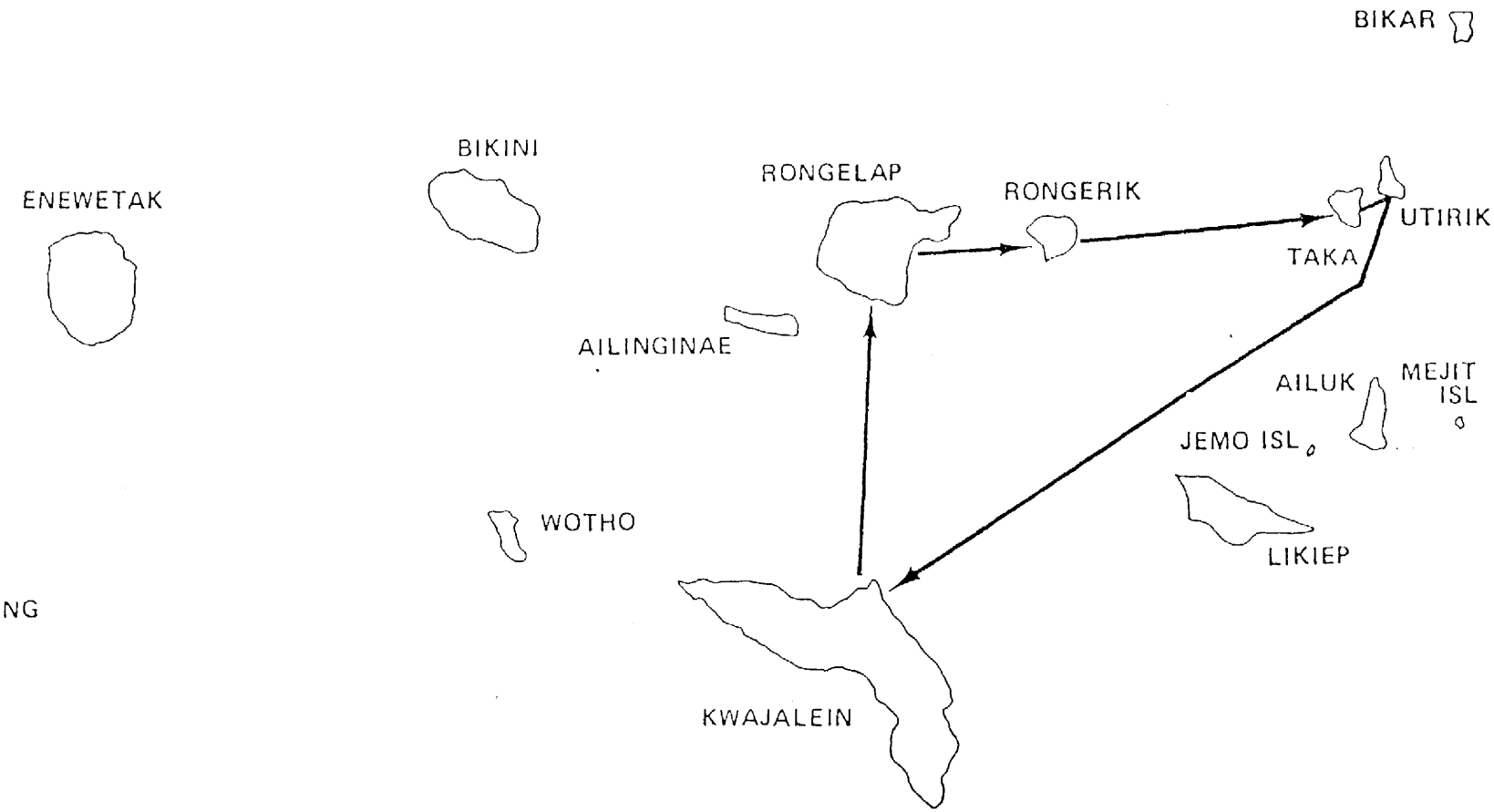
October 10	Travel from Kwajalein to Likiep Atoll	
	Survey Likiep Atoll	7
	Pack and depart for Jemo Island	
	Survey Jemo Island	1
	Pack and depart for Ailuk Atoll	
	Survey Ailuk Atoll	6

APPROX. DATE	ACTION	DAYS
	Pack and depart for Mejit Island	1
	Survey Mejit Island	
	Pack and depart for Bikar Atoll	
	Survey Bikar Atoll	3
	Pack and depart for Kwajalein Atoll Base	
	Then proceed to Honolulu for fuel and provisions	
	3RD SERIES - 33 DAYS	
November 14	Travel to Ailinginae Atoll from Kwajalein	
	Survey Ailinginae Atoll	5
	Pack and depart for Bikini Atoll	
	Survey Bikini Atoll	12
	Pack and depart for Ujelang Atoll	
	Survey Ujelang Atoll	5
	Pack and depart for Wotho Atoll	
	Survey Wotho Atoll	4
	Pack and depart for Kwajalein	

The ship will then return to Port Hueneme, California, via Honolulu, Hawaii.

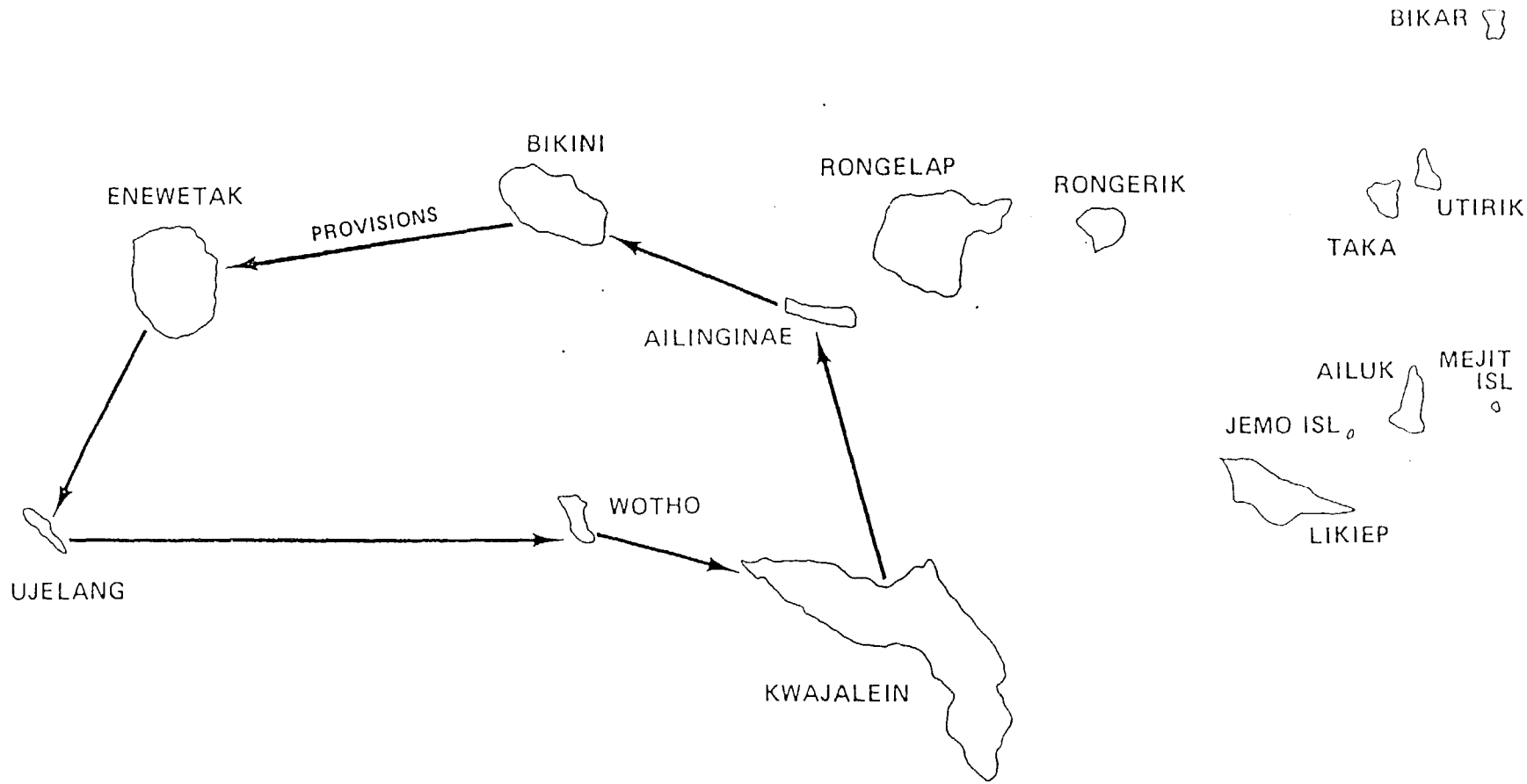
Radiological Survey Plan for the Northern Marshall Islands

First Series
22 Days



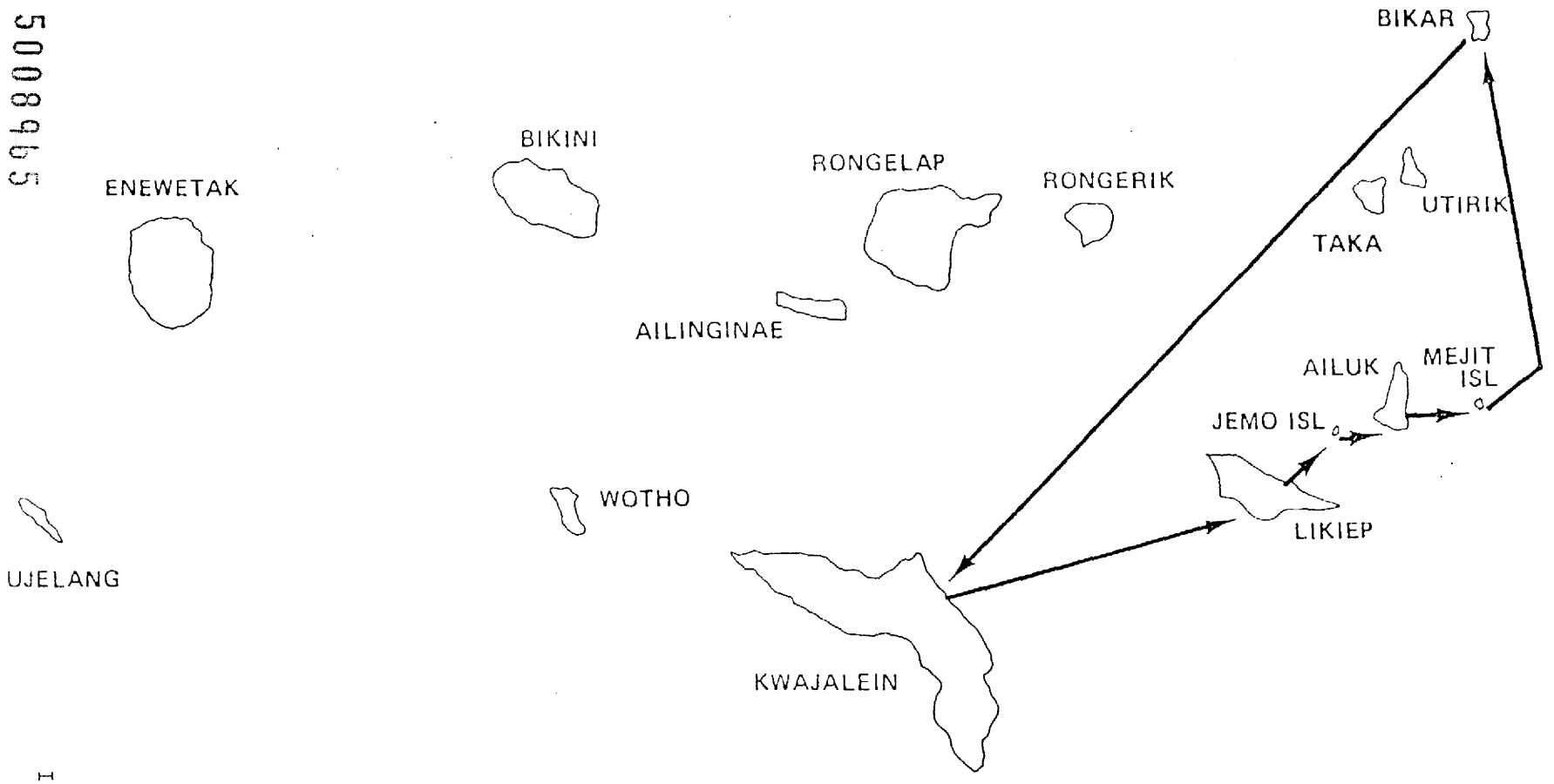
Radiological Survey Plan for the Northern Marshall Islands

Third Series
33 Days



Radiological Survey Plan for the Northern Marshall Islands

Second Series
22 Days



TAB 4

PART IV

MILESTONE CHART

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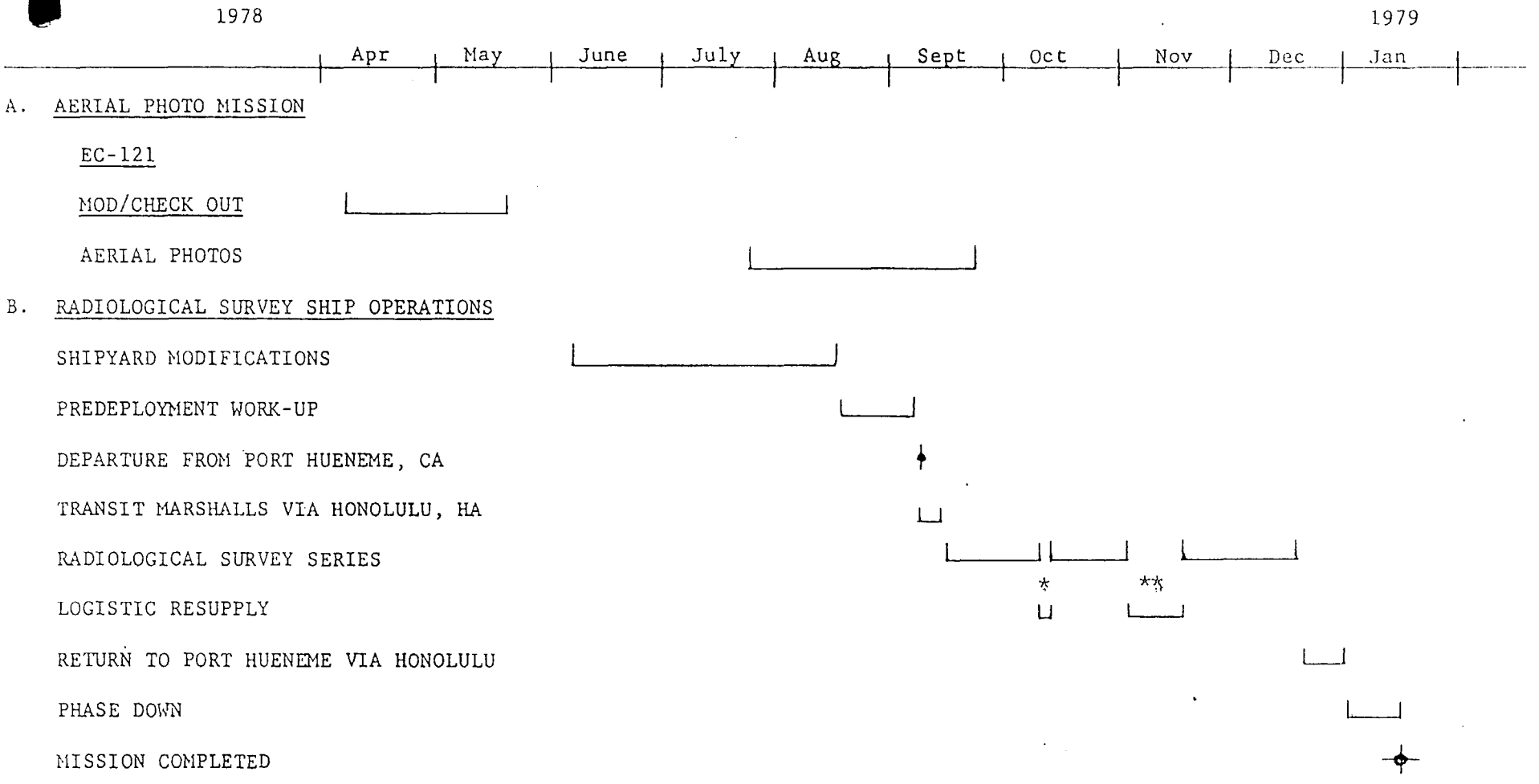
MILESTONE CHART



*Kwajalein
**Honolulu, Hawaii

MILESTONE EVENTS AND DATES

EVENTS	DATES
A. Aerial Photo Mission	
EC-121 Schedule	
Photo Modifications/checkout	12 April - 19 May
Photo Missions	24 July - 24 Sept.
B. Radiological Survey	
1. USNS Wheeling - Schedule	
Shipyard Modifications	5 June - 16 August
Predeployment workup and preparation for overseas move	17 August - 3 Sept.
Depart Port Hueneme, California for Hawaii	3 September
Arrive Honolulu, Hawaii	8 September
Depart for Kwajalein	10 September
Arrive Kwajalein, off load Helo Equipment, board survey personnel, etc.	15 Sept. - 16 Sept.
CONDUCT SERIES 1. (SEE PART III)	17 Sept. - 8 October
Off load and load survey personnel at Kwajalein and provision ship	8 Oct. - 9 Oct.
CONDUCT SERIES 2. (SEE PART III)	10 Oct. - 31 Oct.
Off load survey personnel at Kwajalein and proceed to Honolulu for fuel and provisions - return to Kwajalein for boarding survey personnel	31 Oct. - 14 November
CONDUCT SERIES 3. (SEE PART III)	14 Nov. - 16 December
Off load survey personnel at Kwajalein and proceed to Honolulu	16 Dec. 21 Dec.
Proceed to Port Hueneme, California	22 Dec. - 28 Dec.
Phase down	28 Dec. - 12 January, 1979

EVENTS	DATES
2. Helicopter Schedule	
HC-1 Helicopters	
checkout and training of Helo and crew personnel	1 Aug. - 3 Aug.
Join ship for Helo-ship training	22 Aug. - 24 Aug.
Enroute with ship and fly radiological survey missions	3 Sept. - 28 Dec.

TAB 5

PART V

AGENCY ASSIGNMENTS

MEMORANDUM OF AGREEMENT

BETWEEN

DEPARTMENT OF THE NAVY
DEPARTMENT OF ENERGY
AND
DEPARTMENT OF THE INTERIOR

PART V

RADIOLOGICAL SURVEY PLAN FOR THE NORTHERN MARSHALL ISLANDS

AGENCY ASSIGNMENTS

A. Department of Interior (DOI)

1. Grants authority for the conduct of the Northern Marshalls Radiological Survey to the Department of Energy.
2. Assures that the Trust Territory and Marshall Islands Administrations and other appropriate agencies or organizations are aware of the responsibilities and guidelines of the survey.

B. Department of Defense (DOD)

The Department of Defense has designated the Department of the Navy as the executive agent for the coordination and execution of the responsibilities in rendering the required logistical support to the Department of Energy.

C. Department of Energy (DOE)

1. Responsible for the conduct of the technical program to assess the radiological condition of the identified atolls and environment.
2. Prepare a final report on the radiological condition of the atolls and their environment.

MEMORANDUM OF AGREEMENT

BETWEEN

DEPARTMENT OF THE NAVY
DEPARTMENT OF ENERGY
AND
DEPARTMENT OF THE INTERIOR

Subj: Logistics Support for an Aerial Radiological Survey of the Northern Marshall Islands

Ref: (a) Memorandum of Agreement between Commander, Military Sealift Command and Commander, Pacific Missile Test Center dated 13 Sept/1977/20 Oct 1977
(b) COMSCPAC/COMPMTC RIS Operations Order 302-YR

1. BACKGROUND. In June 1977, the Secretary of Defense (DOD) designated the Department of the Navy (DON) as the Executive Agent for the coordination and execution of DOD responsibilities for rendering logistics support to an Aerial Radiological Survey of the Northern Marshall Islands with the understanding that all costs incurred by Navy are to be on a reimbursable basis. The technical direction of the survey will be the responsibility of the Department of Energy (DOE). Funds have been appropriated by the Congress to the Department of the Interior (DOI) for the reimbursement of the logistics support that will be provided.

2. PARTIES TO THE AGREEMENT.

a. Department of the Navy, represented by the Chief of Naval Operations (OP-09).

b. Department of Energy, represented by Nevada Operations Office, Las Vegas, Nevada (NVOO).

c. Department of the Interior, represented by the Office of Territorial Affairs (OTA/DOI).

3. TERMS OF THE AGREEMENT. This Memorandum of Agreement (MOA) will become effective when signed by the last signatory of the parties to the MOA and will remain in effect until the completion of the subject project.

a. For cost purposes, completion of the Radiological Survey is construed to include return of the USNS WHEELING (TAGM-8) to its assigned CONUS West Coast homeport and completion of phase-down to Reduced Operating Status (ROS), or earlier, as may be determined by the DON and agreed to by the other parties to this MOA.

[redacted]

b. DON will receive timely notification of any intended change in the conduct of the Radiological Survey that would significantly alter the scope of this original or duly amended MOA.

c. This MOA may be terminated by the mutual agreement of all three parties to the MOA, or upon 30 days written notice by any single party to the other two parties.

d. This MOA may be modified or amended as agreed to by the several parties to the MOA.

4. CONCEPT OF OPERATIONS. The Aerial Radiological Survey will be conducted in two separate and distinct phases. The Navy Project Manager for coordination and execution of DOD responsibilities for rendering logistics support to this survey is Commander, Pacific Missile Test Center, Pt. Mugu, California.

a. PHASE I. Initially, support will be provided for a photographic survey of eleven (11) atolls and two (2) islands in the Northern Marshall Islands utilizing a DON EC-121 aircraft. This platform has been specially configured to receive DOE-provided high resolution and infra-red capable cameras, plus additional peripheral support equipment.

(1) Phase I will be accomplished under the operational direction of the Project Manager (COMPMTC), in accordance with the technical direction and advice of the on-site DOE representative and the terms of this MOA.

(2) COMPMTC will promulgate an appropriate Operations Directive for the accomplishment of the Phase I mission.

b. PHASE II. Utilizing data gathered from the foregoing photographic survey, an Aerial Radiological Survey of eleven (11) atolls and two (2) islands will be conducted by means of SH-3G helicopters equipped with DOE-provided radiation detection and recording instrumentation. The helicopters will normally operate from USNS WHEELING (TAGM-8), a base support ship which will, in addition, provide a wide range of logistics support. Flying relatively precise tracks at specified altitudes and air speeds, the data collected will be reduced and result in the radiological documentation and characterization of the eleven (11) atolls and two (2) islands in the Northern Marshalls, for later use as deemed appropriate by DOE and DOI in ongoing rehabilitation and resettlement programs.

(1) Operations of USNS WHEELING (TAGM-8) will generally be in accordance with reference (a) and this MOA. Should there be a conflict as a result of conducting operations in accordance with these two source documents, the provisions of reference (a) will apply while clarification and resolution is sought by the Project Manager.

(2) The Project Manager will promulgate an appropriate Operations Directive in support of this MOA, subject to approval by cognizant major DON operational commanders (COMSCPAC and COMNAVAIRPAC).

5. SCOPE OF THE AGREEMENT.

a. This MOA will apply to all DON, DOE and DOI resources assigned by the several parties to prepare for, undertake and complete the Aerial Radiological Survey of the Northern Marshall Islands. For the purposes of more precisely defining the dimensions of the logistics support package the DON anticipates providing to DOE, and to facilitate establishing accurate cost estimates for planning purposes, this MOA will be bounded as outlined herein.

b. Phase I of survey operations will consist of aerial photographic missions of areas of interest to be defined by DOE. This phase will be limited to 300 EC-121 flight hours, including transits to and from the survey site.

c. Phase II of the survey will be acccomplished by deploying the designated base support ship, USNS WHEELING (TAGM-8), with embarked SH-3G helicopter detachment, technical and support personnel to the Northern Marshall Islands. The current plan is to limit USNS WHEELING (TAGM-8) to 77 days on station and 57 days in transit including transits to port for logistics replenishment and reprovisioning, or some reasonable combination thereof. While on station, a twelve-hour working day is agreed to, recognizing the resulting additional overtime costs. The Radiological Survey, as planned, will be further limited to 556 total flight hours for the assigned SH-3G helicopters, including those flight hours provided for predeployment training, transporting personnel and equipment ashore and for other administrative purposes as required. Upward adjustments to the foregoing limitations amounting to over 10% will require formal amendment of the MOA.

d. Appendix I is an overview of the three (3) series (A, B and C) of radiological missions that will constitute Phase II of the survey. At Appendix II is a framework schedule for the complete survey (Phases I and II).

[redacted]

6. SURVEY TASK GROUP ORGANIZATION. DON, DOE and DOI resources dedicated to the accomplishment of the Radiological Survey will be organized into a Survey Task Group as follows:

a. Project Manager. COMPMTC was designated Project Manager for logistics support to the subject survey in CNO msg 010007Z APR 78 and will continue in this capacity through project completion, coordinating and providing, on behalf of DON, all logistics support required by DOE for the accomplishment of survey objectives.

b. Aerial Photographic Task Element. The Officer in Charge of the EC-121 aircraft detachment will report for operational control directly to the Project Manager for the conduct of Phase I of the survey, and will function as the primary point of contact for the DOE designee having technical direction responsibilities for the conduct of Phase I of the survey.

c. Aerial Radiological Task Element. This Task Element will accomplish Phase II of the survey utilizing USNS WHEELING (TAGM-8), assigned helicopters and associated support personnel and equipment.

(1) Logistics Support Task Commander. Embarked in USNS WHEELING (TAGM-8) will be a Logistics Support Task Commander (LSTC) who will function as the primary point of contact for the DOE representative exercising technical direction responsibility for the conduct of Phase II of the survey. The LSTC will have overall operational control and management responsibility for DON provided logistics support. DOE representatives will channel requests for survey logistics support through the LSTC who will then coordinate the efforts of the USNS WHEELING (TAGM-8) and the OINC of the helicopter detachment. The LSTC is further designated as the Sponsor Designated Representative (SDR) as defined in reference (a).

(2) PMTC Technical Representative. The Project Manager will designate an embarked PMTC Technical Representative who will act as primary advisor to the LSTC on logistics support matters. The PMTC Technical Representative will assume the functions and responsibilities of the LSTC/SDR in his absence.

(3) Master, USNS WHEELING (TAGM-8). The ship's Master will have absolute authority and responsibility for the safety of his ship and embarked personnel as prescribed in reference (a) while responding to the operational requests and recommendations of the embarked LSTC/SDR.

(4) Officer in Charge, HC-1 Detachment. The embarked helicopter detachment Officer-in-Charge will have absolute authority and responsibility for all matters relating to flight operations, particularly safety of flight, while responding to the operational requests and recommendations of the LSTC. Operation of assigned helicopters will be in accordance with appropriate directives to be provided by the parent helicopter squadron commander. Administrative control and procedural matters regarding Naval Air Training and Operating Procedures Standardization Program (NATOPS) and maintenance remain with the parent helicopter squadron commander.

(5) Survey Project Field Director. A DOE employee, embarked in USNS WHEELING (TAGM-8), will be designated the DOE Survey Project Field Director (SPFD) and will have responsibility for on-site technical direction of the survey. He will direct the efforts of all DOE and DOE contractor personnel and will make requests for Navy-provided logistics support from the LSTC. He will be responsible to the designated DOE Survey Project Manager (at NVOO) for the survey results. To this end, the SPFD will develop detailed survey work plans in coordination with the LSTC. He shall be responsible for determining requirements for helo lift, support ashore, duration of stay at each location, and other requirements affecting mission performance, all within an agreed overall resource availability.

d. A diagram of organizational relations is at Appendix III.

7. EMPLOYMENT AND OPERATION OF USNS WHEELING (TAGM-8). COMSCPAC, on behalf of COMSC, will operate USNS WHEELING (TAGM-8) in accordance with reference (a), current directives, and U.S. Navy Regulations. Sponsor/Operator relationships will be as defined in reference (b).

8. RADIOLOGICAL SAFETY, HEALTH AND DECONTAMINATION. The DON will assume primary responsibility for all matters pertaining to radiological safety, health, and where required, radiological decontamination aboard USNS WHEELING (TAGM-8).

a. DON will establish and administer the Radiation Health Program aboard USNS WHEELING (TAGM-8) to ensure the protection of embarked personnel, in accordance with standards and procedures prescribed in NAVMED P-5055 (Radiation Health Protection Manual).

b. DOE will assume responsibility for safeguarding all radioactive material stored aboard USNS WHEELING (TAGM-8) or transported in assigned helicopters and will properly dispose of such material upon completion of the survey operation.

c. DON will assume all responsibilities for determining radiological decontamination requirements and the execution of decontamination measures where required.

9. SUPPORTING SERVICES, SUPPLY SUPPORT, MODIFICATION, ALTERATION AND REPAIRS will be as prescribed herein:

a. The supporting services, supply support, modification, alteration and repair of USNS WHEELING (TAGM-8) will be as defined in reference (a).

b. Supporting services, supply support, modification, alteration and repair for embarked helicopters shall be as defined by the parent helicopter squadron commander.

c. Modifications, alterations, and repairs to USNS WHEELING (TAGM-8) to prepare for deployment and return to ROS will be defined by COMSC/COMPMTC.

d. DON will be reimbursed by DOI for all survey-related modifications, alterations, repairs and ship preparation costs associated with preparing, operating and phasing USNS WHEELING (TAGM-8) down to ROS.

10. FUNDING OF LOGISTICS SUPPORT.

a. General. The net additional costs of logistics support provided by the DON for the accomplishment of the Aerial Radiological Survey of the Northern Marshall Islands will be fully reimbursed from funds appropriated to DOI. Accordingly, such support must be tailored to the availability of these funds to avoid cost overruns. Logistics support addressed herein refers only to those resources provided by the DON, and is exclusive of any other resources that may be provided in support of the survey by any other agency.

b. Application of Funds and Billing. The DON will be solely responsible for the application of DOI funds to the expenses incurred in providing DON logistics support for the project. All subordinate DON elements incurring costs that will be reimbursed by DOI funds will maintain a complete accounting thereof and will forward billings therefor to the Chief of Naval Operations on a monthly basis. Consolidated billings for these costs will be made monthly by the DON to the DOI on a Standard Form 1080, and accompanied by a DON notification of the cumulative application of resources.

[redacted]

11. SIGNATORIES

a. Joseph L. Liverman

FOR THE DEPARTMENT OF ENERGY
Acting Assistant Secretary for Environment

DATE: August 2, 1978

b. Ruth E. Van Cleve

FOR THE DEPARTMENT OF THE INTERIOR
RUTH E. VAN CLEVE
Director, Office of Territorial Affairs

DATE: 25 JUL 1978

c. R. L. J. Long

FOR THE DEPARTMENT OF THE NAVY
R. L. J. LONG
ADMIRAL, U.S. NAVY
VICE CHIEF OF NAVAL OPERATIONS
DATE: 25 JUL 1978

D. B. MacClary

CERTIFIED TO BE A TRUE COPY
D. B. MACCLARY, CAPT, USN
Deputy Director
Logistic Plans Division
4 August 1978

[redacted] 008978

Schedule changed 8/21/78

APPENDIX I

See Part III

OVERVIEW OF RADIOLOGICAL SURVEY SCHEDULES

		DAYS
1.	SURVEY SERIES A	
a.	Depart Kwajalein enroute Ailinginae Atoll (16 hrs transit)	1
b.	Survey Ops Ailinginae Atoll	5
c.	Load-out and enroute Bikini (6 hrs transit)	1
d.	Survey Ops Bikini Atoll	12
e.	Load-out and enroute Wotho Atoll (16 hrs transit)	1
f.	Surveys Ops Wotho Atoll	4
g.	Load-out and enroute Kwajalein for DOE crew change and reprovisioning	1
	Sub-Total	25
2.	SURVEY SERIES B	
a.	Depart Kwajalein enroute Rongelap Atoll (20 hrs transit)	1
b.	Survey Ops Rongelap Atoll	7
c.	Load-out and enroute Rongerik Atoll (6 hrs transit)	1
d.	Survey Ops Rongerik Atoll	5
e.	Load-out and enroute Bikar Atoll (15 hrs transit)	1
f.	Survey Ops Bikar Atoll	3
g.	Load-out and enroute Utirik Atoll (7 hrs transit)	1
h.	Survey Ops Utirik Atoll	4

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APPENDIX I

OVERVIEW OF RADIOLOGICAL SURVEY SCHEDULES

		DAYS
	SURVEY SERIES B (Continued)	
i.	Survey Ops Taka Atoll	2
j.	Load-out and enroute Kwajalein for DOE crew change and reprovisioning	1
	Sub-Total	26
3.	SURVEY SERIES C	
a.	Depart Kwajalein enroute Ailuk Atoll (12 hrs transit)	1
b.	Survey Ops Ailuk	6
c.	Load-out and enroute Mejit Island (3 hrs transit)	1/2
d.	Survey Ops Mejit Island	1
e.	Load-out and enroute Jemo Island (6 hrs transit)	1
f.	Survey Ops Jemo Island	1
g.	Load-out and enroute Likiep Atoll (3 hrs transit)	1/2
h.	Survey Ops Likiep Atoll	7
i.	Load-out and enroute Ujelang Atoll (2 days transit)	2
j.	Survey Ops Ujelang Atoll	5
k.	Load-out and enroute Enewetak (16 hrs transit)	1
	Sub-Total	26
4.	SURVEY SUMMARY	
a.	Series A	25
b.	Series B	26
c.	Series C	26
	Total Survey Days	77

APPENDIX II

Dates changed 8/21/78
See Part III

AERIAL RADIOLOGICAL SURVEY
NORTHERN MARSHALL ISLANDS

FRAMEWORK SCHEDULE FOR COMPLETE SURVEY

1. PHASE I: EC-121 Photographic Survey

   a. 24 July - 24 Sept 1978

2. PHASE II: Radiological Survey utilizing USNS WHEELING (TAGM-8) and three (3) SH-3G helicopters:

	DATE(S)	EVENT
a.	10 Apr - 23 May 1978	Phase Up to WHEELING (ROS TO FOS)
b.	24 May - 04 Jun	Preparation for Overhaul
c.	05 Jun - 03 Aug	Shipyard Overhaul
d.	04 Aug - 06 Sept	Pre-deployment workup; Prepare for Overseas Movement
e.	07 Sept	Deploy from Port Hueneme; enroute Pearl
f.	12 Sept	Arrive Pearl; Logistics
g.	14 Sept	Depart Pearl; enroute Kwajalein
h.	20 Sept	Arrive Kwajalein; Logistics; Disembark 1 SH-3G and 10-man HC-1 Det; Embark DOE Survey Party; Equipment checkout
i.	22 Sept	Depart Kwajalein for Survey Series A; 25 days
j.	16 Oct	Arrive Kwajalein; Disembark DOE Survey Party
k.	16 Oct	Depart Kwajalein enroute Guam
l.	23 Oct	Arrive Guam; refuel and reprovision

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APPENDIX II

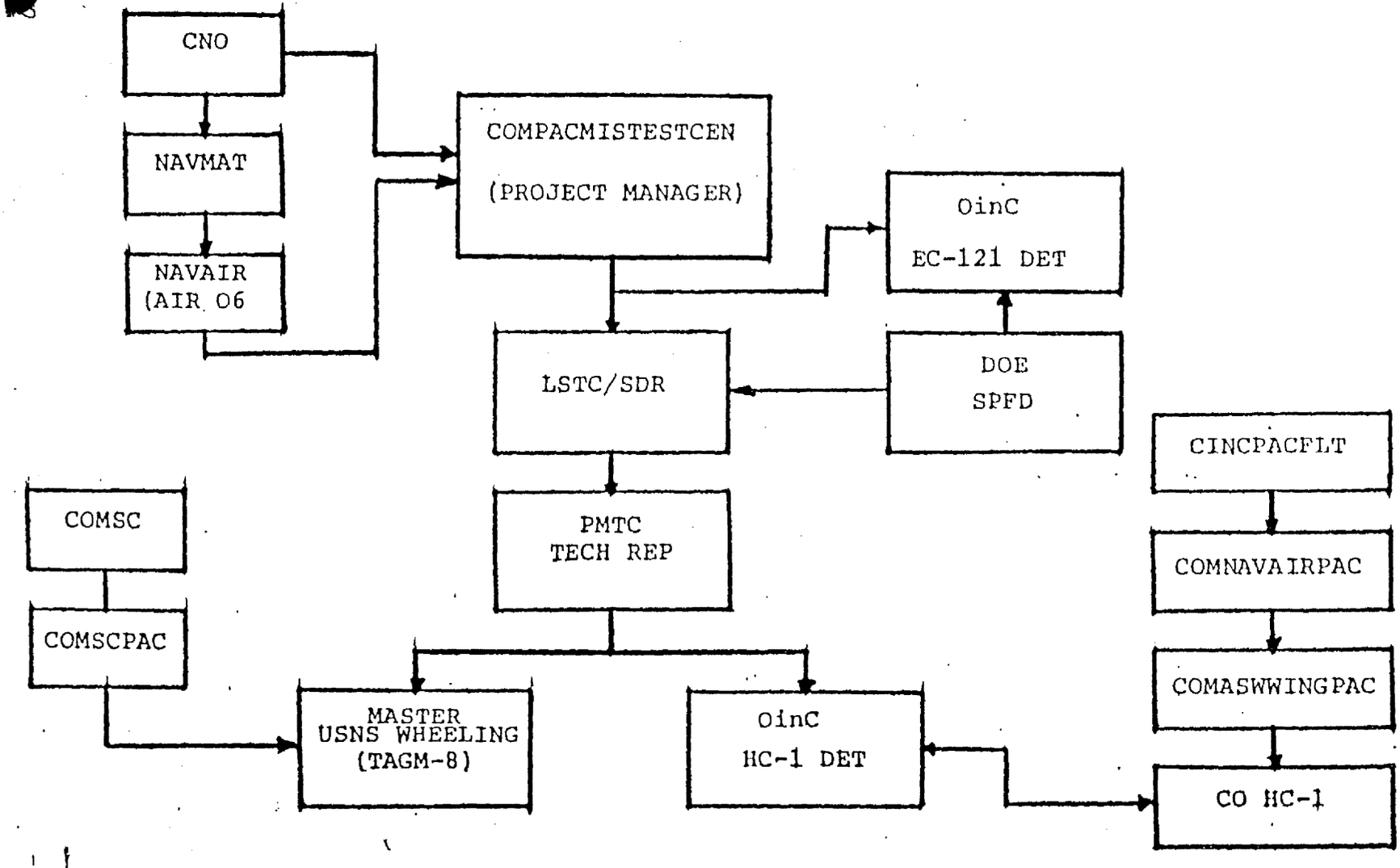
AERIAL RADIOLOGICAL SURVEY
NORTHERN MARSHALL ISLANDS

FRAMEWORK SCHEDULE FOR COMPLETE SURVEY

DATE(S)		EVENT
m.	25 Oct	Depart Guam; enroute Kwajalein
n.	31 Oct	Arrive Kwajalein; Embark DOE Survey Party
o.	31 Oct	Depart Kwajalein for Survey Series B; 26 days
p.	26 Nov	Arrive Kwajalein; Disembark DOE Survey Party
q.	26 Nov	Depart Kwajalein; enroute Guam
r.	02 Dec	Arrive Guam; refuel and reprovision
s.	04 Dec	Depart Guam; enroute Kwajalein
t.	10 Dec	Depart Kwajalein for Survey Series C; 26 days
u.	05 Jan 1979	Arrive Kwajalein; Disembark DOE Survey Party
v.	05 Jan	Depart Kwajalein; enroute Pearl
w.	11 Jan	Arrive Pearl; Logistics
x.	12 Jan	Depart Pearl; enroute Port Hueneme
y.	18 Jan	Arrive Port Hueneme; Commence Phase-down
z.	02 Feb	WHEELING returned to ROS

APPENDIX III

DIAGRAM OF ORGANIZATIONAL RELATIONSHIPS



TAB 6

PART VI

PUBLIC INFORMATION PLAN

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PART VI

PUBLIC INFORMATION PLAN

A series of DOE coordinated public information actions is needed to provide news media with a complete and accurate picture of the rehabilitation, cleanup and medical programs, and the upcoming radiological suvey program scheduled this fall.*

The following publics will need to be kept informed:

1. Residents of the surveyed islands and atolls.
2. Residents of the Marshall Islands.
3. Trust Territory government.
4. Department of the Interior (DOI), Department of Defense (DOD).
5. U. S. Congress.
6. U. S. and foreign news media.

The following program interests should be kept in mind while collecting and disseminating information:

1. Obtaining dose assessments and evaluations of the atoll environments.
2. Obtaining improved feedback of information from the Marshallese people.

In establishing the information dissemination and gathering effort, there are these important considerations:

1. Misunderstandings surrounding the DOE medical followup in the Marshalls have led to complaints and criticism.
2. There has been a lack of coordination between agencies and within agencies and, their contractors in communicating with the Marshallese in the past.
3. News media reaction to Government efforts to right past wrongs has been friendly but sympathies are clearly with the Marshallese people.
4. Information on land use and dietary preferences and practices in the Marshalls is scarce and subject to continuing review and revision.

*For any matter pertaining to public information contact Len Arzt (202) 376-4192.

Public Affairs Guidance

1. Take a completely open approach in conduct of the public information aspects and in the dissemination of information derived by the radiological survey.

2. Schedule a show-and-tell briefing and press conference before the aerial survey begins, in Honolulu, on board the USNS Wheeling with participation by the Department's of the Interior and Defense (DON). Provide news media access to the ship when it arrives in Kwajalein for resupply.

3. Conduct both introductory and post survey briefings at each populated atoll or island. There must be a "dry run" to preview these briefings for DOE, DOI, and TT staff and preparation and coordination of questions and answers.

4. Encourage and welcome coverage of the survey by domestic and foreign news media staff and accommodate their requests. Newsmen who request to accompany the survey team should be allowed to do so under the following criteria: that they pay their own expenses and plan to stay out for at least one week, and that they arrange their own transportation to rendezvous with the ship. Technical staff will be expected to cooperate to the fullest.

5. Allow newsmen to accompany the medical team if they pay their own expenses, do not interfere with the medical team, and a DOE information officer escorts them.

6. Establish closer coordination on public information matters with DOE's own contractors, National Labs and field offices working in the Marshalls.

7. Provide a DOE Public Information Officer to accompany news media who will be responsible for dissemination and collection of information. The PI officer will be supported in on-atoll communications by an expert in cross-cultural communications plus other members of the technical staff as needed.

8. Upon completion of the aerial survey project:

   a. Hold a press briefing in Honolulu and/or Washington to explain preliminary findings and followon activities.

b. Brief the House Subcommittee on Appropriations, Department of the Interior and Chairman S. Yates.

Department of the Navy

The Navy Logistics Support Task Commander will coordinate all Navy-related on scene public affairs activities with the DOE public information representative.

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Department of Energy Information

Office of Public Affairs
Washington, D.C. 20461

FOR IMMEDIATE RELEASE
AUGUST 1, 1978

AERIAL RADIATION SURVEY OF MARSHALL ISLANDS SCHEDULED TO BEGIN THIS FALL

An aerial radiation survey of 11 atolls and two islands in the northern Marshall Islands will be conducted between mid-September and mid-December by the Department of Energy (DOE).

The Department of the Interior is funding the survey, and the Department of Defense is providing air and sea support.

Atolls to be surveyed are Ailinginae, Ailuk, Bikar, Bikini, Likiep, Rongelap, Rongerik, Taka, Ujelang, Utirik, and Wotho. The separate islands (not part of an atoll) are Jemo and Mejit.

The survey project will help determine what hazards may remain from nuclear testing performed in the Marshalls during the 1940s and 1950s. Also, it will help identify islands where some radiological problems may still exist.

As the first phase of the survey, a preliminary aerial photography mission got underway last week. The photographs, taken from a specially-equipped Navy aircraft, will provide accurate maps of the Marshalls for project scientists.

The Marshalls are part of the United States Trust Territories of the Pacific Islands under a United Nations Trusteeship agreement. The Department of the Interior administers the trusteeship agreement. DOE is providing the technical staff and equipment to conduct the radiation survey.

The most advanced systems for detecting radioactivity will be used for the survey. The equipment and techniques, including helicopter-mounted radiation measuring

equipment, were used in the radiological survey of Enewetak in connection with the cleanup and planned resettlement of that atoll, also a part of the Marshall Islands. The airborne gamma-ray detectors are similar to those used in locating radioactive debris from the Soviet satellite that fell over northern Canada last January.

The complex scientific survey will be operated from the Navy ship USNS Wheeling. This will permit DOE scientists to cover a wide geographical area, fly at low altitudes, and document the radioactivity on the islands with precision.

In addition to radiation measurements, project scientists will obtain soil, plant, fish and animal samples from each of the atolls and two islands for laboratory analysis. The resulting report will provide an assessment of the potential radioactive exposure to island residents. However, several of the islands to be surveyed are not inhabited, and some of them are used only for gathering food.

DOE and the Interior Department expect to announce preliminary findings of the aerial survey in January 1979, after field operations are completed.

- DOE -

NOTE TO EDITORS: DOE is looking into the possibility of accommodating reporters who wish to accompany the scientific team for part of the aerial survey. Interested members of the news media should contact Len Arzt, 202/376-4192.

This news release is also being issued by the Department of the Interior and the Department of the Navy.

News Media Contact: Len Arzt, 202/376-4192

R-78-295

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TAB 7

PART VII

COSTS

[redacted]

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PART VII

COSTS

	Technical Costs - $ X 1000		
	FY 1978	FY 1979	FY 1980
Field Operations	570	900	0
Aerial (EG&G)	350	425	0
Ground (LLL)	150	350	0
Contingency & Misc. (NV)	70	125	
Analysis & Assessment	0	3000	550
Sample Processing	0	2800	-
Dose Assessment	0	200	550
Totals	570	3900	550

[redacted]

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TAB 8

APPENDIX 1

FALLOUT FROM PACIFIC TESTS

FALLOUT PATTERN-BRAVO EVENT 1954

[redacted]5008992

FALLOUT FROM PACIFIC TESTS

ATOLLS IN FALLOUT AREA	EVENTS	LOCATION	DATE
AILINGINAE	SANDSTONE-ZEBRA	ENEWETAK	5/48
	CASTLE-BRAVO	BIKINI	2/54
	CASTLE-UNION	BIKINI	4/54
	CASTLE-YANKEE	BIKINI	5/54
	HARDTACK-MAPLE	BIKINI	6/58
AILUK	CASTLE-BRAVO	BIKINI	2/54
BIKAR	CASTLE-BRAVO	BIKINI	2/54
	CASTLE-YANKEE	BIKINI	5/54
BIKINI	ALL BIKINI EVENTS	-	-
LIKIEP	CASTLE-BRAVO	BIKINI	2/54
RONGELAP	SANDSTONE-ZEBRA	ENEWETAK	5/48
	CASTLE-BRAVO	BIKINI	2/54
	CASTLE-UNION	BIKINI	4/54
	CASTLE-YANKEE	BIKINI	5/54
RONGERIK	SANDSTONE-ZEBRA	ENEWETAK	5/48
	CASTLE-BRAVO	BIKINI	2/54
	CASTLE-UNION	BIKINI	4/54
	CASTLE-YANKEE	BIKINI	5/54
TAKA	CASTLE-BRAVO	BIKINI	2/54
UJELANG	IVY-KING	ENEWETAK	11/52
	HARDTACK-MAGNOLIA	ENEWETAK	5/58
UTIRIK	CASTLE-BRAVO	BIKINI	2/54
WOTHO	CASTLE-BRAVO	BIKINI	2/54
	HARDTACK-MAPLE	BIKINI	6/58
JEMO ISLAND*	CASTLE-BRAVO	BIKINI	2/54
MEJIT ISLAND*	CASTLE-BRAVO	BIKINI	2/54

*The term "Island" is used in this case to denote an isolated island that is not part of an atoll and does not have a lagoon.

[redacted]

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FALLOUT PATTERN

BRAVO EVENT
MARCH 1954